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Testimony

Before the

US-CHINA ECONOMIC & SECURITY REVIEW COMMISSION

Hearing on

"*China's High-Technology Development*"

Thursday, April 21, 2005
Palo Alto, CA

Thank you Commissioners D'Amato and Mulloy and other members of the Commission. It is my distinct pleasure to speak before you once again, particularly in the company of this very esteemed panel.[*]

It is particularly fitting that this meeting be held at the heart of US high-tech innovation. That Silicon Valley and other technology centers around the United States remain home to the world's most successful and competitive technology innovators is in America's strategic and economic interest. China's recent science and technology (S&T) advances and growing innovative capacity present a new challenge to US innovation, but not yet one that is overtly threatening nor insurmountable. It is emerging quickly, however, and requires vigilant monitoring and constant analysis. Improving our understanding of China's S&T objectives, capabilities, and future plans will aid US industry, if supported by the Executive and Legislative branch initiatives, to maintain our competitive edge. So, I commend the Commission on holding this hearing and focusing on this vital issue.

In your invitation, you laid out several questions related to China's S&T efforts and issues related to funding, standard-setting, foreign investment, and foreign corporate R&D in China. Let me take each of these issues in order.

China's Science and Technology Policy: Current Priorities and New Directions[1]

The PRC government continues to play a central role in Chinese science and technology development as well as in promoting high-tech industry innovation. As is PRC government practice, Beijing continues to

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outline the nation's long-term priorities and plans for S&T development. The latest of these —the 10th Five-Year Plan (FYP) for 2001-2005— is coming to a close. Among the plan's objectives were to double GDP by the year 2010, to increase overall spending on research and development (R&D) to 1.5% of GDP (a goal carried over from the earlier 9th FYP), to prioritize spending on "pillar industries" and key strategic technologies (including information technology and electronics), and to reform China's state-owned enterprise R&D system in order to provide China with a capacity to leap ahead in its economic development. Foreign investment, as discussed later, plays an important role in China's plans and continuing S&T development efforts.

While a full account of the success (or failure) of this latest FYP plan must wait another year, it does appear that China has made strides toward its stated goals. Most measures of China's S&T input and output show continued growth, distancing China further from the developing world and toward levels common in more developed, Western economies. For instance, Beijing's spending on R&D reached 1.3% of GDP in 2003, putting the stated 2005 goal of 1.5% within reach. Attaining this goal would be an important achievement, placing the PRC on a fast-paced, upward trajectory and closer to the sustained level of R&D spending of about 2-3% that characterizes the world's most developed and technologically advanced economies. [2] In fact, statistical analysis of China's latest S&T output has led some to suggest that China could be in the early stages of an "S&T takeoff," which would have the PRC joining the ranks of the world's top-tier advanced economies within a decade.[3]

Yet, even if this comes to pass, a nagging question for both PRC policymakers and foreign analysts alike is whether China's success will be sustainable and how dependent it will be on continued high levels of foreign investment. There is no clear answer to these questions and much will depend on China's approach to high-tech development and foreign investment in the coming years. There are both worrisome signs ahead and indications of progress that might ease the way for China's high-tech development to be viewed as a win-win scenario by domestic and foreign investors. (It should also be noted here that China's economic failure would risk a troubling lose-lose situation due to the rising level of global economic interdependence, particularly in innovative, IT-based industries).

First a few words on issues of concern. From a US perspective, China's recent efforts to pressure foreign high-tech investors to collaborate with leading Chinese firms in developing advanced technology (e.g., wireless data encryption, computer software, and secure personal computer terminals) are disturbingly reminiscent of pre-WTO Chinese regulations.[4] Other PRC Government policies favoring domestic firms and technologies over, or to the exclusion of, foreign brands are also of continuing concern, particularly

repeated stories of China's policy on software to be procured for government use.[5] Not only do such policies undermine the confidence of foreign investors in China's long-term market potential, but they risk China's continued high-tech development being viewed abroad as threatening to regional and global interests. Already, there is a rising level of alarm evident in industry and government circles over the rapid pace of international outsourcing and the movement of advanced R&D assets to China and other developing economies; implementing techno-nationalistic, protectionist policies such as these is likely only to reduce the level and type of foreign investment available to the Mainland over time and on which China's long-term S&T plans depend.[6]

