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Standards of Power? Technology, Institutions, and Politics in the Development of China's National Standards Strategy*

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ACRONYM KEY

AQSIQ: Chinese General Administration of Quality Supervision Inspection and Quarantine

AVS: Digital Audio-Video Coding and Decoding

CATT: China Academy of Telecommunication Technology

CCSA: China Communications Standards Association

CESA: China Electronics Standardization Association

CESI: China Electronic Standardization Institute

CNIS: China National Institute of Standardization

COSTIND: Commission of Science, Technology, and Industry for National Defense

DAVWorld: Beijing E-World Technology

DHWG: Digital Home Working Group

DLNA: Digital Living Network Alliance

EPC: Electronic Product Code

EVD: Enhanced Versatile Disc

GRI: Government Research Institute

ICT: Information and Communications Technologies

IGRS: Intelligent Group and Resource Sharing (IGRS) Working Group (or Shanlian)

ISO/IEC: International Organization for Standardization and the International Electrochemical Commission

ITU: International Telecommunications Union

JVT: Joint Video Team of the ITU

KHD: Beijing Kaicen High Definition Technology, a member of the EVD consortium and one of the stock-holders of E-World

MII: Ministry of Information Industry

MLP: Medium and Long-term Plan

MOST: Ministry of Science and Technology

NDRC: National Development and Reform Commission

NIS: National System of Innovation

NME: New Media Enterprise

RFID: Product Tracking and Remote Identification (Radio Frequency Identification)

SAC: Standardization Administration of China

SARFT: State Administration of Radio, Film, and Television

SCDMA-WLL: Synchronous Code Division Multiple Access-Wireless Local Loop

SETC: State Economic and Trade Commission

TBT: Technical Barriers to Trade

TD-SCDMA: Time Division-Synchronous Code Division Multiple Access (Third-Generation Mobile Telephone)

WAPI: WLAN Authentication and Privacy Infrastructure

EXECUTIVE SUMMARY

This report examines both China's growing interest in high-technology standards and its efforts to craft a national standards strategy, and identifies important implications for international cooperation with China on standards.

Main Argument:

China's interest in promoting its own high-technology standards must be seen in the context of an ambitious policy for technological development that is intended to make China a world leader in science and technology—and standard-setting—by 2020. An examination of six of the more prominent cases of standards development, however, indicates that the motivations for standards development, the actors involved, the nature of international participation, and the various roles played by the Chinese state are by no means homogenous. Despite the techno-nationalist overtones of the current technology policy, Chinese firms and government agencies are pursuing multiple paths to standardization in ways that reflect the growing influences of techno-globalism.

Policy Implications:

- Given its size, global economic importance, and growing technological sophistication, China understandably wishes to play an increasingly important role in setting global standards. The issues for the international community do not concern whether China has a standards strategy or whether activism in standardization will continue; rather, questions concerning the content of the strategy and the forms the activism will take are now the most pressing issues.
- The broad objectives for international cooperation with China on standards should be to reinforce the internationalist and techno-globalist orientations in the Chinese system, including market-oriented approaches to standards. This collaboration will require detailed knowledge of the technological trends in China affecting standards development, the economic prospects for standards initiatives, and, in particular, knowledge of key players and their interests in these initiatives.
- Though China needs to check the influence of narrow techno-nationalist sentiments on expanding Chinese standards initiatives, the international community in turn must not only show a sensitivity to Chinese concerns over the distributive consequences and procedural fairness of global standards practices but also be willing to accommodate the views of this new member of the standards community.
- Policies toward China that fail to recognize the highly variegated landscape of Chinese technological capabilities, China's economic and political interests in standards, and the strengths and weaknesses of China's policymaking system are bound to be counterproductive. Such policies will likely both strengthen the hands of China's techno-nationalists and lead to a number of missed opportunities to work with China on the promotion of technical standards that serve the interest of common technological progress and economic growth.

In recent years, China's efforts to develop its own technical standards have attracted considerable international attention both from foreign companies operating in China and from foreign governments. China is attempting to develop a national standards strategy that will modernize the Chinese domestic standards regime and bring it into conformity with China's WTO obligations. At the same time China is seeking to utilize its growing technological capabilities and market power to develop technical standards that will enhance the competitiveness of Chinese firms.

Given the growing importance of standards in the international economy as well as China's rapid emergence as a major player in the world's economic activities, Chinese standards initiatives have acquired considerable policy importance. As China seeks to increase the relative gains that the nation receives from participation in the international economy, Beijing has attempted to craft an ambitious national technology policy that features expanded commitments to domestic research and development as well as the use of measures to capture value from successful R&D through the building of a Chinese intellectual property portfolio and the incorporation of Chinese IP into Chinese-developed standards. Foreign corporations and governments have been concerned that these policy initiatives are being developed and implemented as barriers to trade and investment, ultimately leading to Chinese standards that are incompatible both with international standards and with the principles of interoperability upon which the global economy depends. Thus the stakes in China's standards strategy are high both for China and China's foreign partners. As a result, gaining a better shared understanding of the nature of China's strategy, the strategy's domestic and international implications, and the prospects for success are of the utmost importance.

With this goal in mind, in January 2006 the National Bureau of Asian Research sponsored a bilateral workshop at Beijing's Tsinghua University that featured papers both from Chinese and American researchers as well as critical comments from representatives of Chinese, American, and European companies and governments (see **Appendix I**). The workshop, which was attended by some 60 participants, generated useful data concerning China's standards system and standards initiatives as well as a range of views that have provided essential background for this study.

This report explores the relationship between China's evolving technology policies and the role of standards in these policies. After first reviewing this broader context, the study then examines in detail six standards initiatives that have gained prominence during the past five years. Through a comparative analysis of these cases, the essay attempts to shed light on the motivations and interests of the parties involved, the ways in which Chinese initiatives relate to

international standardization efforts, the decisionmaking processes involved, the role of government, and the patterns of government-industry relations as seen in each case. A main finding is that, although Beijing supports the formulation of policies intended to promote the development of Chinese standards and a shared interest among all parties in China in altering China's relative gains from participation in the global economy through its standards strategy, there is nevertheless a considerable variation from case to case with regard to objectives, interests, technological sophistication, and patterns of implementation. Policy stances, for instance, range from the more techno-nationalist to relatively open techno-globalist orientations.

This report suggests that engagement with China on standards is highly desirable, though not without difficulties. Effective foreign government policies and MNC corporate strategies must not only be based upon an informed sensitivity to the diverse interests and capabilities as reflected in the different standards initiatives, but also seek to reinforce the internationalist (or techno-globalist) orientations in the Chinese system.

Background

As new, wealth-creating technologies become incorporated into innovative business strategies, technical standards have become increasingly important for the international economy. These technologies, especially in the area of information and communications technologies (ICT), enable the development of global production networks characterized by outsourcing, the de-verticalization of corporate structure, and new forms of "technological fusion" in which disparate technologies are brought together to achieve new products that exhibit novel performance characteristics and functionality. The nature of this global techno-economic system places a premium on interoperability and creates a new level of demand for acceptable standards, which are thought to have an important effect on as much as 80% of international trade.[1] Technological change within this global system is rapid and necessarily involves technological obsolescence. The combination of the increasing importance of standards for interoperability, and rapid technological change, has created challenges for established standard-setting mechanisms. This combination both creates a bias in standard-setting toward mechanisms that can respond quickly to new demands and makes the institutionalization of standards processes considerably less predictable.

[1] Hratch G. Samerjian, testimony presented to the House of Representatives, Committee on Science, Subcommittee on Environment Technology and Standards, May 11, 2005, as cited in Magnus Breidne and Anders Hektor, "Standards Battle for Competition—ICT Strategies in China and Japan," unpublished paper, Swedish Institute for Growth Policy Studies, April 2006.

At the same time, the rise of a 21st century "knowledge-based economy" highlights the economic value of knowledge and enhances the importance of proprietary claims to knowledge. Intellectual property rights (IPR), IPR protection, and IPR legitimacy have thus become major issues in the formulation of institutional arrangements for the operation of the global economy generally and for standard-setting more specifically. Concerns that IPR will be used as a strategic asset in standards development has broadened the competitive environment from one of competition among products using common standards to competition both among products and among IPR-shaped standards preferences.[2]

In the face of an increasingly integrated global knowledge economy that is driven by market forces, the world of globalization is ironically also a world characterized by national trade and industrial policies that are intended to drive national production assets to high levels of added value. Although much is still unknown concerning the relationships between national standards development and economic growth, recent research suggests a strong connection. For individual companies, active participation in standard-setting activities is seen as lowering both the risks of research and the costs of development as well as increasing competitiveness in the time-to-market delivery of new products.

Thus, unsurprisingly, countries and companies around the world are paying increasing attention to standards as a tool for competitive success, and national standard strategies are emerging in various levels of development in different countries. Of particular note, and of relevance to the discussion of China below, are efforts to systematically relate R&D policies to standard-setting.[3] Many countries have been tempted to use standards as a tool to protect domestic economies and as a means to favor domestic producers in ways that capture national advantage from participation in the global economy. Especially noteworthy were Japan's previous efforts to promote "discriminatory" standards both as a way to protect distressed industries and as a way to foster those industries deemed by industrial policy bureaucrats to be strategic. These efforts helped prompt revisions to the GATT and the inclusion of the Technical Barriers to Trade provisions in the WTO regime.[4]

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[2] Gao Wen (prepared remarks for China's High-Technology Standards workshop, sponsored by the National Bureau of Asian Research and Tsinghua University, Beijing, China, January 6, 2006).

[3] The European Telecommunication Standards Institute, for instance, is closely tied to the EU's major R&D programs and works to facilitate the incorporation of new research results into standards.

[4] John R. McIntre, *Japan's Technical Standards: Implications for Global Trade and Competitiveness* (Westport, CT: Quorum Books, 1997), 146.

The development of a national standards strategy in China, therefore, is not without precedent. Nonetheless, the rapid growth of the Chinese economy, the size of China's domestic market, the growing sophistication of China's technical community, and indications that China intends to be a major player in the international world of technical standards have all combined to generate considerable interest in the international community regarding China's strategies for standards development.[5] This interest was fueled largely by one of China's first efforts at the strategic use of standards—Beijing's promotion of a new encryption standard for wireless devices.

A New Standards War?

In November 2003 Beijing announced that China's indigenously developed encryption standard for wireless communication was being adopted as a "national standard" to which, in the future, all wireless devices sold in China would need to adhere. This WLAN Authentication and Privacy Infrastructure (WAPI) standard was reportedly developed to overcome known security problems with the existing, widely used 802.11x "wi-fi" standard developed by the IEEE.[6] Beijing announced that the technology supporting the standard was to be protected and made available only to a limited number of Chinese companies. Gaining access to the technology, which is necessary for meeting the standard, not only would require that foreign firms partner with Chinese firms but would also increase the chances that valuable intellectual property would diffuse to the Chinese partners. This early Chinese initiative to promote national standards therefore created deep concern—which rapidly escalated into alarm—among foreign companies and foreign governments that China seemed to be using standards as a form of protectionism in violation of the terms of the Technical Barriers to Trade (TBT) provisions of the WTO. The dispute over WAPI has led to mistrust and ill will between segments of the Chinese and foreign information technology communities—feelings that have yet to dissipate. This is a classic example of how the strategic use of standards can be highly divisive.

Thus began the saga of WAPI, a saga that has again highlighted the great importance of technical standards in today's global economy. The WAPI

[5] For a recent discussion from an Asian perspective, see Indrajit Basu, "China and the Art of (Standards) War," Asia Times, April 13, 2006, http://www.atimes.com/atimes/China_Business/HD13Cb05.html.

[6] This discussion of WAPI is drawn from Ping Gao, "Elements Influencing Standardization In Developing Countries: A Case of Wireless Security Standard Disputes," *SIIT2005 Proceedings*, September 2005. 115–24; and Scott Kennedy, "The Political Economy of Standards Coalitions: Explaining China's Involvement in High-Tech Standards Wars," *Asia Policy*, no. 2 (July 2006), forthcoming.

story also illustrates how what had once seemed like an obscure technical issue can become a high-level diplomatic issue relevant to China's rise as a great trading nation. As the saga unfolded, the high-technology community in the United States, aided by the Department of Commerce and the U.S. Trade Representative, made extraordinary efforts to reverse Chinese policy both through representations with the Chinese government and by enlisting Cabinet-level political support to pressure Beijing to reconsider the Chinese position. The United States side seemed to have succeeded in this endeavor when, in April 2004 at the meeting of U.S.-China Joint Commission on Commerce and Trade, State Counselor Wu Yi announced that China would suspend the requirement that the WAPI standard be met.[7]

Those who follow the WAPI saga, however, know that the story did not end with the Wu Yi announcement. Instead, the forces supporting WAPI within China revised their approach and sought to advance the cause of WAPI through more established international standard-setting procedures. Advocates of this new tact have been frustrated and disappointed. A revised version of WAPI was to be discussed in December 2004 at a meeting of the Joint Technical Committee, Subcommittee 6, of the International Organization for Standardization and the International Electrochemical Commission (ISO/IEC JTC1 S6) in Orlando, Florida; some of the key technical personnel from the Chinese delegation were, however, unable to get visas in time for the meeting. A follow-on session of ISO/IEC JTC1 S6 in February 2005 in Frankfurt, Germany ended with the Chinese delegation marching out of the meeting in anger, allegedly because American companies had taken control of the agenda to promote the revised IEEE 802.11i against Chinese interests.

