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Beijing's Innovation Strategy: Threat-Informed Acquisition for an Era of Great Power Competition

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Abstract

The 2018 National Defense Strategy defined a new great power contest. Both the United States and China treat an upper hand in science and technology (S&T) as the determinative variable in today's contest. But they disagree over what the upper hand entails. Discourse in the United States revolves around pioneering basic research. By contrast, China prioritizes applications. Beijing's strategic discourse and resource allocations focus on deploying rather than developing cutting-edge capabilities. They focus on doing so at pace, with scope and scale, under State control. This is innovation of application. Beijing's innovative orientation rests on the ease of acquiring basic research and development (R&D) from the open global system. It is also premised on a new, paradigm for power. Tailored to a world of network-defined interaction, this paradigm is measured by scale and influence, not force and lethality. It de-emphasizes traditional tools and battlefields in favor of controlling networks, standards, and platforms. It plays to China's enduring strengths of scale, scope, and centralization. Beijing's approach to innovation will shape how it prioritizes, allocates resources, and measures standing in the unfolding great power contest. Those decisions will in turn shape the U.S.–China strategic dynamic as well as the U.S. military's operating environment.

Introduction

Science and technology constitute the core element defining the evolution of the geopolitical landscape. As the information revolution leads society to the information age, geopolitics will undergo a transfer of power.

–Zhang Yan [张妍] (2011), China's Ministry of Foreign Affairs

The 2018 National Defense Strategy defined a new great power competition. For decades, Beijing's strategic discourse has described an existential contest between the United States and China. Deng Xiaoping suggested as much in his "hiding and biding dictum, coined in the late 1980s."[1] Even earlier, Mao Zedong had promised that "in the future, China will use force" (Shou, 2017). As China sees it—and the United States increasingly realizes—the contest is coming to a head now, today.[2] "The 'Peace under the United States' that began in 1945 in

[1] China would slowly, subtly build its strength until the time came to strike.

[2] "China's overall national strength is already the second in the world," wrote Yan Xuetong, Dean of Tsinghua University's School of International Relations, in 2013. "The next decade will be China's time to 'leapfrog' the United States" (Yan, 2013).

international politics is about to end," prophesied retired People's Liberation Army Commander Wang Xiangsui in 2017. "After a century of sinking, China is reemerging" (Wang, 2017).

Both the United States and China treat science and technology (S&T) as the determinative variable in today's great power competition contest. Revolutionary advances in S&T are creating new possibilities for and modes of power projection (de La Bruyère, 2020). Leadership over these advances promises to define the world order. If Beijing can pull ahead, it can "leapfrog" the United States. If the United States can maintain its technological superiority, it will cement its incumbency.[3]

But China and the United States disagree over what an upper hand in S&T means. They diverge on what victory looks like in the modern contest, and by extension, how to accomplish it. The United States focuses on pioneering basic research and fundamental S&T, on developing the new capabilities that will define the new era. In 2019, responding to competition with China, Senator Chuck Schumer proposed a five-year, $100 billion "fundamental" research program in artificial intelligence, quantum computing, and telecommunications (AIP, 2019). "What we need to do is have the federal government have a dramatically increased investment in AI, in the basic research, in the pure research," he explained. "We need to match and exceed their [China's] level of commitment" (AIP, 2019).

But China's commitment is differently oriented. Beijing prioritizes applied research rather than basic research. China's strategic discourse and resource allocations focus on deploying rather than developing cutting-edge capabilities. They focus on doing so at pace, with scope and scale, under State control. This is innovation of application. Beijing's innovative orientation rests on the ease of acquiring basic research and development (R&D) from the open global system. It also rests on a new paradigm for power. Tailored to a world of network-defined interaction, this paradigm is measured by scale and influence, not force and lethality. It de-emphasizes traditional tools and battlefields of confrontation in favor of control—over networks, standards, and platforms.

Beijing's paradigm does so across the military and the civilian. China's new-type power projection is both informed and fueled by Beijing's national-level military–civil fusion (军民融合) strategy. Military and civilian transfer S&T in a constant flow. They deploy that S&T for an intertwined coercive end. Their networks are fused, propelling not military or civilian interests but rather a comprehensive national interest (de La Bruyère & Picarsic, 2019).

In competing, Beijing benefits from its inherent advantages of scale and scope. Beijing benefits from its ability to weaponize civilian and commercial actors and their one-sided integration into international systems. Beijing also benefits from the natural U.S. inclination to assume a symmetrical competition; that China will, like the United States, compete by investing in basic research and embark upon a familiar innovation race. Beijing actively encourages such mirror-imaging. It fuels U.S. investment in basic R&D that China in turn siphons. It also blinds U.S. analysis to the reality of China's strategic positioning.

Beijing's paradigm is not necessarily bound to succeed. But it will shape how Beijing prioritizes, allocates resources, and measures standing in the unfolding great power contest. Those decisions will in turn shape the United States–China strategic dynamic and the U.S. military's operating environment. If the DoD is to engage successfully with China's competitive threat and deliberate messaging, it must understand China's particular strategic orientation. Such an understanding does not presently exist. The gap is a product of the PRC's opacity. It is

[3] "There will be a new revolution in science and technology within the next ten to twenty years," explains the Chinese Academy of Science's 2009 Roadmap for 2050. "This is a huge challenge for us. At the same time, it is a great opportunity for the rejuvenation of the Chinese nation" (Chinese Academy of Sciences, 2009).

also a product of China's asymmetrical strategic orientation, which requires a fresh, focused analytical framework.