Another, related area of concern is China's efforts to develop indigenous-design technology standards. While China's interest in doing so is obvious and represents a goal shared by many states, Beijing's approach to developing home-grown technology standards and their potential application to military technologies poses serious concerns for US economic and security interests. The PRC is pursuing new, indigenously developed technology standards in a number of areas, primarily in the information technology sector, in an effort to become more competitive nationally, regionally, and across the globe.[7] Unlike most other markets, however, China's technology standards are often not the result of market competition, industry preference, or consumer choice but of PRCG priorities. Moreover, as reported in the latest report by the American Chamber of Commerce in China, "…member companies note a growing influence of standards working groups that either preclude foreign participation or attach certain technology sharing conditions. This is especially common where there is government-funded or encouraged R&D, or in sectors where strong resistance to foreign competition exists (e.g., construction and building materials)."[8]

While it is true that foreign investors not interested in abiding by Chinese standards have the ability to opt out, the reality is that the China market has become such an influential and integral part of the global economy that whatever standard(s) prevail on the Mainland is likely to have global impact as well. There are few companies, including multinationals, willing or able to compete against such a force.[9] Consequently, many foreign investors in the China market are quietly hedging their bets by developing new product lines compatible or interoperable with new or expected PRC standards.

Indigenously designed technology standards are also intended to aid China's military modernization efforts. PRC defense industrial modernization increasingly relies on commercial technology spin-on to defense applications.[10] As with the US military, China is seeking to exploit the ubiquitous nature of dual-use technology in a global economy and the move toward modular production in both commercial and

defense industrial development. The emphasis on technology standards developed to Chinese specifications is expected to help reduce China's vulnerability to foreign supply, enhance China's competitiveness, and to limit opportunities for possible hacking, backdoor programming, or sabotage by foreign agents. The process of developing indigenous technology standards could also aid China in overcoming the hurdle of advanced systems integration. Though normally considered an important chokepoint in China's development efforts (particularly on the defense side), systems integration could be less of an obstacle for China than generally presumed given ongoing R&D collaboration at foreign-invested R&D centers in China that often involve systems integration activities with, by, or for PRC partners.[11]

In fact, the number of foreign-invested R&D centers in high-tech industry sectors in China continues to rise, apparently rapidly. The latest statistics emanating from China's own studies of this phenomenon list the total number of foreign high-tech R&D centers in China at 750 (as of the end of 2004). China's statistics have varied widely over the past few years, with the most recent tally suggesting a one-year rate of growth of 200 new R&D centers in the 2003-04 period alone.[12] This would seem extraordinary. While the measures used in determining this and previous totals are unknown (and thus their accuracy uncertain), indicators elsewhere also show the rate of overseas high-tech R&D investments rising at a fast clip. Statistics from the US Bureau of Economic Analysis show that US R&D investments in China have risen exponentially (from $7m in 1994 to over $500m in 2000), achieving the 11th spot overall in 2000 in US overseas R&D investments (up from 30th place just six years prior). Given the rapid acceleration of foreign-invested R&D in China in the years since, it is likely that the Mainland holds an even higher place in overseas US R&D investment today.[13] In addition, a recent survey on the "Globalization of R&D" conducted with 100 senior high-tech executives by the Economist Intelligence Unit found that the majority (39%) favored China as the site for future overseas R&D investments over the next three years; the US trailed at 29% and India at 28%.[14] Thus, foreign R&D investments in China represent an important trend and likely key, contributing factor to China's high-tech development. Beijing supports this trend by continuing to provide attractive investment, tax rebate, and other financial incentives to foreign investors.