ISO/IEC JTC1 S6 began to formally consider WAPI by in October 2005 when the standard, along with 802.11i, was placed on a ballot for approval by ISO/IEC members. During the balloting period, which ended in March 2006, voting members of ISO/IEC JTC1 S6 were allowed to choose between approving both standards, neither standard, WAPI only, or 802.11i only. The six-month voting period was characterized by aggressive lobbying from both sides and

[7] Wu Yi announced that the suspension would be indefinite, that the standard would be revised in response to comments from Chinese and foreign firms, and that China would attempt to advance the standard through participation in international standards bodies. See Gao, "Wireless Security Standard Disputes," 119.

by acrimonious charges leveled against the United States by the Chinese.[8] In the end, the wi-fi standard was selected by a convincing margin, thus marking WAPI's defeat as an international standard. Whether this setback marks the end of the WAPI saga remains to be seen. In December 2005 Beijing announced that WAPI-compliant devices would be given preferential consideration in government procurement and subsequently announced the formation of a new WAPI industrial alliance of Chinese companies to promote the standard.[9] As this report goes to press, WAPI's defenders in China have launched new criticisms of the process leading to the approval of 802.11i and the defeat of the Chinese standard.

The story of WAPI has brought heightened attention to China's approach to standardization. Foreign observers are now wondering whether WAPI is a harbinger of a new techno-nationalist standards strategy that is likely to lead to ongoing conflicts with the international community over standard-setting.[10] WAPI, however, is not the only high-profile standards initiative to come out of China within the past five years. Other initiatives include standards for third-generation mobile telephony (TD-SCDMA), product tracking and remote identification (RFID), digital audio-video coding and decoding (AVS), the formats of audio-video disc players (EVD), and digital home networking and next-generation Internet protocols. A review of these cases indicates that technical standard-setting for high-technology industry in China is a more complex, variegated affair than the WAPI case alone would suggest. At the same time, some consistent themes in these cases stem from a rapidly evolving and ambitious set of policies for technological development. Because China's standards strategy cannot be adequately understood outside of the larger technology policy context, the next section will review recent developments in this context.

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[8] The IEEE issued a "WAPI Position Paper" in November 2005 that laid out in considerable detail an assessment of the pros and cons of the two standards. In response to this and other IEEE initiatives, the Chinese side issued an "Urgent Alert on IEEE's Recent Unethical Activities." A sub-theme amid all this acrimony was the status enjoyed by the two sides. China is represented at ISO/IEC by its "national body" the Standards Administration China (SAC), which entitles it to permanent membership ("P member") on JTC1, whereas IEEE is only a "C" liaison organization, not having "national body" status (the United States is represented at ISO and IEC by ANSI as its national body).

[9] See Joe McDonald, "China Touts Wireless Encryption Standard," *BusinessWeek*, March 8, 2006.

[10] Richard P. Suttmeier and Xiangkui Yao, "China's Post-WTO Technology Policy: Standards, Software, and the Changing Nature of Techno-Nationalism," *NBR Special Report*, no. 7 (May 2004).

"The Strategy for Technological Innovation Determines the Future of China"

The rapid growth of the Chinese economy and China's emergence as a great trading power have captured worldwide attention over the past decade. Not only has the rate of Chinese economic expansion been noted but so also has certain qualitative features of this economic growth experience. Of particular interest to the international community has been China's apparent ability to move rapidly from labor-intensive, low-technology industrial activities to a competitive position in high-technology manufacturing and exports. There has, however, been considerable debate regarding both this transition and the implications for China's competitive position in international trade in high-technology, high value-added goods and, by extension, for China's technological capabilities and potential for technological innovation.[11]

This debate is driven in large part by what has been, on balance, a rather disappointing Chinese record of technological innovation as well as by the fact that much of China's success as an exporter of high-technology goods comes as a result of foreign investment and the extensive transfer of foreign technology. Thus while trade data points to remarkable growth in high-technology exports from China, the products being exported are either being produced in foreign-invested firms or in Chinese firms employing foreign technology.[12]

On the other hand, any explanation of why China has been able both to move so rapidly into high-technology trade and to become such an attractive investment destination for high-technology companies requires a consideration of China's indigenous technological assets. These assets would include, for instance, increasingly capable universities that turn out large numbers of well-trained scientists and engineers. Also included would be an extensive system of institutions that, since the 1950s, have supported research and innovation and that, over the past two decades, have been subject to far-reaching reform and rationalization. These reform policies have been matched by rapid increases in material support for research and innovation—together constituting a policy environment that recognizes technological capabilities as essential for shaping the type of society China wishes to develop in the coming decades. Indigenous

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[11] The discussion below is adapted from Richard P. Suttmeier, "China's 'Technology Trap' and the Reconstruction of the Chinese National Innovation System," testimony presented at the hearing on China's High Technology Development, U.S.-China Economic and Security Review Commission, Stanford, CA, April 21–22, 2005.

[12] One recent report suggested that "…foreign-owned companies in China accounted for close to 85% of China's high tech exports in 2003." See Sylvia Scwaag Serger, "China: From Shop Floor to Knowledge Factory?" in *Internationalization of Corporate R&D. Leveraging the Changing Geography of Innovation*, ed. Magnus Karlsson (Stockholm: Institutet for Tillvaxtpolitiska Studier, 2006), 236.

technological assets and a supportive policy environment thus complement foreign investment and technology and management transfers, helping make China an attractive platform for manufacturing and innovation.[13]

The elements of this interpretive debate thus point to an underlying ambiguity concerning the sustainability of China's growth experience as well as the technological capabilities that underlie such growth. China is able to infuse its economy with a range of human and institutional resources for technological development that are more reminiscent of highly industrialized societies. At the same time, China's disappointing record of indigenous technological innovation and high reliance on foreign technologies are more reminiscent of a developing country. This contradiction is well understood in China. A sense of this underlying ambiguity can be gleaned from an especially open discussion that appeared in the official *People's Daily* newspaper in January 2005.[14] Entitled "Giving Full Play to Scientific, Technical Progress," the article calls attention to the problems of indigenous innovation in Chinese industry and agriculture. Reiterating themes that have appeared both in Chinese policy discussions ever since China's accession to the WTO as well as in recent foreign studies of Chinese industry, the commentary bemoans the fact that domestic technological innovation has been disappointing and has tended to make Chinese industry subordinate to global technology leaders. The following excerpt from the commentary clearly states the problem:

> "We should…understand that the overall size of Chinese industry, and the overall scale of China's economy are big, but China's industries' technological level and their abilities in self dependent innovation are still low…Chinese companies lack core technology, depend on foreign companies for crucial parts, are at the lower end or the middle range of the global industrial chain, rely on multinational companies for technological support and rely on the global sales chain…"

To remedy this situation, the commentary calls for a strengthening of the nation's research and development and the need to "…support enterprises in developing self-owned crucial technology, in creating famous brands, and in improving their abilities in research and development."

Having in recent years become very interested in the problems of technological innovation and in the concept of a national system of innovation

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[13] In this, China resembles India, which had also accumulated technical assets that have become "released" through reform and foreign investment. For a discussion of the broader significance of this phenomenon, see Richard P. Suttmeier, "Science and Technology: A New World in the Making?" in *Strategic Asia 2004–05: Confronting Terrorism in the Pursuit of Power*, ed. Ashley J. Tellis and Michael Wills (Seattle: National Bureau of Asian Research, 2004), 457–91.

[14] "Giving Full Play to Scientific, Technical Progress," *People's Daily*, January 30, 2005.

(NIS), China has undertaken extensive reforms in its R&D system in order to create what Beijing believes to be a modern NIS—a defining characteristic of which is the central role to be played (as had been the case under the central planning system of the past) by industrial enterprises rather than government research institutes (GRI). The development of an industrial innovation tradition (in particular an effective industrial R&D) in an economy lacking such a tradition has become a major policy challenge. This challenge has been addressed by extensive reforms in the GRIs and the building of R&D capabilities within Chinese companies, including the marrying of GRI and enterprise. The central message of the commentary is that the building of an effective national system of innovation—essential for launching China on the path to intensive growth and allowing for China to control the technological terms of its participation in the global economy—is a task of cardinal importance at the present time. According to the commentary, the key to an effective NIS is to give industry the lead role. The urgency of this task is captured at the end of this third part in the assertion that "the strategy for technological innovation determines the future of China."

The discussion notes that China's technical community is, by international standards, already quite large and is growing both in quality and in quantity. Citing the growth in output from this technical community as measured in publications in international journals, the article also recognizes that the originality of this output has been disappointing. Even though the number of Chinese publications is growing, citations to these publications have not kept pace: "…the number of significant original achievements is still small and China's international scientific and technological competitiveness is still mired at the lower-middle level."[15] On a funding per researcher basis, the Chinese contingent of professional manpower is by international standards still supported at low levels. In the face of exciting new research challenges that cross disciplinary and organizational boundaries, members of the technical community have much to learn regarding the importance of interdisciplinary cooperation.

The discussion then takes up an especially sensitive issue, one that has constituted a central part of technology policy debates ever since the initiation of the open-door policy of the late 1970s: the role of foreign technology in China and the consequences of technology transfers from abroad for the development of the domestic NIS. Over the past twenty years China has imported vast amounts of foreign technology, which has contributed in no small way to the

[15] While this Chinese assessment is consistent with that of foreign observers, recent work by Ping Zhou and Loet Leydesdorff examining Chinese publication trends points to a notable growth in citations to Chinese-authored papers. See Ping Zhou and Loet Leydesdorff, "The Emergence of China As a Leading Nation in Science," *Research Policy*, forthcoming, http://www.leydesdorff.net/ChinaScience.

quality and rapidly increasing technological sophistication of Chinese exports. This technology transfer experience, however, has negatively affected the NIS in two ways. First, unlike Japan (and later Korea), China has devoted considerably less energy toward assimilating foreign technology, with the result that the technological dependency bemoaned earlier in the commentary has, if anything, become worse. Second, foreign technology has enjoyed a privileged position in Chinese industry relative to domestically developed technology; this position has derived from the often superior performance characteristics of the foreign technology, the failures of the domestic technology diffusion system, and psychological and cultural orientations reflecting the belief in the superiority of foreign technology. Whereas Chinese manufacturers have approached the use of foreign technology pragmatically in order to improve business performance, the commentary laments the absence of a strong indigenous tradition of using technology imports for technological learning. According to the commentary, "we should not pay attention only to increasing manufacturing capacity and neglect technological innovation…the target for (technological) imports is innovation and the creation of new self-owned technology."

Standards and China's Technology Trap

The source of China's anxieties and frustrations regarding innovation and technological achievement can be located within China's so-called "technology trap." Despite progress on a number of dimensions of scientific and technological development (including a manned space program), China is struggling to escape from a series of enduring conditions that have long frustrated indigenous technological progress. There are a number of indicators of the problem. China's patenting activity is disappointing and Chinese products rarely incorporate indigenous intellectual property. Instead, China's remarkable growth as a center of manufacturing and emergence as a significant exporter of high-technology goods have involved a dependence on foreign technologies that has seemingly deepened as a result of China's accession to the WTO.

A number of factors contribute to this condition. For one, Chinese enterprises have long tended to regard technology that originates from the domestic research system as immature and have preferred foreign technology when available. In a number of industries, therefore, Chinese firms have wound up paying substantial license fees for this know-how, payments that

cut into already rather slim profit margins.[16] At the same time, this bias toward foreign technology does nothing to stimulate the domestic research system. These interacting factors—weak enterprise R&D capabilities, relatively strong government research institutes with weak connections to industry, a high degree of dependence on foreign technology, and the unattractive terms required to pay for that technology—set the conditions for China's technology trap. Unfortunately, market-oriented enterprise responses to this trap are often characterized by the widespread pirating of intellectual property, a response that weakens China's efforts to build a strong IPR regime. As a result, the efforts of China's indigenous innovators to lift China out of the technology trap are compromised by a lack of intellectual property protection that further perpetuates the trap.[17] Structural biases in the financial system make the funding of new ventures difficult, and unresolved problems in China's social safety net also work against indigenous innovators and add to the difficulties of escaping the trap.