This paper seeks to help fill that gap. It begins with a survey of Beijing's particular approach to S&T investment—oriented not around rivaling other advanced economies in innovative potential, but rather on siphoning their innovation at low cost and low risk while focusing on applications. The paper's second section describes Beijing's approach to application: Beijing prioritizes integrated real and virtual networks, as well as leverage over global supply chains. The third section explains the strategic theory behind Beijing's particular approach, one informed by platform geopolitics and resting on the role of system-design and network effects in an exchange-based world. The fourth section presents a concrete example of China's approach in the form of Beijing's international logistics information network, while the conclusion outlines immediate implications for the DoD's adversary-informed approach to innovation.

Why Buy When You Can Rent?

Beijing's S&T agenda is based on two, twin elements of the modern global environment. First, innovative resources—both military and civilian—are easy to come by. Second, victory in a world of exchange is premised not on having the best technology but on building the global systems in which technology is deployed and information is transmitted.

Beijing's outward-facing messaging harps on the need for domestic innovation. But Beijing's internal strategic discourse and policy do not. China has oriented its S&T apparatus around obtaining innovation, research, and development from abroad—for both military and civilian purposes. As Hou Qiang of Jiangsu Institute of Technology's Institute of Marxism puts it in a paper supporting Beijing's National Social Science Planning Project, Beijing deploys a "one-sided strategic policy in international high-tech cooperation" (Hou, 2019). That one-sided strategy manipulates access to today's open, global system to acquire cutting-edge innovation at low cost and low risk. Thus positioned, Beijing can focus, more effectively and efficiently than its global peers, on deploying and applying the advanced S&T it acquires from abroad for competitive advantage.

Beijing's is a deliberate orientation, based on careful calculations of both efficiency and effectiveness. China recognizes the limitations of its "innovative" capabilities. The global system readily offers a solution at low cost. Qiaohai Shu of the Chinese Academy of Social Sciences explained the logic in 2011:

> China's technological innovation cannot catch up with the developed countries in the West. … It is necessary to find another path. … It is not only time-consuming and laborious to bet on innovation, but also risky. However, at the level of technology *application* [emphasis added], the gap between domestic and foreign is small, and the opportunity cost of surpassing low. Moreover, the chances of getting the desired result are greater. (Qiaohai, 2011)

Wang Xiangsui suggests the same. "The transcenders are usually the best students of the leader. They not only inherit the teacher's advanced system and technological innovation, but also make significant improvements to these systems and technologies" (Wang, 2017). Accordingly, the Chinese Academy of Science's Roadmap for 2050 lays out the plan: Beijing's S&T strategy should "absorb various S&T innovation resources across the world, and selectively bring in professionals, intellectual resources, technologies, and management" (Chinese Academy of Science, 2009).

China integrates into the global innovation ecosystem with a web of educational exchanges and "talents programs," ostensibly private venture capital investments, strategic limited partnership stakes in third party investment funds, cooperative research hubs at home and abroad, predatory joint ventures, and of course, explicit espionage. These fuel low-cost access to cutting-edge advances across the world. Take the teams of Chinese students in U.S. research labs or Chinese professionals in cutting-edge U.S. technological firms whom Beijing then lures back—with both heady incentives like the Thousand Talents Program [千人计划] and fear of the reverse—to apply their expertise at home.[4] Take Baidu, Alibaba, and Tencent's R&D hubs in Silicon Valley. Or take the "Two Machines Special Project," a national Chinese industrial plan that directs Chinese State champions to partner with foreign companies—Siemens, General Electric, and Mitsubishi—in order to acquire their jet engine and gas turbine technologies (de La Bruyère & Picarsic, 2020a).

Beijing's parasitic S&T activity is increasingly recognized. In February 2020, Charles Lieber, chair of Harvard University's chemistry department, was arrested for selling knowledge to China, through their Thousand Talents Program. His arrest came two years after Attorney General Jeff Sessions launched the U.S. Justice Department's China Initiative, a program dedicated to preventing China's asymmetric acquisition of U.S. innovation (Brumfiel, 2020). Tesla has accused China of stealing billions of dollars' worth of secrets (Bloomberg, 2019). When China put in a bid to lead the United Nations' World Intellectual Property Organization (IPO), the response in the United States was one of outrage: "Why would you want to put the fox in charge of the henhouse?" asked a former WIPO deputy director-general (Lynch, 2019).

Less recognized is the degree to which Beijing's R&D siphoning stems from a centralized system of planning and oversight—and the extent of that system. In 1986, the State Council issued the "Regulations on the Introduction of Foreign Technology to Digest and Absorb" [引进技术消化吸收工作条例] and the Fifteen Year Science and Technology Plan, which outlined a series of policies and measures to, as the plan puts it, "strengthen international S&T cooperation and introduction of technology" (State Council of the People's Republic of China, 1986), That 15-year plan culminated with accession to the World Trade Organization (WTO) in 2001.

With accession, Beijing initiated a series of dedicated five-year plans for international S&T cooperation. The first, promulgated in 2001, called for "expanding the fields, channels, and methods of international economic and technological cooperation … supporting overseas cooperation in developing domestically scarce resources, [and] encouraging enterprises to use foreign intellectual resources to set up research and development institutions and design centers abroad" (Hou, 2019). In line with that tasking, the Ministry of Science and Technology (MOST) established a Special Office for International S&T Cooperation.[5] In 2003, MOST also set up a program of international S&T cooperation industrial parks. Between 2001 and 2005, the Special Office launched a total of 677 international S&T cooperation projects. It led investment of some 8.439 billion RMB (about $1.2 billion) in international S&T cooperation (Hou, 2019).