Lastly, another interesting trend, though still in an early stage of development, is an emerging "techno-regional" approach to high-tech development. In the IT sector, China, Japan, and South Korea have signed agreements to collaborate on developing new technologies primarily, though not exclusively, for the Asian region.[15] The three "CJK" parties have agreed to co-develop products in at least seven areas of IT technology, including 3G and next-generation mobile communications, next-generation internet

(IPv6), digital TV and broadcasting, network and information security, open source software, telecommunications service policies, and the 2008 Beijing Olympics.[16] This model of development was recently applied in developing a new Linux-based computer operating system ("Asianux") developed for the Asia market by China's Red Flag Software Co., Japan's Miracle Linux Corporation, and (since the product's debut) Korea's Haansoft software company.[17] Asianux was developed in cooperation with the US firm, Oracle through joint work reportedly conducted at Oracle's China-based R&D center.[18] While the political issues and challenges surrounding this model of development are significant, this apparent new regional approach to collaborative high-tech R&D could yield interesting and impressive results if these issues can be overcome. This model might also be applied with other neighboring states in Northeast, Southeast, and South Asia, as suggested by recent statements promoting increased Sino-Indian high-tech collaboration.[19] If so, in these relationships, China is likely to continue to serve as the hub for regional high-tech investments, development efforts, and exports, particularly as China focuses on developing the central and western parts of the country, which are hungry for foreign investment akin to that witnessed along China' east coast.

This leads to your question: Is China successfully integrating R&D and know-how from foreign companies into the development of competitive domestic technology firms? The answer is probably, yes. Anecdotal evidence and ongoing studies of the impact of foreign technology transfer and R&D in China and elsewhere suggest this is the case.[20] A recent UN analysis describes the typical process this way:

> …while the innovation function of TNCs [transnational corporations] is the slowest to relocate from the home country, particularly to developing countries, it *does* shift to affiliates over time. Given the availability of the high-level skills and infrastructure (including R&D institutions and universities of sufficient quality), affiliates in developing countries do start to conduct R&D. They initially start with simple adaptive tasks, move on to process development, then move to product development and finally to basic ("blue sky") research. Only a few economies have reached this stage, for example Singapore, Brazil, India, the Republic of Korea and Taiwan Province of China (China is catching up fast), and the amounts involved are small relative to TNC R&D in advanced economies, but the trend is clear.[21]

Additionally, recent statistical analysis of foreign and domestic high-tech R&D firms in China finds that China's own enterprises appear to be more innovative, efficient, and profitable than many foreign-invested firms operating on the Mainland.[22] Nevertheless, hard and compelling data on the R&D phenomenon in China are hard to come by and may only become available once a large number of PRC

high-tech firms have emerged as competitors in the China market and beyond (which might be interesting from a historical perspective, but would come too little, too late for US industry). The prudent, course, therefore is to assume, based on past experience in other developing countries, that PRC firms will learn from this dynamic, which if anything has been accelerated by recent globalization dynamics, and will become more competitive and innovative more quickly than imagined. This also places the emphasis where it belongs: on what the US approach will be to an increasingly high-tech Chinese economy.

US Policy Response to Rising High-Tech Competition from China

Several studies have been published over the past year or so examining the impact that globalization — and China's economy in particular— are having on US high-tech industry. Among these is the recently published, *Task Force on the Future of American Innovation*, the Council on Competitiveness' *Innovate America*, and the Electronic Industries Alliance's *Policy Playbook on Innovation and Global Competitiveness*.[23] The common denominator among all these efforts is that US technology policy is lacking in its response to the growing challenges posed by China and other developing countries in a global economic environment conducive to increasingly advanced forms transnational research and development. As the evidence mounts that this trend is growing and likely to be a lasting phenomenon, US policy must keep pace.

Among the suggestions made in these reports and that make sense in the context of the US-China trade relationship are the following:

- **Increase funding for basic or fundamental research**, which remains the key driver of innovation, development, and market competitiveness. US Government funding of basic, non-defense R&D has declined over a number of years as China and other states are increasing their funding levels. Although US funding overall far outpaces China's, basic R&D funding represents an investment in America's future and must remain a priority and be sustained over time if the US economy is to maintain its competitive edge.