China's efforts to develop a national standards strategy should be seen in the context of these themes of technology policy. The current interest in standards, for example, is rooted in long-held aspirations for Chinese technology and the belief that through technological development, China can reclaim a position of wealth and power lost to technologically superior countries over the course of the past 150 years. As a great country, China should of course have its own technical standards. Chinese technology policy, as developed over the past six years, seeks to lay the foundation for these standards, enable escape from the technology trap, and build Chinese capabilities for indigenous innovation over the next fifteen years.

Toward this end, China recently completed a major national conference on science and technology, during which time a new Medium and Long-term Plan (MLP) for scientific and technological development was announced. More than two years in the making, the plan covers a variety of research objectives, institutional reform measures, and policy instruments intended to make China an "innovation-oriented society" by the year 2020. One central concept in

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[16] In the manufacturing of DVDs (discussed further below) China now accounts for more than 90% of world production. Chinese producers operate on razor thin profit margins, however, in part because of license fees they must pay for the technology. The Japanese suppliers of know-how and components, in comparison, are able to enjoy considerably larger margins by virtue of their control over the IP and standards. A somewhat different case, contributing to the energy being put into the AVS standard, concerns digital television. Chinese broadcasters wishing to use audiovisual compression technology based upon the MPEG4 standard face licensing fees that could exceed 10 billion RMB per year. Cited in Breidne and Hektor, "ICT Strategies in China and Japan," 2.

[17] Anne Stevenson-Yang and Ken DeWoskin, "China Destroys the IP Paradigm," *Far Eastern Economic Review* 168, no. 3 (March 2005): 9–18.

the plan is the phrase *zizhu chuangxin*, translated variously as "indigenous," "independent," or "homegrown innovation."[18] A central objective of this stress on *zizhu chuangxin* is the development of products incorporating Chinese intellectual property and employing Chinese developed standards. China's standards strategy, therefore, will lie at the core of Beijing's technology policy objectives for the next fifteen years.

WTO and the Evolving Standards Regime

The timing of China's emerging new technology policy is closely related to China's anticipation of WTO membership and subsequent accession. This relation is especially true with regard to the new attention being given to technical standards. With new WTO commitments, China faces the loss of established industrial policy tools while at the same time having to confront—with fewer tools of protectionism—new foreign competition in China's more liberalized markets. In addition, WTO membership carries an obligation both to modernize the national standards system and to attempt to harmonize this system with international practices. Standards have thus moved toward the center of the policy agenda both as a possible WTO-compliant tool of industrial policy[19] and as a challenge to modernize and internationalize the inherited standards system.[20]

This new concern for standards is reflected in the special attention given the topic by the Ministry of Science and Technology (MOST), which has included both generous support for research on standards in its portfolio of high priority R&D projects during the tenth five-year plan period (2000–05) and the commissioning of a major national policy study on standards and the drafting of a national standards strategy under the leadership of the China

[18] This term encompasses genuinely "original innovation" (*yuanshi chuangxin)*, "integrated innovation" (*jicheng chuangxin*, or the fusing of existing technologies in new ways), and "re-innovation" (*yinjin xiaohua xishou zaichuangxin),* which involves the assimilation and improvement of imported technologies.

[19] In a 2004 draft of the standards strategy paper, the authors discuss the need to "…formulate China's own technical standards, build the technical barriers to trade that can achieve the justifiable objectives, reasonably protect the domestic market, ward off the impact of foreign products and technologies, and take a critical position and initiative in international competition while abiding by the international rules." Cited in Breidne and Hektor, "ICT Strategies in China and Japan," 2.

[20] Suttmeier and Yao, "China's Post-WTO Technology Policy."

National Institute of Standardization (CNIS).[21] Though the final version of the strategy paper has not yet been released, the main elements have been presented at various meetings over the past two years.[22] The strategy paper defines the responsibilities of various parties in the national standards system and lays out a series of principles and objectives for the system. The main elements are as follows.

First, the paper seeks to define different types of standards and the responsibilities of different Chinese organizations for each type. Standards are categorized hierarchically both by levels of responsibility and by whether the standards are voluntary or mandatory (the latter applying mainly to matters of health and safety). With regard to the former, national standards—both mandatory and voluntary—are at the top of the hierarchy and are the responsibility of the Standardization Administration of China (SAC). SAC, which has vice ministerial status, is part of the Chinese General Administration of Quality Supervision Inspection and Quarantine (AQSIQ). AQSIQ emerged out of the reorganization of China's standards system in 2001 that followed WTO accession.[23] SAC serves as China's "national body" at most international standards organizations (such as the ISO and IEC)[24] and oversees the administration of the national standards system.

By the end of 2004 China had some 21,342 national standards, of which 3,045 were compulsory. These compulsory standards include regulations for processes and products, accounting, hygiene and safety, and environmental protection. As a member of WTO, China is expected to try to harmonize national standards with international standards. Of these 21,342 national standards, 9,381 were either international standards adopted as national standards or were derived from international standards, including 4,917 ISO standards and 1,902 from the IEC.[25]

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[21] During the tenth five-year period, MOST sponsored a series of "megaprojects" in conjunction with its "863" High-Technology Program. Among the megaprojects was a major initiative on standards titled "Key Technical Standards Project," which included R&D support for WAPI, AVS, 3G telephony, optical networks, IP technologies, and other standards that have gained prominence. Reportedly, some 29 standards have resulted from this work, of which 13 have been submitted to ISO, IEC, or ITU for consideration. See Breidne and Hektor, "ICT Strategies in China and Japan." The project also included the policy study supporting the standards strategy through a project entitled "Study on the Development Strategies for China's Technical Standards." See Chaoyi Zhao, "China's Evolving Standards System: Institutions and Strategy" (paper prepared for the China's High-Technology Standards workshop, sponsored by the National Bureau of Asian Research and Tsinghua University, Beijing, China, January 6, 2006), 14.

[22] The discussion here is drawn from Zhao, "China's Evolving Standards System."

[23] Suttmeier and Yao, "China's Post-WTO Technology Policy."

[24] The Ministry of Information Industry, however, represents China at the ITU.

[25] Zhao, "China's Evolving Standards System," 6–7.

Industry standards (also known as "trade" standards) represent the second tier of the hierarchy. Responsibility for the development, approval, and propagation of standards at this level is entrusted to relevant government bodies under the State Council and approved trade associations. The former includes industrial ministries such as the Ministry of Information Industry (MII), the National Development and Reform Commission (NDRC),[26] and the Commission of Science, Technology, and Industry for National Defense (COSTIND).[27] By 2004 more than 37,850 industry standards had been registered with SAC.

The third tier of the hierarchy is represented by local standards that are the responsibility of local governments. One of the objectives of China's standards strategy has been to overcome excessive diversity in local standards and harmonize these with national standards. As a result, local standards are to be superseded by national and industry standards once they are available and established. By 2004 some 15,800 local standards had been registered with SAC.

Enterprise standards constitute the fourth and bottom rung. Again, under many conditions enterprise standards would be superseded by national and industry standards; in some circumstances, however, the development of enterprise standards would be encouraged, especially when they are considered improvements on national or industry standards.

In addition to the governmental and industry organizations noted above, the operation of the standards system also involves some 264 technical committees and 386 subcommittees involving some 30,000 technical experts. The standards system also includes the work of more than 25 standardization research institutes at the national level and 158 local institutes. In the field of electronics, for instance, the China Electronic Standardization Institute (CESI) supports the industry standards work of MII. In recent years, some 12 national level and 257 local level standardization associations have also emerged, including the China Association for Standardization, as well as industry-focused groups such as the China Electronics Standardization Association (CESA) and China Communications Standards Association (CCSA).[28] Thus the evolving Chinese standards system is usefully understood as being constituted by a series of industry specific subsystems involving parent government agencies, technical

[26] Having responsibilities for standards in seventeen areas of industry, NDRC increasingly works with trade associations (such as the China Machinery Industrial Federation) and enterprises (such as China National Offshore Oil Corporation) in standards development.

[27] COSTIND oversees standards work in five industries, including shipbuilding, nuclear power, aviation, space, and civilian products manufactured by the arms industry.

[28] Zhao, "China's Evolving Standards System," 11–12.

committees, standards research institutes, and standards associations whose members are drawn from industry and academia.

In addition to laying out the structure and organization of the standards system, the standards strategy paper also lays down a set of interesting principles for integrating standardization efforts with technology policy. The strategy paper reflects the concerns regarding China's technology trap as well as the growing importance of standards in the global economy. The paper also recognizes that WTO obligations have eliminated many policy tools for protecting national industries, that the players in the international economy who control standards also enjoy many competitive benefits, and that a number of countries around the world are therefore adopting national standards strategies. The paper tries to establish a workable set of relationships between government and industry under the rubric of a standards strategy that is guided by government, yet takes enterprises as the major player, and is market-oriented. Following the timeline of the MLP, the paper envisions a phased development of Chinese standards that will allow for the new standards system to have been institutionalized by 2010 and Chinese standards work—and the standards themselves—to have caught up to international levels. By 2020 China is expected to become one of the leaders in international standard-setting, with Chinese standards becoming more and more the basis for international standards. China thus hopes to move from the current phase of localizing international standards to the internationalization of national standards.[29]

As in other countries, the standards strategy calls for an increasing effort at coordinating R&D activities with standards development, with particular emphasis placed upon ensuring that the products of the *zizhu chuangxin* programs aimed at indigenous innovation get translated into Chinese standards incorporating Chinese intellectual property. The strategy calls for the commitment of resources so as to ensure that "scientific and technological achievements" lead to "experimental demonstration" and then to "technical standards development" and "application and promotion."[30] To support the "internationalization of national standards," the paper recognizes that special measures will be necessary to enhance China's effective participation in international standard-setting bodies. These measures include the development of expert teams who have the language ability, knowledge of how international standardization bodies operate, and technical expertise to represent China effectively in these forums.

[29] Zhao, "China's Evolving Standards System," 15–16.

[30] Ibid., 17.

China's aspirations for its standards system are clearly ambitious. China seeks to have not only a modern, coherent, and efficient standards regime but also one that is systematically coordinated with a research and development system that could be expected to become a world leader by 2020. Though the aspirations of this strategy are reasonably clear, the more specific measures for implementation are less so.

The standards strategy document has attempted to reconcile what are often contradictory impulses in Chinese thinking regarding standards: attempting to apportion the proper roles for government in terms of standard-setting and for enterprises in terms of responding to market signals, clarifying the distinction between voluntary and mandatory standards, and deciding the proper balance between domestic standard-setting and international standardization. The document has also grappled with competing preferences for formal international standards bodies (in keeping with European and Japanese preferences) as opposed to more informal market-oriented working groups and consortia that have become so important in the fast-moving world of ICT (and which are more in keeping with U.S. approaches). The thinking evident in the standards strategy document reflects the inherent tension visible in other countries—and in international standardization more generally. On one side is cooperative behavior to produce a public good or common benefit that facilitates technological progress and economic activities. On the other is strategic behavior that seeks to enhance self-interest by becoming a standard-setter who uses control over standards, and the intellectual property embedded in them, to seek competitive advantage.

China's standards strategy is still a work in progress, and many adjustments are likely to be made during the actual implementation of the strategy over the coming fifteen years. It is impossible to predict how successful this strategy will be and what consequences the strategy will hold for China's interactions with other members of the international community. Nevertheless, the international community is beginning to accumulate experience with some interesting cases of standards initiatives and, as noted above, the WAPI experience may not be an adequate guide to understanding some of these other relatively prominent standards cases. It will therefore be useful to review what we know about these cases, draw whatever preliminary lessons we can from them, and consider the implications of those lessons for the broader standards strategy.

Current Standards Initiatives

TD-SCDMA

China's efforts at standardization for third-generation (3G) mobile telephony centers on the TD-SCDMA (Time Division-Synchronous Code Division Multiple Access) standard developed by the Datang Corporation with cooperation from Siemens.[31] TD-SCDMA was formally submitted to the International Telecommunications Union (ITU) in 1998 for acceptance as an international 3G standard. ITU approved the standard in May 2000, with the result that TD-SCDMA joined the European-backed WCDMA and the U.S.-backed CDMA 2000 as competing standards for the next generation of wireless phones.