When MOST refreshed the five-year planning for international S&T cooperation in 2006, it made foreign S&T cooperation and exchange a priority for the entire range of national S&T plans, programs, and priorities—the National Science Foundation, 211 and 985 projects, and

[4] And this does not apply just to Chinese nationals. Beijing uses the same tactics to co-opt the most promising foreign talents in the most promising technological fields. The Tencent AI fellowship offers a prime example. So does the case of Harvard University Chemistry Department Chair Charles Lieber (Brumfiel, 2020).

[5] "According to the National Congress of the Communist Party, the office's purpose was better to integrate the 'introduction' [of technology] and the 'going out' [of companies] by supporting enterprises' international operations in research and development, production, and sales" (Hou, 2019).

national high-tech research and development plans. This move underlined that so-called S&T cooperation was as much a military as a civilian tool. Foreign targets were to be selected according to national development plans and projects, but also national security requirements. The 2017 edition of the five-year plan for international S&T cooperation added a new layer of centralized, top-level organization and oversight (Hou, 2019).

That top-level organization oversees an immense arsenal of technology acquisition tools. Overseas R&D centers, exchanges, and industrial parks are just the beginning. There is weaponization of commerce: Chinese "Go Out" champions receive State support to form joint ventures with high-tech companies (de La Bruyère & Picarsic, 2020a). Beijing has a dedicated class of subsidy for the import of advanced technology (Horizon Advisory, 2020). China weaponizes capital, too: Chinese State–owned and –backed funds funnel money to U.S. fronts that in turn invest in cutting-edge, often dual-use technologies (Horizon Advisory, 2020). This process manages to skirt existing investment review mechanisms and monitoring, granting Beijing access to sensitive technological domains.

If the coordination and extent of Beijing's technology acquisition is underestimated, the deliberate strategic positioning behind it is overlooked. Conventional Western analysis assumes that Beijing's parasitic technological siphoning is a short-term fix—and a sign of relative weakness. As conventional wisdom has it, Beijing wants to out-innovate the United States. China will only rely on siphoning foreign technologies until it can achieve as much—it steals to reach parity so that it can then compete symmetrically to rival global leaders in advanced R&D.[6] This hypothesis predicts that as Beijing earns its S&T chops—largely through international engagement—it will increasingly devote its attention to basic and fundamental areas; not to stealing those from abroad, but from developing them at home. Chinese messaging to the United States encourages this mirror-imaging. Beijing tells its interlocutors in Washington that its "indigenous innovation" is modeled after the fundamental innovative capacity of the developed world (Laskai, 2019). The United States responds by investing more in basic R&D. Beijing siphons that R&D.

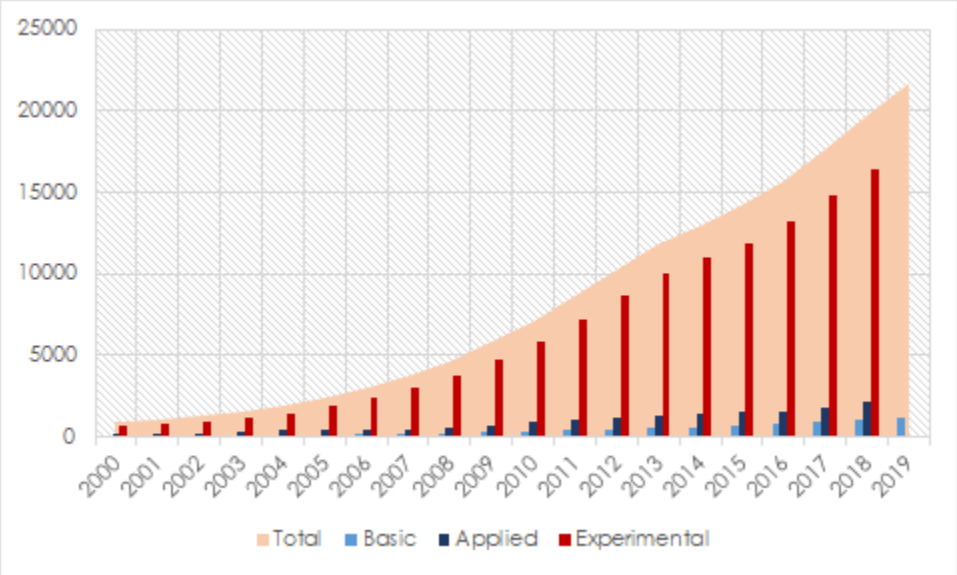

Figure 1. China's R&D Expenditures, 2000–2019 (100 mm RMB)

[6] See, for example, James Manyika, William McRaven, and Adam Segal, "Keeping Our Edge: Innovation and National Security Force Report," Council on Foreign Relations, September 2019.

Chinese strategic discourse and resource allocations suggest otherwise. They suggest that Bejijng's "one-sided strategic policy" of integration into the global innovation ecosystem might be a long-term orientation. The 2006 National Medium- and Long-Term Program for Science and Technology (MDLP) is seen as the guiding document for Beijing's S&T efforts. Western analysts frequently cite it as evidence that Beijing intends to innovate according to the U.S. model, referencing its emphasis on "indigenous innovation." But the MDLP's definition of "indigenous innovation" is not that of the United States. "Indigenous innovation refers to enhancing original innovation, integrated innovation, and re-innovation *based on assimilation and absorption of imported technology* in order to improve our national innovation capability" (State Council of the People's Republic of China, 2006, emphasis added).