- **Work more closely and regularly with industry to analyze this complex challenge and to devise appropriate policy responses**. Industry is on the front lines of this global phenomenon and the best situated to identify new and important challenges to US economic competitiveness. Whatever policy prescriptions are decided must also ensure that these measures aid rather than impedes US business and investment. Regular meetings of a high-level body comprising leading high-tech industry representatives, US Government officials, and academic experts would benefit

each community in keeping track of, and responding to, emerging challenges posed not only by China but by ongoing, fast-moving economic forces having an impact around the globe. The National Academies' Government-Industry-University Research Roundtable (GUIRR) serves this purpose in part. However, such meetings would ideally involve a larger cross-section of experts, be conducted even more frequently, and be free and open to the public.

- **Work more closely with PRC counterparts**. Chinese and American officials as well as analysts are trying to get a better read on overseas R&D investments and other aspects of globalization. While scientific and governmental exchanges occur regularly on a bilateral and multilateral basis in official and informal settings, these could be expanded further, if backed by US Government funding, to improve cooperation on collecting data and discussing data collection techniques in the context of changing global economic dynamics. This is a common problem and could be addressed more effectively through enhanced cooperation and transparency.

- **Finally, the re-constitution of a resource such as the former Office of Technology Assessment** (OTA) would be highly beneficial in gathering the interdisciplinary expertise that is needed to confront the challenges outlined in this hearing. The problem is too large and fast-changing for any single analyst, team, or even institution to monitor, much less analyze while taking into account the United States' myriad economic, political, and security interests. An OTA-style research and analysis unit, particularly located in the Legislative branch, would be a welcome asset and reserve in effectively confronting the ongoing challenges posed by globalization.

In Beijing, meanwhile, officials have begun to formulate the goals to be set out in the next or 11th Five-Year Plan, which will guide Chinese S&T efforts over the period 2006-2010. This plan will no doubt include further lofty objectives to which China's S&T community will aspire. It is likely that among these goals will be to reach an R&D per GDP spending rate of 2%. Another focus, according to press reports, will be on enhancing domestic development efforts, particularly in China's central and western provinces, in part to alleviate the widening disparity in income between coastal and inland areas. Also, in the next phase of China's technological development, Beijing is seeking to move China from an imitation to an innovative stage of production or, put more colloquially, from "made in China" to "made by China." Beijing's strategy of pursuing "informatization" in civil and military development and the promotion of indigenously developed high-tech standards are designed to further this "made in China" goal.

But perhaps more important than China's stated goals in the upcoming plan will be how PRC officials seek to achieve these objectives. The upcoming FYP may be telling in this regard. If, as recent press reports suggest, the next strategic plan focuses more on establishing guidelines than on outlining a detailed "blueprint" and specific targets for S&T development, it may reflect a new and more successful approach to enhancing China's S&T capabilities.[24] That is, the plan could more resemble long-term development strategies followed in technologically advanced economies than the PRC's own traditional planning documents. If so, this would suggest a new understanding of modern S&T development and innovation policy and could prove more successful than past plans, which have not fared particularly well against the historical record. In this case, we could witness a more S&T-advanced industry on the Mainland than previously expected, perhaps within the next five or so years.

PRC officials have of late also shown greater flexibility in planning and their approach to S&T development, demonstrating a willingness to review funding programs, alter course if necessary, and experiment on an interim basis. China is also becoming more transparent in its S&T statistics and analysis, in other words, willing to admit some failings as well as successes. As a result, efforts to engage PRC experts and officials on what are sometimes sensitive issues are becoming easier and bearing more fruit than in the past. This presents a potential new opportunity for US-China relations.

I thank you for your time and consideration of these remarks. I look forward to any questions you may have.

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ENDNOTES

[1] Much of this discussion is taken from material included in a paper entitled, "China's S&T Strategy: Drivers, Dynamics, and New Directions," prepared for a conference on "*Chinese Military Modernization and East Asian Security: Political, Military, and Defense Industrial Responses*" (Maui, Hawaii, Center for Strategic & International Studies, May 19-20, 2005).

[2] For data on China's S&T progress, see National Bureau of Statistics (NBS) of China, *Chinese Statistical Yearbook 2003*, no. 22 (Beijing: China Statistics Press, 2003); and National Science Board, *Science & Engineering Indicators — 2004* (Arlington, VA: National Science Foundation, 2004). For context, see Albert Hu and Gary Jefferson, "Science and Technology in China," Prepared for Conference 2: China's Economic Transition: Origins, Mechanisms, and Consequences," Preliminary Draft (29 October 2004), accessed online at http://people.brandeis.edu/~jefferso/res.html.