TD-SCDMA is said to offer technical advantages over WCDMA and CDMA 2000 that relate to higher spectrum efficiency, asymmetric downloading and uploading data rates, and the utilization of smart antennas.[32] Apart from technical advantages, however, the story of TD-SCDMA is closely related to the influence of government policy and market size in a wireless telecommunications market that has now become the largest in the world.

TD-SCDMA is based upon the Synchronous Code Division Multiple Access-Wireless Local Loop (SCDMA-WLL)[33] technology developed at the parent of Datang, the China Academy of Telecommunication Technology (CATT), which was under the former Ministry of Posts and Telecommunications.[34] CATT's work on SCDMA, using "smart antenna" technology, began in 1994 and was approved by the Ministry of Posts and Telecommunications in 1997. SCDMA later won a first class of prize for technological progress awarded by MII. CATT first proposed a Chinese 3G

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[31] The discussion below is derived from Alex Zixiang Tan, "Competition and Collaboration among 3-D Wireless Standards in China" (paper prepared for the China's High-Technology Standards workshop, sponsored by the National Bureau of Asian Research and Tsinghua University, Beijing, China, January 6, 2006).

[32] Tan, "Wireless Standards in China."

[33] SCDMA-WLL was developed by Beijing Xinwei, a joint venture established in November of 1995 by the State Planning and Reform Commission, the Ministry of Posts and Telecom, and CWill, a U.S. company created by Chinese students. In 1999 Xinwei reportedly drafted the TD-SCDMA standard. See Haifeng Yang, "Chen Wei and His Story with Wireless Communication," *Tongxin shijie wang*, July 30, 2003, http://www.cww.net.cn/Technique/getmsg.asp?id=24&articleID=3944. This report has detailed information regarding SCDMA-WLL's origin and relations to TD-SCDMA. See also United States Information Technology Office, "Listing Plans to Buoy Chinese Telecom," http://www.usito.org/USITO/uploads/258/weekly_sep10.htm; and United States Information Technology Office, "Recent Developments in SCDMA," http://www.usito.org/USITO/uploads/41/weekly_dec5.html.

[34] For more information about Datang and CATT, see Datang's home page, http://www.catt.ac.cn/intro/fzlc.asp.

standard on the basis of SCDMA when in 1997 ITU solicited a draft proposal for IMT-2000.[35]

The commercial promotion of the standard began in October 2002 with the establishment of the TD-SCDMA Industry Alliance (composed of seventeen domestic firms and eight joint ventures) and the TD-SCDMA Forum in December 2002 (now with a total membership of approximately 420 Chinese and international firms; see **Appendix II**). In October 2002 MII issued a notice on frequency planning for 3G telephony, reserving the 155MHz frequency for TD-SCDMA. Since 2002 there has been a steady growth both in the establishment of partnerships between Chinese and foreign companies and in the gradual introduction of devices designed for the TD-SCDMA architecture. In December 2004 Chinese Prime Minister Wen Jiabao made the first international call using TD-SCDMA technology. Though having selected TD-SCDMA as a national standard in January 2006, MII has yet to issue any licenses for 3G operations. Meanwhile, network trials of the technology are being conducted in five locations by China's three telecom operators: China Telecom, China Netcom, and China Mobile.[36]

The Chinese government has supported the development of TD-SCDMA with R&D support and preferential financing for domestic firms. The most important role for government in this particular case of standards, however, will be the government's licensing decision, a decision that MII has delayed until now. In the view of some observers, the delay has been due to MII's judgment that TD-SCDMA is not yet technologically mature and thus could not be favorably licensed on technical grounds; delay, therefore, would give the Chinese proponents more time to refine the technology. Others, however, have pointed to the complex politics in which the TD-SCDMA licensing decision is embedded. Given the declarative themes of technology policy as discussed at the outset, it would be reasonable to expect strong pressure from parts of the technical community to use the license decisions to advance a Chinese developed standard, perhaps through an exclusive license. Such a decision, however, would certainly not be welcomed by the domestic and foreign firms, which have substantial interests in the other two standards.

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[35] Chunhua Liu, "Historic Overpassing—the Path of TD-SCDMA's Indigenous Innovation," *People's Post and Telecommunication*, December 27, 2005, http://www.cnii.com.cn/20050801/ca330265.htm. See also "Keynote Speakers: Li Shihe," IEE Mobility Conference 2005, http://www.mobility05.org/keynote. Professor Li is Chief Technology Officer of Datang and leader of the TD-SCDMA research team.

[36] See "Chinese Carriers Finalize Locations for TD-SCDMA Testing," *Xinhua*, March 6, 2006, http://www.tdscdma-forum.org/EN/news/see.asp?id=2720. See also "China to End Testing on TD-SCDMA Network in Q3," *SinoCast*, April 24, 2006, http://www.tmcnet.com/usubmit/-china-end-testing-td-scdma-network-q3-/2006/04/24/1600347.htm.

As Tan has clearly shown, foreign firms would not be the only companies to be negatively affected by the failure to license CDMA 2000 and WCDMA. China's equipment manufacturers and service providers also have strong interests in the latter two standards. This is due to the fact that current 2G operations are based on these standards and that the 3G technology builds on 2G. A degree of technical "lock in" thus factors into industry decisionmaking, with China Mobile, for instance, more inclined to favor WCDMA (because of the company's experience with the 2G GSM standard) and China Unicom more oriented toward CDMA 2000 (due to the company's current use of CDMA). In actuality, of course, both international and domestic firms have hedged somewhat and are preparing to work within whatever standards are selected. Nevertheless, the complex politics of the case have suggested to some that all these standards will eventually be licensed.[37] An additional factor influencing the licensing decision is that China will want to have a functioning 3G system in operation in time for the 2008 Olympics, thus making indefinite delay on the license issue increasingly untenable. A decision will likely be forthcoming sometime this year.

As with other standards reviewed in this essay, the TD-SCDMA initiative is strongly influenced by concerns over the importance of using technologies that incorporate Chinese-developed intellectual property as well as the avoidance of burdensome licensing fees. Tan's analysis suggests, however, that meeting these objectives may be more difficult than previously thought. Qualcomm patents still underlie much of the technology behind wireless telephony, and Qualcomm has indicated an intention to pursue fair payment for its IP with TD-SCDMA manufacturers. In addition, as noted above, many of the products that have begun to appear using the TD-SCDMA architecture involve the active participation of multinational companies with Chinese firms, with the former bringing their own IP to these collaborations.[38]

AVS

A working group on standards for Audio Video Coding (AVS) was established in June 2002 upon the initiative of MII's Department of Science and Technology.[39] The group's current members include both Chinese and foreign

[37] Tan, "Wireless Standards in China."

[38] Ibid.

[39] This discussion of AVS draws on Gao Wen, "AVS—An Open and Cost-Efficient Chinese National Standard On Audio Video Coding Tools" (opening address at China's High-Technology Standards workshop, sponsored by the National Bureau of Asian Research and Tsinghua University, Beijing, China, January 6, 2006), and on Jun Su and Min Du, "Market Failure and Government Failure: Research on the Mechanism of AVS Standard-Setting" (paper prepared for the China's High-Technology Standards workshop, sponsored by the National Bureau of Asian Research and Tsinghua University, Beijing, China, January 6, 2006).

companies and research entities (see **Appendix II**). The work of AVS actually includes four separate technical standards (for the integration of the system, audio, video, and digital copyright management).[40] The AVS standard for video compression became a national standard in April 2005.

Work on advanced audio and video coding systems began in 1996 under the leadership of Professor Gao Wen, with support from the Multimedia Subcommittee of the National Committee for Information Technology Standardization and with funding from the 863 National High-Technology Program's "Intelligent Computing" project. Much of this early work was focused on support of the MPEG standard and led to the formation of a MPEG-China group in 1998. With support from 863, China sent a delegation to present four proposals to the 48th MPEG meeting in July 1999.

By 2001 China (with representatives from the Institute of Computer Technology of the Chinese Academy of Sciences, Tsinghua University, and Microsoft Research Asia) began to participate in the work of the Joint Video Team (JVT) of the ITU. A central concern of the Chinese specialists in these activities was control over intellectual property and the excessive license fees that seemed to attend to the next generation of audio video standards. In May 2002 a group comprised of 24 international companies and 7 Chinese firms began to explore the possibilities of developing a royalty-free standard. The establishment of the AVS Working Group followed shortly thereafter with the expectation that close cooperation with MPEG-China would be maintained. At the June 2003 meeting of JVT, Gao Wen's group at the CAS Institute of Computer Science was given the lead for the development of video coding software.

The development of AVS has received high-level review and approval from the Ministry of Science and Technology's Department of High and New Technology, CAS's Bureau of High-Technology Research and Development, the Chinese Academy of Engineering's Division of Information and Electronic Engineering, and MII's Department of Science and Technology. Progress has continued on the various standards that comprise the AVS package and, as noted above, the video standard has now been approved as a national standard.

Many observers of Chinese standardization activities call attention to the work of AVS as a particularly positive example of a technically advanced and procedurally fair standards body, one that is open and internationalized in its proceedings and has devised a progressive set of policies for managing IPR issues through its patent pool system. Nevertheless, in 2003 the AVS program received a significant setback when the State Administration of Radio, Film, and Television (SARFT) rejected the AVS system in favor of MPEG-4.

[40] For more information about AVS, visit the AVS home page, http://www.avs.org.cn/en/.

EVD

EVD is a standard for high-definition optical disc players created by the Beijing E-World Technology Company that is targeted for use in the greater China region. MII has approved EVD as a recommended national standard for high-definition discs. As with other standards initiative, EVD has an interesting and complicated history.[41]

In May 1999 the major players in China doing research on digital optical discs made a proposal to the State Economic and Trade Commission (SETC) for National Key Technological Innovation Project support for R&D on a "Special Project on a New-generation High Definition Digital Laser Video Disc System." The Science and Technology Office of the Ministry of Information Industry took the lead in organizing the project, and in October the SETC approved the formation of the China Digital Optical Disk Technology Consortium (made up of several enterprises and research institutes) and allocated 10 million *yuan* for the project.

With permission from the MII Department of Science and Technology, Beijing E-World Technology (also known as "DAVWorld" in some reports) was established as a spin-off from the Consortium in March 2000, with all members of the consortium becoming stockholders of E-World. In April 2000, following the establishment of Beijing E-World, China's National Audio Video and Multimedia Systems and Devices Standardization Committee (under the State Bureau of Quality and Technical Supervision and MII) approved the formation of a "New-Generation Digital Optical Disk Standardization Working Group" to be led by Beijing E-World (for membership details, see **Appendix II**). The working group was charged with developing the specifications for a next-generation laser video disc system, and in September 2000 the first draft of the specifications had been finished.

By July 2001 E-World Technology had finished the design for its EVD Digital Video Disc System and two manufacturers from Guangdong had successfully manufactured one hundred EVD discs using E-World's technology. That same month the working group met and approved EVD as a draft standard. In December, on behalf of the Consortium, E-World signed an agreement for cooperation on next-generation HD discs with a group composed of research institutes and DVD manufacturers from Taiwan. At the end of December,

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[41] See "Jiu tuo reng bu jue: guojia gaoqing dieji biaozhun daodi shi zenme le?" [Long Time But No Decision—What Happened to National High Definition Optical Disc Standards?] Sina Sci&Tech News, February 2, 2005, http://www.ynkaiyuan.gov.cn/news/show.asp?url=TechNews/it/2005-02-02/1342521840.shtml; "EVD jishi" [EVD Milestones], http://www.davworld.net/productsystem/EVD/js.htm; and "EVD xiangmu jianjie" [Brief Introduction of EVD Project], EVD.org.cn, http://www.evd.org.cn/evd/ReadNews.asp?NewsID=310.

the EVD system received a positive evaluation at a "new technology product appraisal meeting" organized by the Ministry of Information Industry.

In March 2003 E-World signed an agreement with the United States' LSI Logic to establish a joint research lab in Beijing for EVD chip development and design. On July 8, 2004 the EVD standard was published on the home page of Chinese Electronics Standardization Association in an effort to promote the standard's adoption. After a month of promotion, the standard still had not generated much enthusiasm, in part because MII had concluded that EVD should be subject to further evaluation in comparison with the competing HDV[42] and HVD[43] standards. Working with the EVD, HVD, and HDV consortiums, both MII's Offices of Science and Technology and New Products and MII's Testing and Evaluation Center agreed in mid-July 2004 to entrust the testing and evaluation of the three standards to the National Testing and Inspection Center for Radio and TV Products. Following this evaluation, in February 2005 MII announced its approval of EVD as a national standard for the next-generation high-definition optical disk technology.[44]

The approval of EVD as a national standard, however, does not secure EVD's place in the electronics industry. EVD is classified as a voluntary standard and continues to face stiff competition in the marketplace. On April 23, 2005 the Shanghai-based HVD Consortium announced that HVD would become the standard for the Shanghai Information Electronics Association and would be supported by the relevant agencies of the Shanghai government and the TV and Electro-Acoustic Institute of the Beijing-based No. 3 Research Institute of the China Electronics Group Corporation, which drafted the HVD specifications.[45]

EVD, of course, also faces daunting competition from the international heavyweights—Sony's Blu-ray consortium (which includes Panasonic, Samsung, Dell, HP, and Philips, among others) and Toshiba's HD-DVD alliance

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[42] HVD (High-definition Versatile Disc) is mainly supported by AMLOGIC (Shanghai), Inc. and Skyworth, Changhong, TCL, and Konka. See AMLOGIC, press release, "HVD Alliance is Founded in Shanghai, China," April 28, 2004, http://www.amlogic.com/News/News_042804.pdf.