China can obtain innovation from the open, global system at low cost and low risk. Then it can dedicate its resources to applying that innovation first and to scale. Beijing's investments in international S&T cooperation have only increased since 2001. They have made Beijing a powerhouse in applied and experimental research. But there has been little concomitant increase in investment in basic research. China has become a player. It has not changed its game.

Compared to other advanced economies, Beijing invests shockingly little in fundamental S&T or cutting-edge capabilities. This is true in both the civilian and the military domains. According to MOST's statistics, Beijing spends only about 10% of its R&D funds on basic research. That figure has been largely constant over the past 20 years. Other developed economies spend upwards of 70% of their R&D on basic research in particular fields. Yes, Chinese government statistics must be taken with a grain of salt. But trends and ratios remain telling.

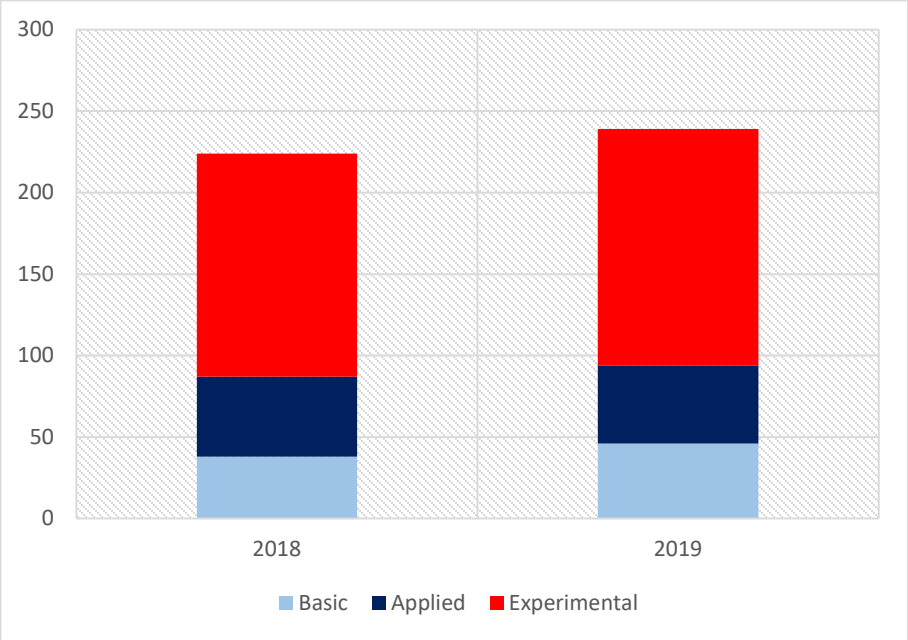

Figure 2. Breakdown of Research Maturity in National S&T Prizes, 2018 and 2019 (Per China's Definition)

More granular Chinese empirics bear the story out. Beijing rewards and encourages S&T development through a centralized, institutionalized process. Every year, MOST awards

some 200 researchers and teams prizes for outstanding achievements in S&T. Candidates are recommended by provinces, ministries, and institutions (e.g., the Chinese Academy of Sciences). Winners receive a cash prize. They receive more than the equivalent in reputational advance: MOST's national-level prizes define success in the Chinese S&T ecosystem. They shape not just individual researchers' status but also that of the institutions to which they belong. These are not about messaging. They are about Chinese priorities, perceptions, and progress (National Science and Technology Award Office, 2020).

The relative balance of basic and applied research in the national S&T prizes parallels that of MOST's reported spending. The S&T prizes are broken down into three categories, which roughly map onto basic, applied, and experimental categories of research. In 2018, MOST awarded a total of 225 prizes: 38 of those were in the category designated as basic research, 186 in applied or experimental. In 2019, those figures were 46 and 193, respectively.

Even those statistics understate the reality. The category designated as basic research does not match U.S. definitions thereof. Most of the projects that Beijing awards for advanced in basic research would, in the U.S. system, be considered applied. They tend not to focus on developing new theory or capabilities so much as on testing existent theories, refining existing capabilities, and applying them for practical purposes. For example, winning projects in the basic research category over the past two years have included work on the "age and evolution of China's continent," "the mechanism of selective adsorption of environmental pollutants by nanomaterials and the regulation of water phase separation function," and work on gene mapping.[7] Coding by the authors of this paper suggested that, applying U.S. definitions to the 2018 and 2019 prize lists, only 36 of the 422 recognized projects would be considered basic research.

Applying to Win

This is not to say that Beijing does not invest in S&T. Nor is it to say that Beijing's S&T capabilities are not formidable. It is however to say that Beijing invests differently. Its capabilities are formidable, but according to a particular, and non-traditional, set of metrics. Beijing is investing in the *application* of advanced technology. The broad focus areas of such application are reflected in China's industrial planning, especially the Strategic Emerging Industries Initiative, Made in China 2025, and the nascent China Standards 2035 (Horizon Advisory, 2020). Specific subfields within those emerge in the S&T prizes as well as in research topics of Beijing's National Key Projects for S&T. From those, a two-pronged strategy emerges.

First, China prioritizes capabilities that allow it to control **key nodes in critical supply chains** (e.g., microelectronics). This makes the international S&T—and more broadly economic and security—system dependent on Beijing, securing China's continued access to innovation. Second, Beijing invests in developing, scaling, and exporting the **network infrastructure** that hosts cutting-edge S&T. This may allow Beijing to circumvent the traditional vulnerabilities associated with its downstream position in the innovation chain; to benefit, first, from R&D resources funneled from abroad. Finally, where Beijing does invest in basic research, it tends to prioritize capabilities that grant control of and access to networks and their information.