[3] According to Jefferson's analysis: "S&T takeoff is defined here as an abrupt increase in a country's ratio of research and development (R&D) spending to GDP from less than one percent to more than two percent. For these large, high-income economies, this remarkable acceleration in the ratio of R&D spending to GDP occurred on average within the span of a single decade." See Gary H. Jefferson, "R&D and Innovation in China: Has China Begun Its S&T Takeoff?," Prepared for the *Harvard China Review (*August 11, 2004)., p. 1.

[4] The first case involving China's Wireless Authentication Privacy Infrastructure (WAPI) data encryption technology is well-known and initially required foreign invested enterprises to collaborate on development with a select set of domestic firms. This case was resolved, at least tentatively, with China's agreement at the 2004 Joint Commission on Commerce & Trade to indefinitely rescind it's policy. Another case recently reported in the media suggests that foreign pc makers will be expected to collaborate in some fashion with China's leading pc company, Lenovo, if interested in competing in China's future pc terminal market. Fiona Chou, "China's WAPI Evokes Foreign Protest," *Telecom Asia* (March 2004); Lenovo Launches China's First Security Chip, *SinoCast China Business Daily News* (April 12, 2005).

[5] See, for instance, Mure Dickie, "Beijing reviews rules on foreign software buying Procurement Policy," *Financial Times* (April 12, 2005). China is also reported to be favoring domestic firms to the detriment of foreign investors in other sectors such as semiconductors. See "China-IC-Policy," *China Business News Online* (April 7, 2005).

[6] See, for instance, articles on outsourcing to China and elsewhere appearing over the past year in *Business Week*, *CIO Magazine*, *Technology Review*, among other venues. Pete Engardio and Bruce Einhorn, "Outsourcing Innovation," *Business Week* (March 21, 2005), pp. 84-94; Christopher Koch, "Innovation Ships Out," *CIO Magazine* (January 15, 2005), online at http://www.cio.com/archive/011505/outsourcing.html; Corie Lok, "Where's My Job?," *Technology Review* (April 2004), pp. 74-75, online at http://www.technologyreview.com/purchase/pdf_dl.asp?79juh=337948&hy6f0=16564.

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

[8] The report also notes that creating new technology standards was highlighted recently as an overall strategy outlined by the Science & Technology and Education Leading Group (which falls under China's civilian State Council) in a draft report published in 2004 entitled "*Study on the Construction of National Technology Standard System*." The AmCham report also notes that the PRCG plays a "key role" by funding most and approving all national standard projects. See American Chamber of Commerce in China, "White Paper on American Business in China (2004).

[9] Deloitte Touche Tohmatsu , "Changing China: Will China's Technology Standards Reshape Your Industry?" (July 2004), available online at < http://www.deloitte.com/dtt/cda/doc/content/DR_ChangeChina_July2004%281%29.pdf>.

[10] China's spin-on approach has evolved since Deng Xiaoping first announced the strategy of "Combining the Military and Civilian Sectors" (*junmin jiehe*). Today, the emphasis is less on defense conversion than on spin-on activities by civilian and defense industry enterprises for, or in concert with, China's military (the PLA or People's Liberation Army). China's emphasis on "coordinating military and economic development" is noted in Beijing's most recent *Defense White Paper*. See Information Office of the State Council, "China's National Defense in 2004" (December 2004). See also Tai-Ming Cheung, "Harnessing the Dragon: Civil-Military Integration and China's Defence Modernisation," Richard H. Yang, ed., CAPS Papers No. 36 (Taipei: Chinese Council of Advanced Policy Studies, January 204), particularly pp. 4-5.