[43] HDV (High Definition Video) is mainly promoted by KHD (Beijing Kaicheng High-Clarity Electronics Technology Co., Lt). Interestingly, KHD is a member of the EVD Consortium and one of the stock-holders of E-World.

[44] See "Zhongguo gaoqing dieji biaozhun chutai, EDV wei xingye tuijianxing biaozhun" [EVD Becomes China's Recommended Industrial Standard for High Definition Optical Discs], *Sina.com*, February 24, 2005, http://tech.sina.com.cn/it/2005-02-24/1649534940.shtml.

[45] Meiying Yu, "Zhang Baoquan: Fangdichan bu neng chi tai jiu, biaozhun ke chi yi beizi" [Zhang Baoquan: You Can Live on Standards Your Whole Life], *Sina.com*, June 1, 2005, http://tech.sina.com.cn/it/2005-06-01/0616623129.shtml.

(which includes NEC and others).[46] Both Blu-ray and HD-DVD represent efforts to replace the current DVD technology and are seen by some to be technically superior both to EVD and to HVD.[47] In the face of such competition, some in the Chinese media have begun to question the rationale behind the EVD initiative:

> …at its very beginning, EVD was designed to avoid the patent trap of DVD technology. Chinese developers own only 20% of the IPR of EVD technology, however, and could not break away from DVD patents. EVD is not a break-through in key technology and doesn't fundamentally improve storage capacity of optical discs.[48]

The EVD initiative has also encountered problems in cooperation with international companies. The early prototype of EVD, for instance, used LSI Logic's MPEG-2 based technology.[49] In order to save on royalties, however, the EVD group sought to use On2 Technology's VP5 and VP6 data compression technology as a substitution of MPEG-2; this attempt quickly led to a contract dispute with On2.[50] One purported reason for E-World's new relationship with the United Kingdom's New Media Enterprise (NME) (discussed further below) is that E-World wanted access to NME's VMD technology in order to compensate for the small storage capacity problems in E-World's own technology.[51]

In addition to technological shortcomings, EVD also suffers from institutional problems evident in other high-technology initiatives. Although organized by the government at the outset, the EVD standardization effort quickly evolved into a commercial activity through the formation of E-World. In the absence of the administrative authority of the government, however,

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[46] David Carnoy, "Fully Equipped: HD-DVD vs. Blu-ray: Who Cares?" CNet Reviews, December 7, 2004, http://reviews.cnet.com/4520-8900_7-5600201-1.html. Toshiba's HD-DVD appearance recently has left some observers underwhelmed. See David Pogue, "Why the World Doesn't Need Hi-Def DVDs," *New York Times*, May 11, 2006.

[47] Zhenpeng Liang, "Jieli Yingguo cunchu jutou, EVD juji Riben liang da languang zhenying" [EVD Takes Advantage of UK NME Technology and Challenges Two Japanese Blue-ray Consortium], *NetEase*, September 9, 2005, http://tech.163.com/05/0909/05/1T6DPJ9A000915BD.html.

[48] "EVD—Jishu qixing de dianxing shibai?" [EVD—A Typical Failure of Technological Malformation?], *NetEase*, http://tech.163.com/special/E/000915LH/EVD_DIE.html.

[49] See LSI Logic, "Enhanced Versatile Disc (EVD): Developed by Leading Chinese Consumer OEMs for Use in Greater China Region," http://www.lsilogic.com/technologies/industry_standards/enhanced_versatile_disc_evd.html.

[50] See On2 Technologies, press release, "Beijing E-World and On2 Announce the Inclusion of VP5 and VP6 In the People's Republic Of China EVD Standard," November 18, 2003, http://www.on2.com/company/news-room/press-releases/?id=199; and On2 Technologies press release, "On2 Technologies, Inc. Will File for Arbitration Against Beijing E-World," April 29, 2004, http://www.on2.com/company/news-room/press-releases/?id=222.

[51] Liang, "EVD Takes Advantage." For detailed information about VMD technology, see New Medium Enterprises, "Significant Technology for Future High Definition Systems," http://www.nmeinc.com/vmd.htm.

the conflicts of interest among the commercial stakeholders have become unmanageable. For example, Beijing Kaicen High Definition Technology (KHD), a member of the EVD consortium and one of the stockholders of E-World, appears to harbor little reluctance in introducing and promoting the competing HDV standard.

In addition, a high-profile conflict involving E-World's relationship with NME has recently developed. The conflict involves a dispute between E-World and Zhang Baoquan, the president of the Antaeus Corporation.[52] Zhang has been a vocal supporter of EVD and a major investor in the building of cinemas that use EVD technology.[53] Because E-World has sold approximately 70% of its stock (including ownership of the EVD standard) to NME, Zhang has accused E-World of national betrayal.[54] Continuing controversies over the E-World-NME deal have further clouded the future of EVD.[55]

Home Networking

With the accumulation of digitally based smart devices in the modern home, industrialized countries around the world have a growing interest in developing technologies that will allow these devices to be linked together in a network. In China, interest in home networking began in 1999 when, with the blessing of the State Economic and Trade Commission, twelve Chinese companies joined together to form the Home Informationization Network System Structure and Product Development Platform Working Group.[56] In 2001 MII took the initiative to establish a Digital TV Receiver Equipment and Home Network Platform Interface Standards Working Group, which included the members of the former group plus eleven new companies. In August 2005 the working group was renamed the Ministry of Information Industry Home Networking Standards Working Group.[57]

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[52] Antaeus is a joint venture by Zhang Baoquan and E-world.

[53] "Surprise at E-Worlds UK Deal," *People's Daily*, December 1, 2005, http://english.people.com.cn/200512/01/eng20051201_224906.html.

[54] See "Dujia: Fuguo bomai shenji jiulun, Zhang Baoquan nu chi Hao Jie yanxing" [E-World Denies Selling itself to NME, Zhang Baoquan Denounces Hao Jie's Words and Behavior], *Sohu IT*, December 1, 2005, http://it.sohu.com/20051201/n240849552.shtml. Hao Jie is E-World's CEO.

[55] On January 1 Hao Jie, E-world's CEO, was arrested for embezzling Antaeus property. For more details, see "Ma Jian: Hao Jie bei ju, EVD biaozhun he qu he cong," [Hao Jie Arrested—Where Will EVD Standard Go?], *ChinaByte*, January 16, 2006, http://tech.sina.com.cn/it/2006-01-16/1156821235.shtml.

[56] The discussion below draws on Kennedy, "Political Economy of Standards Coalitions."

[57] See MII China Home Network Working Group's home page, http://www.chinahomenetwork.org/aboutus/aboutus.htm.

The Digital TV Receiver Equipment and Home Network Platform Interface Standards Working Group in effect superseded the former. By October 2003 the working group had considered four standards proposals from its members, two of which were accepted and submitted to MII for approval. Lenovo expressed dissatisfaction with the direction of the group's work and lobbied MII to allow Lenovo to set up another working group. MII approved the suggestion on the condition that the new group would focus more on the digital office and allow the original group to focus on the home. The Lenovo-led group became known as the Intelligent Group and Resource Sharing (IGRS) Working Group (or *shanlian*). The original group, now led by Haier, became known as the ItopHome Alliance (e-*jiajia*). Both groups have now submitted standards that have been approved by MII and are in the process of commercializing them. Konka and TCL, for instance, are now producing IGRS compliant televisions.[58]

Both groups have expanded, with IGRS now having some 50 members and ItopHome having 244. Though both permit foreign members, IGRS has become the more internationalized, with member companies from Japan, South Korea, and Taiwan, and memoranda of understanding for technical cooperation with home networking groups in Japan and Korea.[59] IGRS requests that its members disclose relevant patents for contributed technology that can be made available to other members on the basis of the RAND ("reasonable and nondiscriminatory") principal. IGRS also employs a patent pool for the licensing of technology to non-member companies.[60]

As in other cases, the Chinese initiatives are being undertaken in the face of ongoing standards development in the international economy. In this case, the Digital Living Network Alliance (DLNA), formed in 2004 out of the Digital Home Working Group (DHWG), has been promoting its DLNA Home Networked Interoperability Guidelines v1.0. The alliance has approximately 238 members from relevant industries around the world and has begun to certify products as DLNA compliant. Interestingly, Lenovo was a founding member of DLNA, and TCL and Huawei have subsequently joined. Products from MNCs that comply with the DLNA guidelines have begun to enter China and have stimulated the accelerated commercialization of the Chinese standards. The cross-membership phenomenon represented by Lenovo, TCL, and Huawei,

[58] Kennedy, "Political Economy of Standards Coalitions."

[59] On November 17, 2005 IGRS, ECHONET Consortium of Japan, and the Home Network Forum of Korea together established the Asia Home Network Council (ANHC), the first cross-region standard organization in East Asia.

[60] Kennedy, "Political Economy of Standards Coalitions."

however, also suggests possibilities for cooperation.[61] On January 9, 2004, IGRS Working Group and Digital Living Netowrk Alliance (DLNA) met in Beijing and explored a common vision for IPR management, technical frameworks, and marketing. This led to the July 27, 2005 IGRS-DLNA Cooperation Summit in Beijing, at which the two organizations expressed enthusiasm to cooperate based on the common goal of the two parties' standard interoperability and compatibility in the future.

RFID

An especially important Chinese standards initiative, still in its early stages, concerns radio frequency identification (RFID) technology. Industry analysts predict that the demand for systems employing RFID are likely to grow into a $5.9 billion business within the next two years, with China playing a major part in this growth story.[62] The importance of this technology for China is due to the nation's rapidly growing adoption in supply-chain management and inventory control, particularly by such major retailers as Wal-Mart, which sourced over $20 billion worth of products from China last year.[63] Although Wal-Mart is supportive of the existing international standard, Electronic Product Code (EPC, the so-called "Gen2" standard developed by EPCGlobal), China, as with other standards, has expressed concern over having to pay royalties to EPCGlobal on a technology that will have such a ubiquitous presence in China's foreign trade.

China's interest in RFID, however, is not limited to supply-chain management. Having already experimented with the use of RFID technology in its "golden card" initiative of the early 1990s, China will reportedly be issuing approximately 900 million RFID-enabled identification cards by the end of 2008.[64] In light of the diffusion of bags of blood contaminated with AIDS and hepatitis, there is also interest in using RFID to monitor blood supply and track blood products. Thus the interest in the technology is closely intertwined with aspects of social policy and the promotion of the "informatization" of Chinese society. As with other technologies relating to radio transmissions, RFID is also one in which China's security apparatus takes an interest.

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[61] Kennedy notes that Intel is interested in introducing its "Viiv" home entertainment system into China, a move that has led to the opening of discussions between IGRS and DLNA. See Kennedy, "Political Economy of Standards Coalitions."

[62] Fred Stakelback, "RFID: New Markets for an Old Technology," *Asia Times*, April 29, 2006, http://www.atimes.com/atimes/China_Business/HD29Cb02.html.

[63] Stackelback, "New Markets for an Old Technology."

[64] Ibid. The "Golden Card" project was intended to promote the use of credit cards and, more generally, e-banking and e-commerce.

RFID technology consists of a "tag" (a transponder located in the object to be identified), a reader of the signal coming from the tag, a database that enables identification, and software to operate the system. For supply-chain management in particular, a standardized system is important in order to realize the many advantages of RFID at locations around the world.[65] This is the reason why China's RFID initiative is causing some concern—there are indications that the Chinese approach may diverge from what is becoming the international standard.