Beijing's S&T and industrial focus has remained largely consistent over the past 15 years. The MLDP's priority areas align roughly with the Strategic Emerging Industries (first outlined in 2009 and updated consistently thereafter) and the Made in China 2025 industrial

[7] They also included, in 2019, a study on cross-species infection of human influenza virus and its transmission ability.

plan. All are in turn reflected in the 12 National Key Projects for Science and Technology (MOST, 2020):

- microelectronics
- integrated circuit equipment
- broadband mobile communications
- CNC machine tools
- oil and gas development
- nuclear power
- pollution control
- genetically modified agriculture
- new drugs
- infectious disease prevention
- high resolution earth imaging
- manned space exploration

Table 1. Comparison of Research Topics by Chinese Government Initiatives

Medium- and Long-Term Development Plan for Science and Technology (2006): Frontier Technologies*	Made in China 2025 (2015)	Strategic Emerging Industries (2016 update)
The transportation sector and agriculture are included in "main areas and priority topics."	Agricultural machinery and equipment	Energy efficient and environmental technologies
	Advanced rail transportation equipment	
	Energy saving and new energy vehicles	New energy vehicles
Advanced energy technology	Power equipment, especially clean and alternative energy	New energy
Advanced materials technology	New materials	New materials
Information technology	Next-generation information technology	Next-generation information technology
Advanced manufacturing technology	CNC machine tools and robots	Advanced manufacturing
Aerospace technology	Aerospace	
Marine technology	Marine engineering equipment and high-tech ships	
Biotechnology	Biotech and high-performance medical equipment	Biopharmaceutical and high-end medical equipment
Lasers technology		Digital creative industry
		Other services

These broad fields reveal an orientation around three main areas: basic social welfare (e.g., agriculture, pollution), chokepoints in the modern industrial system (e.g., CNC machine tools, microelectronics), and foundational networks (e.g., information technology, energy).

Analysis of Beijing's S&T prizes aligns with that story while fleshing out its details. The prizes are divided into categories for physics and astronomy, math, chemistry, biology, earth science (including environment and water conservation, climate change), medicine (including Chinese medicine, surgery, pharmaceuticals, biotech), information technology (including information science, computers and automation, communication), materials science, engineering (including transportation, civil construction, power), mechanics, agriculture (including agriculture, forestry, crop genetics, aquaculture), light industry, and some miscellaneous categories (popularization of science, electronic instruments, sports).

Both of the past two years reflect outsize focus on medicine, agriculture, information technology, and engineering. The first two are necessary elements for social welfare. They also, as the COVID-19 crisis highlights, provide valuable independence for China while establishing roots of a global system dependent on China, whether for pharmaceuticals or agricultural products. Such one-sided dependence is an explicit strategic priority for China. It is enshrined in the principle of "two markets, two resources" [两个市场两种资源], first enunciated under Deng Xiaoping. The domestic market is to be protected and the international one penetrated; domestic resources are to be insulated and foreign ones siphoned (de La Bruyère & Picarsic, 2020b).

Table 2. Beijing's S&T Prizes 2018 and 2019

Category	2018	2019
Physics and astronomy	2	4
Math	3	3
Chemistry	13	13
Biology	4	5
Earth science (environment and water conservation, climate change)	19	20
Land and resources, oil and gas	14	16
Medicine (medicine, Chinese medicine, surgery, pharmaceuticals, biotech)	**25**	**32**
Information technology (information science, computers and automation, communication)	**29**	**27**
Materials Science	21	24
Engineering (transportation, civil construction, power)	**32**	**32**
Mechanics	15	17
Agriculture (agriculture, forestry, crop genetics, aquaculture)	**27**	**30**
Light Industry	8	8
Other	5	7
Total	217	238

The engineering and information technology prize categories tell a slightly different story. In the first, awards go primarily to work on transportation, especially high-speed rail, and energy systems. They also go to technologies necessary for advanced equipment manufacturing, especially in the aerospace and automotive domain (e.g., aircraft technology). Prizes in the information technology category revolve around information networks and collection: cloud

computing, wireless networks, imaging and image processing, satellite systems. Core physical elements of information technology also figure (e.g., semiconductors and base stations).

Together, the developments in physical transportation and energy infrastructures as well as in information systems and networks add up to the foundation of global exchange—of people, goods, and energy—and their informatization; their ability to collect and disseminate information, as well as to extend across physical boundaries. These are not just the virtual and real foundations of the globalized world. They are also the integration of the two of them.

Control over informatized infrastructure networks is precisely what Beijing defines as the core of today's S&T contest. As the Communist Party of China (CCP) sees it, the S&T revolution underway revolves around the reconstruction of, and transformation in, the world's foundational architectures. The Politburo Standing Committee frames these as "new infrastructures:" 5G, UHV, high-speed railway, new energy vehicles, artificial intelligence, and industrial internet (*People's Daily,* 2020). Ultimately, those disparate parts will connect into what the Chinese Academy of Sciences calls a "ubiquitous information backbone" (Chinese Academy of Sciences, 2009). Control over it, per Chinese discourse, will grant control over, and superior information on, global movement, and with it, control over the globe. And such control is up for grabs. "Industry, technology, and innovation are developing rapidly," explained Dai Hong, director of the Second Department of Industrial Standards of China's National Standardization Management Committee in 2018. "International technology research and development and patent layout have not yet been completed, and global technical standards are still being formed. This grants China's industry and standards the opportunity to surpass the world's" ("National Standards Committee," 2018).