[11] On the commercial side, see Kathleen Walsh, *Foreign High-Tech R&D in China: Risks, Rewards, and Implications for US-China Relations* (Washington, DC: Henry L. Stimson Center, 2003); and, for instance, "China, EU, and Galileo," *GPS World* (September 1, 2003). Regarding the defense sector, see Richard D. Fisher, "The Impact of Foreign Weapons and Technology on the Modernization of China's People's Liberation Army," commissioned report for the US-China Economic and Security Review Commission, January 2004; and Eugene Kogan, "Russo-Chinese aerospace cooperation on the up: over 100 joint defence programmes are believed to be in progress; joint development of a commercial transport could be on the way," *Interavia Business & Technology*, no. 669, vol. 58; p. 17 (1 January 2003).

[12] Excerpts from China's Ministry of Commerce's think tank, the Chinese Academy of Foreign Trade and Economic Cooperation, *2005 Report of Transnational Corporations in China*, cited in "Overseas Investment on the Up," *China Daily* (February 1, 2005).

[13] For information on foreign R&D centers in the ICT sector, see Walsh, *Foreign High-Tech R&D.*

[14] See "China is #1 for R&D Investments," *Economist Intelligence Unit* (October 2004).

[15] Suttmeier and Yao; Martyn Williams, "Major Asian IT Groups to Collaborate on Open Source," *InfoWorld* (November 14, 2003), http://www.infoworld.com/article/03/11/14/HNasianitgroups_1.html;

[16] See Ministry of Public Management, Home Affairs, and Posts and Telecommunications (MPHPT), *Communications News*, vol. 12, no 22 (February 4, 2002), online at http://www.soumu.go.jp/joho_tsusin/eng/Releases/NewsLetter/Vol12/Vol12_22/Vol12_22.html; MPHPT, *Communications News*, vol. 13, no. 14 (Oct 2002), online at

http://www.soumu.go.jp/joho_tsusin/eng/Releases/NewsLetter/Vol13/Vol13_14/Vol13_14.html#3; and MPHPT, "Results of the Second China-Japan-Korea ICT Ministerial Meeting," *Communications News*, vol. 14, no. 12 (September 26, 2003) online at http://www.soumu.go.jp/joho_tsusin/eng/Releases/NewsLetter/Vol14/Vol14_12/Vol14_12.html#3.

[17] Research conducted in Beijing (May 2004). Kathleen Walsh, "Sino-Korean IT Industry Cooperation and Regional Security Implications" paper commissioned by the Center for Strategic and International Studies (CSIS) International Security Program (June 2004).

[18] "Asianux Gains Strength as Oracle Pledges Support," *ITNetCentral* (26 July 2004) accessed online < http://www.itnetcentral.com/article.asp?id=13764&icontent=17147>. See also joint news release, "Official Signing Redflag Software, Miracle Linux and Haansoft for Co-development of 'Asianux'" (October 6, 2004), accessed online < https://www.miraclelinux.com/english/press/2004/102601.html>.

[19] China is planning to cooperate with Indian software companies to form an industrial alliance, according to the Sino-India Cooperative Office, which was established in December 2004. See "China and India join forces in software," Sina.com (March 10, 2005), online at http://tech.sina.com.cn/it/2005-03-10/0342546148.shtml

[20] See, for instance, recent work by economist Gary Jefferson of Brandeis University on R&D in the China market, available online at http://people.brandeis.edu/~jefferso/res.html. Also, see Maximilian von Zedtwitz, Managing Foreign R&D Laboratories in China," *R&D Management*, vol. 34, no. 4 (September 2004), pp. 439-452.

[21] United Nations Conference on Trade and Development, "Investment and Technology Policies for Competitiveness: Review of Successful Country Experiences," Technology for Development Series, UNCTAD/ITE/IPC/2003/2 (New York, NY: UNCTAD, 2003), p. 12.

[22] Jefferson, "R&D and Innovation in China: Has China Begun Its S&T Takeoff?".

[23] For copies of these reports and supporting materials, see http://www.futureofinnovation.org/, http://www.compete.org/pdf/NII_Final_Report.pdf; and http://www.eia.org/docs/innovation_playbook.pdf.

[24] Xu Binglan, "Plan Ponders Most Pressing Issues," *China Daily* (6 April 2005), http://www.chinadaily.com.cn/english/doc/2005-04/06/content_431623.htm.