China's worries about the direction of international standardization for RFID seem to turn on three issues. The first involves intellectual property and royalty questions. Although EPCGlobal has indicated the possibility of licensing its technology on a royalty-free basis, other companies making products employing the Gen2 standard have indicated an intention to charge royalties. The second issue concerns the numbering system used to identify objects with embedded RFID tags. The EPCGlobal approach, which is becoming adopted internationally, uses a fairly simple coding system that allows authorized parties to acquire information about the tagged object from the EPC database. Companies wishing to use the system must register with EPC and pay an annual fee for the service. China, on the other hand, uses its own coding system (the National Product Code) and has been reluctant to accept the idea that Chinese manufacturers should have to pay for the EPC system and adopt an additional numbering scheme. Finally, the EPCGlobal system is designed to allow participating supply-chain partners to share information about products through an open registry. EPC has subcontracted the maintenance of the registry to an American company, Verisign. Some in China believe that control over information resources of this sort, which pertain to commercial success, would violate national security norms.[66]

There also seems to be some confusion regarding China's management of its RFID initiatives. SAC reportedly supports EPCGlobal. Yet MII has recently indicated that research on RFID will be one of six major projects on information technology during the eleventh five-year plan (2006–10). In addition, the Ministry of Science and Technology is currently taking the lead in an interagency project to draft an RFID strategy paper that will chart a course for technological development in this area.[67] Until now, however, there seems

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[65] Jonathan Collins, "Metro Calls for Action on RFID Standards," *RFID Journal*, February 13, 2006, http://www.rfidjournal.com/article/articleprint/2150/-1/1.

[66] Craig Harmon and Leslie Downey, "RFID: Will China Throw in a Monkey Wrench?" *BusinessWeek*, September 12, 2005, http://www.businessweek.com/technology/content/sep2005/tc20050912_6790.htm.

[67] Stackelback, "New Markets for an Old Technology."

to have been some confusion as to who has the lead on promoting the standard. Though a working group on RFID was established in November 2003, SAC suspended this group in October 2004 on the grounds that it duplicated the work of another working group on RFID; thus the first group was disbanded in the name of RFID standardization.[68] In October 2005 the Department of Science and Technology of MII issued "Document [2005] No. 52," which approved the establishment of an RFID working group (see **Appendix II**); reportedly, there is a "Leading Working Committee for RFID" operating in Shenzhen. RFID work is also occurring in the Article Numbering Center of China's Electronic Product Code (EPC Global-China) Working Group and the China Electronic Standardization Institute's RFID Working Group.[69] As with other standards cases considered, there may have been a degree of disarray in advancing the cause of a Chinese approach to RFID, perhaps necessitating stronger central direction and coordination (as illustrated by the initiation of the MOST-led policy paper). According to a spokesman for MII, "the main obstacles to a national standard have been disagreements among concerned parties within China and the ability of the country's national standard to operate with the three other international standards—ISO/IEC 18,000; EPCGlobal; and Ubiquitous ID."[70]

Worth noting is that the "Generation 2" standard developed by EPCGlobal has received preliminary endorsement by the ISO. Despite interest in working with ISO in other areas of standards, however, thus far China has apparently been reluctant to subscribe to the ISO process on this standard, perhaps putting a strain on China's WTO commitments to support international standards where they exist.[71] The confusion over responsibilities for RFID in China and apparent dissensus within the government may also be reflected in a July 2005 incident in which some members of a Chinese delegation (including those from MII) chose not to participate in a scheduled U.S.-China workshop on RFID hosted by the U.S. National Institute of Standards and Technology.

Understanding the Cases

Table 1 shows both similarities and differences among cases in the areas of motivations, major international competitors, domestic competitors, international cooperation, and the state's role in standardization.

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[68] See "RFID Working Group Suspended—Uncertain Factor of China's New Standard," *SouthCn.com*, October 27, 2004, http://www.southcn.com/tech/yjzx/200410280852.htm.

[69] Stackelback, "New Markets for an Old Technology."

[70] Ibid.

[71] Harmon and Downey, "Will China Throw in a Monkey Wrench?"

Motivations

Although the broad motivations for promoting a national standards strategy can be found in the development of a technology policy consistent with China's WTO commitments, a number of other more specific factors can also be identified from these cases. In the first instance, as exemplified by the WAPI case, national information security—in combination with commercial opportunities—

Table 1: Comparison of Chinese Standard Initiatives

Case	Motivation	Major International Competitor	Domestic Competitor	International Cooperation	State's Role in Standardization
EVD	Avoid royalty fees.	Blu-ray HD DVD FVD (Taiwan)	HDV HVD	Yes? (Contact with LSI Logic and On2, controversial deal with NME for VMD technology.)	State initiated the effort, but state's role decreased dramatically when it evolved into commercial activities.
AVS	Avoid royalty fees.	Mpeg4, H.264	No	Yes	Initiated by the state, but there are conflict of interests in AVS case. For example, CCTV preferred MPEG-4 for IPTV standard.
TD-SCDMA	Avoid royalty fees and improve Chinese competivieness in telecommunication industry.	WCDMA CDMA2000	No (Major telecom operators also use WCDMA and CDMA2000)	Yes	Strong state support. State established special projects for development of SCDMA technology. Currently state's support lies in decisions about 3G licensing.
WAPI	Security.	IEEE 802.11	No	No	Strong state support.
RFID	Establish Chinese competive status in RFID industry and also a security concern.	EPC (Gen2)	No	Yes?	State initiated, but confusing roles of different state agencies.
IGRS	Establish Chinese competive status in home networking field.	DLNA	ITopHome	Yes (IGRS formed a consortium with Japanese and Korean companies. Also, IGRS cooperated with DLNA.)	State initiated, but most efforts were from the industry, where differences between IGRS and ItopHome emerge.

has played an important role. WAPI was developed in institutions with close ties to China's security apparatus, and WAPI's staying power may be explained by the influence of the security bureaucracy on Chinese policy. Information security, mixed with commercial considerations, also seems to be an important consideration in the RFID case as well (though the mix is apparently richer in commercial considerations in RFID).

In other cases, such as AVS and EVD, motivations for initiating a new standard are closely linked to the sense that the "relative gains" from becoming the "workshop of the world" are not to China's liking. Although benefiting in absolute terms from participation in international production networks, Chinese firms often feel that they are not getting a fair return because of excessive royalties on licensed technologies. Because the intellectual property that is incorporated into technical standards lies in the hands of foreign companies, license fees are thought to cut unacceptably deeply into the profits of Chinese firms. Hence the strong emphasis placed upon developing products with Chinese intellectual property, and Chinese standards, in the *zizhu chuangxin* formulation.

Though questions of relative gains also figure into other cases, these questions get mixed with motivations relating to technology innovation objectives. In these cases, such as TD-SCDMA and RFID, growing Chinese technological capabilities in relation to the scale of the Chinese market and economic activities argue for the development of Chinese standards. In this view, given how important the Chinese market has become, China has the technical capability to set standards and should do so. For instance, as the largest and fastest-growing market in the world for cellular phones, China believes that there is no reason the Chinese should not be setting their own standards. In the case of RFID, the feeling again is that, since China now supplies so much of the world's consumer goods, China should be setting its own standards for technologies pertaining to the shipping and inventories of such goods.

There may also be a growing influence of cultural preferences in standard-setting activities. Technologies, after all, do experience social and cultural "shaping." Unsurprising, therefore, is that certain standards developed in non-Chinese settings may not be as suitable for Chinese conditions. Thus, in addition to commercial considerations, the development of standards for next-generation telephony and the "digital home" may be motivated by cultural preferences—as would the active Chinese interest in the development of standards for the next-generation Internet (IP V6).[72]

[72] Although Internet standards are not covered in this report, there is active interest in next generation Internet standards in China, in part to produce standards that are more accommodating to the need to express Internet addresses in Chinese characters.

In an earlier work, the authors argued that China's standards strategy is also rooted in a deep-seated techno-nationalism, albeit one accommodated to the realities of techno-globalism.[73] In many ways, this "neo-techno-nationalism" continues to characterize China's technology policy and standards strategy. The cases presented above, however, provide new insights into the characteristics of Chinese techno-nationalism, in particular the ways in which this nationalism is intermingled with techno-globalism. Indeed, in reviewing individual cases of standards initiatives, the relative importance of techno-nationalism and techno-globalism seems to vary considerably across a spectrum, with WAPI exemplifying the former and AVS and perhaps IGRS the latter. The diversity of views regarding techno-nationalism as evident in the standards strategy reflects the broader discourse on techno-nationalism in technology policy. This discourse can be seen, for instance, in the ambiguities surrounding the concept of *zizhu chuangxin*.

Actors

Understanding the consistency, or inconsistency, of Chinese motivations for China's standardization projects requires attention to the variety of actors involved in the standards strategy and the diverse sources of initiatives for standard-setting. Among these actors are government standards agencies (SAC) with formal authority over standards, other agencies with active technology promotion agendas (and the government research institutes that support them), Chinese companies and industrial associations, and interested parties from the international community. At times, therefore, it appears that there is no simple or consistent identity of interest among these diverse players, making the harmonization of preferences on standards initiatives quite difficult. For some Chinese companies, for instance, financial success has been achieved by working within an architecture of standards and IPR that has already been established internationally; new government-supported initiatives for distinctive Chinese standards may not be welcomed by such firms. Even within government, there are signs that different ministries, or parts of ministries, may have rather different views on the desirability of promoting particular standards. Hence, if pursued without finesse, a national standards strategy could increase domestic policy conflict and could actually retard technological development. A lack of finesse, as seen in the WAPI case, can also induce international conflict that may lead to significant costs and an interruption of technological progress.

[73] Suttmeier and Yao, "China's Post-WTO Technology Policy."

Foreign Participation

Another issue pertaining to the current state of China's efforts to promote a national standards strategy is the role to be played by MNCs. Generally speaking, foreign companies have been dissatisfied with the access they have been given to Chinese standard-setting forums and continue to lobby for greater participation and transparency from the Chinese.[74] Nonetheless, MNCs have been active players in helping to provide technology for Chinese standards development (the role of Siemans in the development of TD-SCDMA is one such example) and many of the standards working groups now have foreign members (see **Appendix II**). In most of the more prominent cases of Chinese standards initiatives, foreign know-how has been an important component in the development of the Chinese standard. Indeed, despite suggestions of techno-nationalist motivations (which are evident in some cases), Chinese standard-setting initiatives provide further evidence that technological development is increasingly an international (if not global) exercise and that a narrow techno-nationalism is likely to be self-defeating.

Implementation and Institutional Models

Another series of interesting questions concern Chinese strategies for implementing standards. Among these is the extent to which China will embrace market-driven approaches to standard-setting as opposed to the setting of standards by government or by formal standards bodies. This question is closely related to the important issue of whether European approaches to standards, more closely associated with the latter approaches, will have greater influence with the Chinese than U.S. approaches, which favor market forces and action through voluntary associations. Europe has been actively working with China to promote a European vision of a standards regime. Although the United States has also undertaken initiatives with China for bilateral cooperation, intending in part to promote the U.S. vision, U.S. efforts may require additional resources. Implementation issues also extend to whether China's regulatory capacity and ability to enforce standards are sufficiently developed. Such questions all suggest that China's standards strategy faces many uncertainties and is not necessarily guaranteed success.

The Politics of Standards and the Ambiguous Role of the State

A consideration of various cases of contemporary standard-setting in China also raises questions regarding the role of the Chinese state in standard-setting and the political dynamics involved in different cases. As with other areas

[74] Ann Weeks and Dennis Chan, "Navigating Chinese Standards Régime," *China Business Review*, May-June 2003, http://www.chinabusinessreview.com/0305/weeks.html.

of public life in China, the role of the state is often ambiguous and changing. More importantly, opinions regarding the proper role for the state are often divided. In the WAPI case, for instance, there is a strong state sponsorship of the WAPI standard. As Kennedy has argued, however, there are reasons to think that Chinese state support was by no means unified. Because of the important implications of WAPI for information security, WAPI's strongest support seemingly came from authorities in the state's security system; other parts of the state, notably those associated with economic and trade functions, may have been much less enthusiastic after witnessing the intense negative reaction to WAPI from important foreign trade and investment partners.[75]

A somewhat different pattern of state behavior is evident in the TD-SCDMA case. Though having played a role in supporting the development of the technology going into the standard, the state has until recently been somewhat more tentative in endorsing and accepting TD-SCDMA as a national standard, even as the standard is being recognized internationally by the ITU. By virtue of a regulatory role vis-à-vis the telecommunications industry, however, the state—in this case, the Ministry of the Information Industry—will play a critical role in the standard's ultimate use. Yet as Tan has demonstrated, multiple interests are involved in 3-G standards, with major Chinese companies having already sunk costs in technologies more consistent with alternative standards.[76] As a result, MII is in the ambiguous position of wanting to promote an indigenous Chinese standard involving at least some Chinese technology—in keeping with MII's role as an agent of the "developmental state"—while simultaneously serving as a more neutral regulator in the face of market forces and competing interests from other Chinese players.[77]

A third pattern is seen in the digital home network case, where the state has approved the formation of two competing alliances of Chinese companies—one led by Lenovo, the other by Haier. In this case, the state seems to be retreating from an active role in standard-setting by letting market forces operate in standards development more in the regulatory state mode. On the other hand, the state's R&D support represents an active intervention to foster technological development in this area.