But Beijing does not intend to surpass through basic research. New infrastructure is not some amorphous thing to emerge from nowhere through innovation or new technologies, synergies among them, and Silicon Valley buzz-speak. **New infrastructure is the improvement and transformation of traditional infrastructure.** It is a gradual development that will prompt revolutionary effects. Legacy systems will remain the physical support—or, as a *People's Daily* piece puts it, the "body"—of international movement. They will be equipped with sensors, "the brain" (*People's Daily,* 2020). Those sensors will be powered by data processing systems and high-bandwidth information networks. The result will be a merged real and virtual system that controls both information and physical resources. Wang Xiangsui summarizes Beijing's intentions:

> The emergence of new types of transportation, information, and energy exchange tools such as high-speed railways, information networks, high-voltage power grids, and energy pipelines have broken through the geopolitical concepts of traditional technologies. … Through One Belt One Road, China will establish an integrated information network of railways, highways, shipping, aviation, pipelines, and space—which will undoubtedly transform the existing geo-economic system. (Wang, 2017)

Importantly, one of the few areas where Beijing *does* appear to be pursuing basic research is in the technologies that enable connection between brain and body—as well as control and defense of that connection. Over the past two years, Beijing has awarded basic research prizes to projects in distributed network systems, cross-domain collaborative computing, high-throughput calculation and method, and neural networks. It has also recognized three projects in control theory and two in network security.

These prizes and plans are in theory civilian indicators. But they also apply to Beijing's S&T investment and ambitions in the military domain. China's S&T apparatus is predicated on

the strategic concept of "military-civil fusion" (军民融合; MCF); that "the military is for civilian use, the civilian is military, and the military and civilian are fused" (quoted in de La Bruyère & Picarsic, 2019). Civilian and military domains transfer technology in a constant flow. Ultimately, both civilian and military entities apply that technology internationally for intertwined coercive end (de La Bruyère & Picarsic, 2019). This is no mere rhetoric. Turning once more to the prizes, those ostensibly civilian indicators reflect projects recommended by Beijing's military and MCF apparatus (e.g., the People's Liberation Army, Ministry of Industry and Information Technology, MCF companies like Beidou).

The MCF strategic orientation rests on the same manipulation of the open, global system that propels China's innovation-lite approach to S&T. In a world of increasingly blurred boundaries between military and civilian S&T, military-relevant capabilities can readily be acquired through commercial and civilian interaction. What need, then, to invest heavily at home in their development? "The national defense S&T industry can rely on conveniently absorbing and digesting the latest foreign civilian technology to serve China's national defense military industry and continuously incorporate the high-tech private economy into its own system," wrote Ma Qing Feng of Henan University in 2013 (Ma, 2013). Or, per the Chinese Academy of Social Sciences:

> Under the background of globalization and information age, the new military revolution and the rapid updating of science and technology around the world have made the application of high and new technology in the defense sector and the civil sector increasingly convergent. The boundary between military technology and civilian technology is no longer obvious. Therefore, the integration of military and civilian can optimize the allocation of resources … and achieve dual benefits for military combat effectiveness and economic benefit. (Feng & Zhu, 2014)

MCF rests also on the idea that informatized network control grants, at the same time, military and economic advantages. It promises superior global information and command and control—decisive in an era of information warfare. One beat farther, the information network offers the ability to *shape* the operating environment: the information that the adversary receives in the commercial and military domain and, by extension, his incentives. "Network technology links the world's economy and geopolitics together," explains Wang Xiangsui. "If a war breaks out, it will turn the unified network into a battlefield of confrontation." The United States depends on the network. If Beijing can control that network, it can also ensure that the United States "will not, cannot fight" (Wang, 2017).

A Network Strategy

The Chinese Academy of Sciences describes the network that Beijing seeks to build as a "ubiquitous information backbone for the world" (Chinese Academy of Sciences, 2009). This network links real and virtual economies, controlling both of them.[8] To hold it is to set the rules for global exchange. It is also to collect information on that exchange, and ultimately to shape such information. This translates to determinative commercial and military advantages.

[8] In doing so, this ubiquitous network solves for what Chinese, Marx-informed economic thinking defines as a constant conflict between virtual and real economies—the root of capitalist collapse. See forthcoming analysis from the authors on "China's Bio-Economy Future" at www.horizonadvisory.org/analysis.

In the Chinese rubric, this network contest is zero sum. There can only be one ubiquitous network, so only one global player will win. Beijing has updated its geopolitical framing for network effects. Networks incline toward winner-take-all monopolies (Li, 2000).

Victory will be determined not by basic technological capabilities, but by network scope and scale. The deciding factors are the number of users and the breadth of coverage. "Where there are network effects, when a country has a larger user base, even though its technology is no better, even worse, than other countries, it can win the international competition for standards," wrote Cao Yunhan of Hunan University in 2002 (Cao, 2008). Jiang Ailing of Dongbei University echoed the sentiment in 2008: "China has one fifth of the world's population and the largest regional market. As long as its companies can protect their markets, they hold the most important resource in strategic competition. … Even without the best technology, with a high market share and many manufacturers it can become the standard" (Jiang, 2008). Or, as Zhao Longyue, Director of the China Society of Economic Law wrote succinctly in 2016, "The strategic game among big powers is no longer limited to market scale competition and technological superiority competition. It is more about system design competition and rule-making competition" (Zhao & Li, 2016).

In this context, innovation is not about having the best technology first. It is about having technology sufficient to support a competitive network, and then extending that network broadly while attracting users. This game plays well to Beijing's enduring strengths: its scope, its scale, and its centralization. China is a country of more than 1.3 billion people. It is also an authoritarian country, in which the State can settle on a single network champion and ensure that that be the one that 1.3 billion people use. Meanwhile, Beijing's relative insulation means that foreign players are disadvantaged in competing for the Chinese market. Here, again, is the strategic value of two markets, two resources. Beijing's user base becomes a reserved resource.