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[75] Kennedy, "Political Economy of Standards Coalitions."

[76] Tan, "3-D Wireless Standards in China."

[77] A classic formulation of the differences between the "developmental state" and the "regulatory state" is that of Chalmers Johnson. As Peter Evans has argued, however, developmental states also have multiple repertoires in their efforts to enhance national economic and technological well-being. See Peter Evans, *Embedded Autonomy: States and Industrial Transformation* (Princeton, NJ: Princeton University Press, 1995). The authors are grateful for Scott Kennedy's reminder of Evan's perspective.

The AVS case represents another pattern. In this case, the state intervened in order to facilitate the organization of the AVS working group (thus overcoming market failures in meeting organizational costs) and has also provided R&D support, as noted above. The work of the AVS group has, however, apparently proceeded largely independent of the state. As was the case with TD-SCDMA and the digital home cases, foreign companies have also been involved in the development of the standard. In the first critical commercial test of the standard, however, in a procurement decision by SARFT, the state actually backed away from the indigenously developed Chinese standard and opted for the more familiar, but arguably technically inferior, MPEG international standard.

Thus, contrary to the impression first created in the WAPI case, defining the interest of the Chinese state in standards is by no means straightforward and unambiguous. Though the state is clearly committed to the development of Chinese standards—a commitment seen in the development of the standards strategy and in the inclusion of research on standards in major national R&D projects—there remains both a diversity of interests within the state regarding particular standards and a diversity of policy tools (such as regulation, procurement, and R&D support) that can be employed (or, in the case of SARFT, not employed) in the implementation of standards policy.

Thus the politics of standards in China cannot be understood simply as a matter of state direction. Kennedy has suggested that the political dynamics of contemporary high-tech standard-setting should be understood in terms of the relative strength of competing coalitions of interests.[78] The apparent failure of WAPI can also be understood in terms of the standard's rather narrow constituency of interest. In other cases, broader coalitions are emerging that involve both Chinese and foreign companies. Tan's work has also shown how various "interest groups" composed of Chinese and foreign companies—from both the service delivery and equipment manufacturing sectors—embrace competing standards. Though still the ultimate regulator, MII is one that can now only ignore market forces at great peril to the delivery of Chinese telecommunications services.

It is still too early to draw any firm conclusions regarding the general role of the Chinese state in standards development. On the one hand, the diversity of patterns that this essay has attempted to document might be interpreted as a reflection of a trend toward greater marketization in which the state retreats to a more neutral regulatory role—as one might expect in a more laissez-faire economy. That same diversity, however, might also be a reflection of well-known problems within the Chinese government—the "stove-piping" and "fragmented

[78] Kennedy, "Political Economy of Standards Coalitions."

authoritarianism" phenomena many observers have noted—in achieving effective coordination across multiple bureaucratic systems. According to this interpretation, greater state capacity would result in a more active and coherent state direction of the standards development efforts. In this context, the new long-term science and technology plan, which both emphasizes *zizhu chuangxin* and carries techno-nationalist overtones, would seem to be a prod to the state to achieve a more effective standard-setting process in the interest of enhancing Chinese technological capabilities. The growing importance of Chinese firms in the national innovation system, however, may be a force for greater techno-globalism. Though clearly seeking support and favors from the state, Chinese firms are also increasingly aware of global market realities and are involved with complex international commercial interactions. While Chinese firms certainly cannot ignore the wishes of the state, the idea that these enterprises march lockstep in implementation of the state's technology policies seems increasingly to be unfounded.

Puzzles

In spite of Chinese efforts to develop a reasonably transparent standards strategy statement and develop coherent policies to advance this strategy, a number of puzzles and uncertainties remain regarding the future direction of the strategy. For instance, the motivations examined above do not seem to reveal a clear consistency; actual and potential contradictions are evident. Considering that the development of a standards strategy is fairly recent and there is still much to learn regarding the many dimensions of standards in modern economies, this inconsistency is perhaps not surprising. Underlying questions yet to be answered concern the types of standard-setting organizations, the relative importance of market forces in standard-setting, the ways in which intellectual property concerns affect standard-setting, the implications of standards for other areas of policy (such as antitrust), and the ways in which international cooperation in standards should be approached.

A national standards agenda is a complex phenomenon, one that is also made behaviorally complicated by the existence of competing interests and preferences with regard to standards, standard-setting mechanisms, and the ways in which national standards activities fit within a global economy. The more prominent cases of standard-setting reviewed here suggest that the achievement of a consistency of preferences among the actors participating in China's standards strategy is by no means a simple matter. Preferences regarding standards vary both within and among industry, government, and the research community. This variation reinforces the idea that China's standards must be understood with due regard to case variation, as the international community

seeks to comprehend the interests in, and sources of initiatives for, standards coming from the government, the research community, individual companies, and industrial associations.

Ongoing puzzles also remain regarding the preferred institutional mechanisms for standard-setting as well as the extent and nature of an international orientation in the standards strategy. For instance, drafts of the standards strategy paper revealed an appreciation for the importance of market forces in the setting of standards and the persistence of strong traditions of state direction of the economy and in standard-setting. Similarly, though much is made of the importance of harmonizing domestic standards with international standards (in keeping with the terms of the TBT agreement), Beijing has also issued clear statements asserting that Chinese national interests should be served by China's standards system. When these two objectives seem to conflict, as in the WAPI case, the true intentions of China's standards strategy seem to be blurred. On the other hand, China appears to appreciate some of the aspects of the U.S. standard-setting tradition, in which informal or consortium-like organizations play a key role in standard-setting. On the other hand, China seems to show a preference for working through established, institutionalized standards organizations, more in keeping with European and Japanese practices.

Another set of puzzles concerns China's capabilities in standard-setting, the relative importance of the domestic market in China's standards strategy, and the role of multinational corporations in standard-setting activities. As suggested above, China's large market clearly shapes Chinese thinking regarding the development of Chinese standards, but not entirely clear is whether standards development should focus mainly on products for the Chinese market or for the international market. In the case of TD-SCDMA, for instance, the size of the Chinese market could sustain a Chinese standard. Conversely, the promotion of the Chinese standard for the Chinese market may not serve the interests of Chinese handset producers who are seeking to penetrate and capture market share abroad, where different standards are in use.

Market power can be substituted for technological deficiencies as well, and some observers have argued that the technical quality of some prominent Chinese standards are behind international levels—despite China's plans to strengthen these standards. If true, this disparity would then suggest that China must either appeal to market power to advance Chinese standards or partner with multinational corporations to develop technologies and advancing standards. Worth noting is that foreign participation of one sort or another is evident in most of the cases reviewed in this report. Yet as Scott Kennedy has recently argued,

the overall record of success of the standards strategy is not compelling.[79] A related issue is the extent to which China has a regulatory capacity to make its standards strategy work.

Implications

In spite of both a less than impressive record in implementing the evolving standards strategy and the further problems that can be anticipated, there is no doubt that China takes the implementation of its standards strategy seriously. Given its market size, cultural preferences, and growing technological capabilities, China will be active in standard-setting for the long term. Nevertheless, China's approach to standard-setting is likely to be considerably less monolithic than the early conflict over WAPI might have indicated. The players in China's game of standard-setting are numerous and diverse and have differing interests in standards. Engagement with China on the development of a standards strategy is both possible and highly desirable. Given that there is still much to learn regarding standards and standards use in technology policy, such engagement requires a sense of strategy that recognizes the formative process through which China is now passing as the economy continues the transition to marketization and more complex ownership patterns. Thus Chinese interest and activities in the world of standards will only increase in the years ahead. The issues do not concern whether China has a standards strategy or whether activism in standardization will continue. Rather, questions concerning the content of the strategy and the forms the activism will take are now the most pressing issues.

The above discussion demonstrates both that there is an intense aspiration for technological progress in China that is backed by strong political will and increasingly abundant resources and that standards are seen as an important part of national technology policy. At the same time, this report has shown that, due to technological weaknesses, institutional fragmentation, and competing interests, the full implementation of a coherent standards strategy is often elusive. These conditions pose both challenges and opportunities for the international community: though unable to ignore the seriousness of purpose that China brings to its standards initiatives, the international community also has multiple opportunities for cooperating with China to reach mutually beneficial outcomes.

The broad objectives for engaging China on standards should be to reinforce the internationalist and techno-globalist orientations in the Chinese

[79] Kennedy, "Political Economy of Standards Coalitions."

system. This engagement requires knowledge of, and sensitivity to, the complexity of the system and the multiple interests at play within the system. Toward such an end, it may be useful to differentiate among those actors having formal institutional responsibilities for the overall standards system (centered in the SAC), those having policy responsibilities for the development of industrial technologies (MII, NDRC, MOST, and research institutes), and the Chinese companies and industrial associations (the players in the market who face global competition). Though each of these has strong interests in standards, the interests are not necessarily identical. The primary interests of the former lie in the establishment of a modern standards regime and the maintenance of credible relations with international standards bodies and the formal standards institutions of other countries. In pursuit of these interests, SAC will seek to build technical capabilities and professionalism upon which its legitimacy will rest, and will be open to cooperative activities in support of these goals.

Those in the second category, having policy responsibilities for advancing Chinese technological development, see their mission as one of protecting Chinese national interests in the face of powerful global forces shaping both the directions of technological change and the distributive consequences of that change. These actors can be expected to aggressively devise strategies that will enhance national technical competence. Some of these strategies will conflict with the interests of international companies and foreign governments and will at times test the limits of international regimes and agreements. At the same time, these players acknowledge the limits of Chinese technological capabilities and appreciate the importance of international cooperation.

Finally, those Chinese companies that are becoming increasingly important in standardization are generally evincing a more pragmatic approach to standards, one that reflects the business interests of these companies. Though unable to dismiss the state-driven standardization aspirations as found in national technology policy, Chinese companies and industrial associations can take comfort in the national industrial policy that is designed to insulate Chinese firms from the full force of MNC competition. These companies and associations also understand that their success will ultimately be determined in the marketplace and that a standards strategy that is not flexible and accommodating is likely to undermine that success.

Recognition of the diverse interests of the different players in China's standards initiatives is the first step toward positive international engagement with China on standards issues. Due to concerns over commercial success, relative gains, security, and technological progress, China can be expected to vigorously defend and promote Chinese interests in standards. Beijing does, however, seem to be increasingly cognizant of the limitations of following a

narrow techno-nationalist approach. Thus a multi-pronged approach involving appeals to the formal standards authorities, to the industrial and technology policy authorities, and to the Chinese corporate world to encourage techno-globalist instincts, should be encouraged.

As indicated at the outset, standards have become an increasingly important issue both in global commerce and in terms of achieving the interoperability of the technologies upon which international economic progress depends. China's rise as a great trading nation and a global manufacturing center, combined with the country's growing technological capabilities and expanding technological aspirations, make an expanding Chinese role in the world of technical standards inevitable. Though China needs to check the influence of narrow techno-nationalist sentiments on expanding standards initiatives, the international community in turn must both show a sensitivity to Chinese concerns over the distributive consequences and procedural fairness of global standards practices and be willing to accommodate the views of this new member of the standards community.[80]

The world of standards will always be one of an essential tension between the employment of standards as an instrument of cooperation that facilitates mutually beneficial interactions, on the one hand, and the use of standards in struggles for self-interested advantage on the other. China's commitment to enter this world not only complicates the struggle but also expands the value of pay-offs from cooperation. Though there is much that China can learn about standards, there is also much that the international community can learn about Beijing's rationale for China's standards strategy and the modalities of implementation. A process of mutual learning can help ensure that the conflict generated by the inevitability of struggle does not compromise the promise of expanding benefits through collaboration.

[80] Linda Garcia and Kelsey Burns, "Globalization, Developing Countries, and the Evolution of International Standard-Setting Communities of Practice" (paper prepared for the China's High-Technology Standards workshop, sponsored by the National Bureau of Asian Research and Tsinghua University, Beijing, China, January 6, 2006).

Appendix I

China's Technology Standards Policy: Implications for the United States & China

Workshop Agenda

Tsinghua University (Beijing, China), School of Public Policy and Management
January 6, 2006

8:30 AM–8:45 AM **Welcoming Remarks**

8:45 AM–9:15 AM **Keynote Address**
Keynote Speaker: **Gao Wen**, Institute of Computing Technology, Chinese Academy of Sciences; Chair, AVS Working Group

9:15 AM–10:15 AM **Session A: Standards Systems Issues**
The Growing Importance of Standards in the International Political Economy
Presenter: **Linda Garcia**, Georgetown University

China's Evolving Standards System: Institutions and Strategy
Presenter: **Zhao Chaoyi**, China's National Institution of Standardization

Standards Development, IPR Regimes, and Anti-Trust Policies
Presenter: **Mu Rongping**, Chinese Academy of Sciences

10:30 AM–12:00 PM **Commentators & Group Discussion**
An Baisheng, Ministry of Commerce (PRC)
Chris Lanzit, Executive Director, Consortium on Standards & Conformity Assessment (China Office)

12:00 PM–1:45 PM **Lunch**
Keynote Speaker: **Lester Ross**, Partner, Wilmer Cutler Pickering Hale & Dorr

1:45 PM–2:45 PM **Session B: Case Studies**
Telecommunications and 3G
Presenter: **Alex (Zixiang) Tan**, Syracuse University

AVS and RFID
Presenter: **Su Jun,** Tsinghua University

WAPI and IGRN-Home Networking
Presenter: **Scott Kennedy**, Indiana University

3:00 PM–4:30 PM **Commentators & Group Discussion**
Alison Birkett, Information Society, EU Mission (Beijing)
Gao Shi-Ji, Development Research Center of the State Council

4:30 PM–5:30 PM **Panel Discussion and Questions/Comments from the Floor**
Remarks: **Richard P. Suttmeier**, University of Oregon
Ji Fusheng, Tsinghua University

Appendix II

Standards Development Working Groups

1. EVD Case

A. EVD Working Group Members:[1]

1. Beijing E-World Technology Co., Ltd. (working group leader)
2. CESI (CHINA Electronics Standardization Institute) under MII (coordinator)
3. KHD (Beijing Kaicen High Definition Technology)
4. Beijing HOMAA Microelectronic Technology Co., Ltd.
5. Lenovo Beijing
6. Shinco Electronics
9. Dongguan City Gaoya Electronics Co., Ltd.
8. Research Institute of TV and Electro-Acoustic (No.3 Research Institute China Electronics Group Corporation)
9. CEPREI Laboratory (Fifth Electronic Research Institute of China Ministry of Information)
10. AMOI
11. BBK Electronics Co., Ltd.
12. Central Research Academy of SVA Group Co., Ltd.
13. Nintaus
14. Yuxing InfoTech Holdings Limited
15. Zhengjiang Jiangkui Group
16. CETC (China Electronics Technology Group) Information Technology System Co., Ltd.

[1] New-Generation High Definition Digital Video Disc Standard Working group (ECD working group) is under China Electronic Standardization Institute. A list of its members can be found on the CESI home page: http://www.cesi.ac.cn/www/standgroup/groupmember/22.pdf.

2. TD-SCDMA Case

A. TD-SCDMA Industry Alliance

Members of TD-SCDMA Industry alliance:[2]

Domestic members (17):

1. Datang Mobile Communications Equipment Co., Ltd.
2. Holley Group
3. Lenovo
4. ZTE Corporation
5. CECW (China Electronics Corporation Wireless)
6. POTEVIO Corporation
   State key enterprise directly under the leadership of the State-owned Assets Supervision and Administration Commission of the State Council (SASAC).
7. Chongqing Chongyou Information Technology Co., Ltd. (CCIT)
   CYIT is one of the earliest companies involving in the research and development of TD-SCDMA, the third generation mobile telecom Terminal. Since 1998, CYIT has participated in the constitution of the Chinese criteria of TD-SCDMA.
8. Hisense Group
9. Xi'an Haitian Antenna Technologies Co., Ltd.
10. Beijing ZhongChuang Telecom Test Co., Ltd. (ZCTT)
11. Zhongyou Technology Industry & Commerce Co., Ltd.
12. Tongyu Communication Equipment Co., Ltd.
    Founded in 1996 and located at the Torch High-Tech Development Zone in Zhongshan City of Guangdong Pearl Delta.
13. Haier Mobile Division
14. Koretide Corporation
15. FiberHome Technologies Group
    Established in 1974, Wuhan Research Institute of Post and Telecommunications (WRI) is the predecessor of FiberHome Technologies Group.
16. TCL Mobile Communication Co., Ltd.
17. Guangzhou NewPostCom Co., Ltd.
    Established in January, 2005.

[2] See TD-SCDMA alliance home page: http://www.tdscdma-alliance.org/english/Members/index.asp.

Foreign/Joint Ventures (8):

1. TD Tech Ltd.
   TD Tech Ltd. is a wholly foreign owned enterprise (WFOE) of Siemens Communications Group and Huawei Technologies, Ltd.
2. T3G Technology Co., Ltd.
   T3G is a joint venture by Philips, Datang Mobile, Samsung, and Motorola.
3. COMMIT Incorporated
   Its investors consist of 17 well known and respected enterprises such as China PUTIAN Corporation, China Academy of Telecommunications Technology (CATT), Texas Instruments (China), Nokia (China) Investment Co., Ltd., LG Electronics, Inc., and Hyper Market International, Ltd.
4. Spreadtrum
5. Alcatel Shanghai Bell
6. Shanghai DBTEL Industry Co., Ltd.
   One of member enterprise of Taiwan DBTEL group.
7. UTStarcom
8. Inventec Appliances (Shanghai) Co., Ltd.
   A foreign-funded IT enterprise established in Shanghai

B. TD-SCDMA Forum Members:[3]

Forum Director Members (16):

1. China Mobile
2. China Network Communications (CNC)
3. China Railway Telecommunications Center (CRTC, or China TieTong)
4. China Telecom
5. China Unicom
6. China SatCom
7. Datang
8. Huawei
9. Alcatel Shanghai Bell

[3] On December 12, 2000, 8 companies established the TD-SCDMA Forum including China Mobile, China Telecom, China Unicom, Datang, Huawei, Motorola, Nortel, and Siemens for promoting the global uptake of TD-SCDMA technology. The forum currently has 420 members home and abroad, including China Mobile, China Telecom, China Unicom, Motorola, Nortel Networks, Huawei, Datang Telecom, and Siemens. See the TD-SCDMA Forum home page: http://www.tdscdma-forum.org/EN/index.asp.

10. InterDigital
11. NortelNetworks
12. Motorola
13. Qualcomm
14. Siemens
15. UTStarcom
16. TCL Mobile

Forum Senior Members (19):

1. Analog Devices
2. Chongyou Information Technology (CYIT)
3. Fujitsu China
4. Infineon Technologies (China) Co., Ltd.
5. Intel China Co., Ltd.
6. LG Electronics China R& D Center
7. Lucent Technologies Ltd.
8. MCCI
9. T3G
10. FiberHome Technologies Group
11. Philips Semiconductors Co., Ltd.
12. Samsung Electronics Co., Ltd.
13. Tektronix
14. Spreadtrum
15. KORETIDE (Shanghai) Co.
16. Comba Telecom Technology
17. DBTEL
18. Longcheer Holdings, Ltd.
19. Texas Instruments

3. AVS Case

A. AVS Working Group Members:[4]

Currently, the AVS working group has 134 full members, including Chinese and foreign companies (such as Legend [now Lenovo]), Founder, Huawei, Intel, Legend Group, Ltd., IBM, and LG), many research institutes (several institutes under CAS, Matsushita Research & Development [China], China Electronics Standardization Institute, Harbin Institute of Technology, and Electronics Standardization Institute), and many universities (such as Tsinghua University, the University of Science and Technology of China, and Hong Kong University of Science and Technology).

In addition, the AVS working group has 34 observing members, including Taiwan and international companies (like Cheertek, Fujitsu Microelectronics [Shanghai], France Telecom China, Fujitsu Microelectronics [Shanghai], Envivio, Sony China, Texas Instruments, Germany's Sci-worx GmbH c, and Sun Microsystem China), and international research institutes (such as Singapore's Institute for Infocomm Research and the Beijing Samsung Communication Technology Research Institute).

4. RFID Case

A. RFID Working Group Members:[5]

RFID working group has 63 full members, including many government agencies and research institutes (like China Electronics Standardization Institute, CESI, China Computer Testing Center [NCTC], State Radio Regulation Committee, and Institute of Micro-electronics of CAS), universities (such as Beijing Post and Communication University), and Chinese and foreign companies (including IWNCOMM, PUTEVIO [Putian], and NEC China).

There are 5 observing members, such as Beijing University and IBM.

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[4] For the full membership list, see the AVS Working Group home page: http://www.avs.org.cn/en/membership.asp.

[5] See RFID Standardization Work Group's home page for details: http://www.rfidgroup.org.cn/.

5. Home Networking Case

A. IGRS working group:[6]

Core Members (15)

1. Legend Group Co., Ltd. (now Lenovo)
2. TCL Group Co., Ltd.
3. Konka Group Co., Ltd.
4. Hisense Group Co., Ltd.
5. Great Wall Group Co., Ltd.
6. Grand Element Digital, Ltd.
7. Estarcom Co., Ltd.
8. Beijing Zhong He Wei Software Co., Ltd.
9. Hunan Yiheng Electronic Co., Ltd.
10. Century Herosoft Computer Technology Co., Ltd.
11. China Electronic Standardization Institute
12. Changhong Electronic Co., Ltd.
13. Skyworth Group Co., Ltd.
14. China Netcom Corporation, Ltd.
15. Huawei Technologies Co., Ltd.

Promoter Members (22):

1. ZTE Corporation Co., Ltd.
2. Beijing LHWT Microelectronics Inc.
3. Institute of Shanghai Tongyong Chemical Technique Academy
4. Beijing Zhongke Hope Software Co., Ltd.
5. China Telecom Co., Ltd.
6. Amoi Electronics Co., Ltd.
7. Idealest Technology Development Co., Ltd.
8. Smartisys Electronics Co., Ltd.

[6] The IGRS (Intelligent Grouping and Resource Sharing) working group under the Ministry of Information Industry was formally established on July 17, 2003 by five of the biggest computer and consumer electronics companies in China—Lenovo, TCL, Konka, Hisense, and Great Wall. Lenovo acts as the chair company of the working group. More information about IGRS is available at: http://www.igrs.org/en/index/index.asp.

9. Accton Technology Co., Ltd.
10. LG Co., Ltd.
11. Shanghai Tongshang Net Software development Co., Ltd.
12. HuaXun Electronics Co., Ltd.
13. ST Microelectronics Co., Ltd.
14. BII Group Co., Ltd.
15. Institute of Micro-electronics of Chinese Academy of Science
16. Semiconductor Manufacturing International Corporation
17. Hedigi Co., Ltd.
18. Cisco-Linksys (Chengdu) Networking Technology Co., Ltd.
19. Hong Kong Applied Science and Technology Research Institute Company, Ltd.
20. Suzhou CAS IC Design Center
21. Versilicon Co., Ltd.
22. Celestial Semiconductor Co., Ltd.

Ordinary Member (22):

1. Peking University
2. USI Co., Ltd.
3. Institute of Computing Technology, Chinese Academy of Sciences
4. Tsinghua University
5. Inspur Group Co., Ltd.
6. Shanghai Econ AVIT Co., Ltd.
7. DW Net Co., Ltd.
8. Beijing University of Post and Telecommunication
9. Sino Wave Communications, Ltd.
10. Promoting Center
11. VLI (Shanghai) Co., Ltd.
12. Gemtek Co., Ltd.
13. Broadband Technology (Shenzhen) Co., Ltd.
14. VINNO Technology Co., Ltd.
15. Future Systems, Inc.

16. New soft Co., Ltd.
17. Guilin Qianzhiye Network Technology Co., Ltd.
18. Freescale Semiconductor (China) Co., Ltd.
19. Beijing HuaTong Guoxin Technology Development Co., Ltd.
20. FiberHome Technologies Co., Ltd.
21. Sigma Microelectronics Co., Ltd.
22. NanShanZhiQiao (Beijing) Microelectronics Co., Ltd.

B. ITopHome (E-*jiajia*) Alliance:[7]

ITopHome was initiated by Haier, Tsinghua Tongfang, China Netcom, SVA, Shanghai Belling, Great Wall, and Chunlan. The alliance now has 190 members, mostly Chinese companies, research institutes, and government agencies. Members include Midea, Langchao, Beijing Leader Group, Datang, China Software Testing Center (CSTC), Research Institute of TV and Electro-Acoustics, Beijing Electronics Instrument Industry Association (BEIIA), Freescale Semiconductor, Echelon, Alerton, and UIITEC.

[7] See ITopHome's home page for a comprehensive membership list: http://www.itophome.org.cn/.