A corollary: Beijing also benefits from having honed one-sided dependence. An emphasis on key nodes in critical supply chains—whether those be semiconductors, CNC machine tools, or commercial drone hardware—has allowed Beijing leverage over international supply chains. At the same time, Beijing actively works to ensure that the same is not true; that, as the CCP puts it, Beijing has "independent supply chains." Such one-sided dependence may provide Beijing with coercive leverage, the means to ensure that only its network can win.

These particularities of network competition allow Beijing to overcome the traditional disadvantages of the downstream player in an innovation contest. Conventional wisdom suggests that the country that fails to innovate can only get so far. Yes, it can acquire cutting-edge R&D at low cost. It can use that to ensure low labor and production costs and to reach some degree of parity. But it will always be one beat behind the advanced players. It will not rise to the top of the value chain. As a result, its macro-economy will not overcome the perils and limitations of the so-called middle-income trap.

According to Beijing, the dynamic is different today. Modern technological advances bear fruit only when applied to scale. Applying them to scale is not a function of being the first to develop cutting-edge technology. It hinges on being the one to build the infrastructure for that technology, and to acquire the users. In the commercial domain, fintech capabilities mean little unless they are widely used. In the military sphere, monitoring and command and control (C2) mean little without information. Across both, communications are a function of the network infrastructures on which they sit. Where that is not true of specific capabilities themselves (some things are not networked) it is true of the systems on which they are built: globalized supply chains. So, Beijing focuses not just on building networks globally and to scale, but also on ensuring leverage over international supply chains.

China's Geopolitical Operating System

Beijing's ubiquitous information network—its fusion of the physical and virtual economies—may seem a distant future or an amorphous attempt at strategic theory. But it is already taking form. Look, for example, at Beijing's National Transportation Logistics Platform (LOGINK; de La Bruyère & Picarsic, 2020c) LOGINK is an international platform for logistics interconnection and communication. It illustrates China's emergent platform geopolitics.

As Beijing invests in international transportation infrastructures, it also integrates them into a government-controlled logistics information system. LOGINK can be thought of as a Facebook for global transportation. It aggregates and connects the otherwise fragmented information systems and streams that define modern transportation and logistics. It does so horizontally across transportation sectors and vertically along industrial chains. LOGINK collects and disseminates ratings data (e.g., on individuals, vehicles, and companies, shaped by the Chinese social credit system); tracking data (e.g., on vehicles, cargo, customs clearance); resource data (e.g., price indices, route planning, supply chains); and so-called "comprehensive data" (e.g., on policies and regulations, standards, operations of companies, infrastructures, and software). LOGINK receives those data from Beijing's government monitoring systems and State champions, as well as from foreign companies, infrastructures, and information systems to which it connects. LOGINK provides its data and the services built on them, selectively, to its connected company, government, multilateral, regulatory, and infrastructure users across the industrial chain. Unlike Facebook, LOGINK is controlled by China's Ministry of Transport.

Beijing promotes LOGINK as an international standard for logistics interconnection. LOGINK has integrated into South Korea and Japan's port information systems. It also has a partnership with the International Port Community Systems Association (IPCSA)—an industry group that spans every continent and includes operators and authorities from seven of the top 35 non-Chinese ports in the world (Port Technology International, 2019). LOGINK also has bilateral relationships with the ports of Klang, Rotterdam, Antwerp, Hamburg, Bremen, Barcelona, and Abu Dhabi, among others. LOGINK's information network and standards are also exported—in ecommerce and transportation logistics—by global Chinese commercial giants, including Alibaba and Baidu.

To underscore: LOGINK is a Chinese Ministry of Transport–devised information platform. It is already international. And it is on the verge of gaining traction as an international standard in a critical domain.

Table 3. World's 20 Largest Ports and LOGINK Relationship			
Rank	**Port**	**Volume 2018** (Million TEU)	**Integration with LOGINK or NEAL-NET**
1	Shanghai, China	42.01	Yes
2	Singapore	36.6	In talks to join NEAL-NET
3	Shenzhen, China	27.74	Yes
4	Ningbo-Zhoushan, China	26.35	Yes
5	Guangzhou Harbor, China	21.87	Yes
6	Busan, South Korea	21.66	Yes
7	Hong Kong, S.A.R., China	19.6	Yes
8	Qingdao, China	18.26	Yes
9	Tianjin, China	16	Yes
10	Jebel Ali, Dubai, United Arab Emirates	14.95	Maqta Gateway partners w/ LOGINK
11	Rotterdam, The Netherlands	14.51	Yes
12	Port Klang, Malaysia	12.32	Yes
13	Antwerp, Belgium	11.1	Yes
14	Kaohsiung, Taiwan, China	10.45	
15	Xiamen, China	10	Yes
16	Dalian, China	9.77	Yes
17	Los Angeles, U.S.A.	9.46	IPCSA member
18	Tanjung Pelepas, Malaysia	8.96	
19	Hamburg, Germany	8.73	Yes
20	Long Beach, U.S.A.	8.09	

A logistics information system hardly sounds like the stuff of great power politics. It certainly does not sound like a bid to redefine global affairs. In fact, it sounds unfathomably boring. But this integrated, multi-dimensional, Beijing-controlled information system fuels a revolutionary form of power projection (de La Bruyère, 2020). It allows Beijing to control how resources are exchanged by controlling the information on their exchange. Chinese leaders promote LOGINK as a global standard and platform for modern transportation and exchange. If LOGINK is accepted as such, Beijing will be able to cement international information superiority and control. Those promise enduring and mutually reinforcing advantages in commerce, military affairs, and global governance.

The Chinese Ministry of Transport's China Communications and Information Center governs LOGINK and its information. At a minimum, this allows Beijing to harvest worldwide data about global movement. Such data is invaluable, commercially and militarily.

Beijing's network also lets it shape global movement. As users join Beijing's platform, China decides who gets what information. Beijing might choose to give domestic shipping champions an information advantage. It might also obstruct critical information going to a user on its network.

LOGINK's foothold across the global information landscape grants Beijing an inherent advantage in market shaping and governance of the global commons. LOGINK also builds the

foundation for an asymmetric military advantage. The Chinese military receives two unique advantages from its connection to LOGINK: a detailed global operating picture and the potential for near-effortless presence and denial.

LOGINK's information web is integrated with military systems. The "National Logistics Hub Layout and Construction Plan" issued by the Ministry of Transport and National Development and Reform Commission in 2018 called for the "promotion of military–civil fusion of the national logistics network." The plan outlined four key prongs of such promotion: "socialization of military logistics support;" development of specific military information channels covering transportation, storage, and exchange; a special, secure, military data exchange sharing platform; an operation mechanism to serve military logistics needs (State Council, 2018). LOGINK also has strategic partnerships with Chinese military and MCF authorities (e.g., the Ministry of Public Security, the Ministry of Industry and Information Technology) and MCF commercial champions. LOGINK shares information with and collects information from those. LOGINK's platform therefore permits integration of MCF information with additional, commercial sources—COSCO's on commercial shipping, for example. **This integration can support the People's Liberation Army Navy (PLAN) global operating picture and provide redundancy in command and control.**

Beijing's control of LOGINK information platform also gives it the power to deny and coerce. Beijing can restrict users' permissions or shape what information they receive. Beijing can also adjust how information is presented on the public portal to suits its interests. Based on its current development trajectory, LOGINK also stands eventually to have access to industrial control information that risks permitting ubiquitous, rapid cyber threats. The international systems built on and disseminated through LOGINK now rely on a platform governed by China. As LOGINK facilitates connections to Chinese champions' operating software (e.g., Kingdee), that connection to Chinese technology deepens. Chinese governance over those technologies may give Beijing the ability to hold operation of critical infrastructures at risk.

Operationally this might affect Beijing's analysis of the "Malacca Dilemma," a phrase coined by Hu Jintao since 2003. The Malacca Strait is one of several critical chokepoints along the path of maritime trade. Eighty percent of Beijing's oil imports flow through Malacca. This creates a geographical dependence. Analysts frequently cite that dependence as one of China's core strategic motivators, akin to Russia's historical quest for a warm water port. They use it to explain the CCP's naval buildup, militarized positions in the South China Sea, investments in Central Asia, and expansion of energy imports over land corridors.

But LOGINK might offer Beijing a means to de-risk the Malacca dilemma. LOGINK has already integrated Malaysia's Port of Klang. Should it expand more throughout Malaysia, and to Singapore and Indonesia, LOGINK would provide information advantage along a critical supply chokepoint. LOGINK could also be used for commercial coercion. Beijing could, say, manipulate the credit ratings of Malaysian enterprises such that they lobby Malaysian governmental authorities in Beijing's favor. Such subversive power could further be magnified by the cyber security leverage that LOGINK's technical integration may permit.

The overlooked development—and impact—of LOGINK is just one example of Beijing's approach to innovation, military–civil fusion, and great power competition. It underscores the different way in which this competition may unfold.

Adversary Informed Assessment and Investment

Beijing's particular conception of innovation, and the strategic orientation underlying it. raise any number of problems, threats, and opportunities for the U.S. Department of Defense. In investment, operations, and power projection, Beijing is pursuing an asymmetric strategy. It is

also pursuing a parasitic one. It is doing so through obfuscated means, and according to a rubric wholly misaligned with U.S. conceptions of security and power.

This asymmetry demands two, first-order responses. First, the DoD ought to adjust its investment protocols and priorities for Beijing's approach. China is siphoning American innovative resources—then winning the application contest. The U.S. government ought to re-orient around an application rather than an innovative race.

And the DoD ought to take measures to protect its innovation, where possible, from Beijing's parasitic positioning to avoid fueling its adversary's offensive. Such protective measures should in turn update for the extent of China's arsenal. Conventional methods of screening for foreign influence and control in the supply and reviewing for adversarial investments into sensitive technology, infrastructure, and data are insufficient. Beijing weaponizes capital, through obfuscated means, across military and civilian domains.

Of course, not all innovation can be protected. Beijing has adeptly diagnosed as much. The DoD will therefore have to craft a prioritization logic informed by sensitivity of technology and by the feasibility of defending it. To invest heavily in protecting areas in which Beijing is likely to acquire parallel capabilities from an uninsulated commercial environment is, for example, likely a waste of resources.

While adjusting its investment priorities, the DoD should also adjust its means of benchmarking relative standing. China is not optimizing for conventional capabilities, whether those be cutting-edge domestic research or traditional military tools. Instead, Beijing is optimizing for scale and for scope, control and influence, across the military and civilian. LOGINK is neither a precursor to People's Liberation Army deployment nor a subversive channel for aircraft carrier movements. Beijing sees in tools like LOGINK the potential to leapfrog traditional means of power projection by instead controlling the channels, information, and systems on which military and commercial movements depend.

U.S. analytical frameworks ought to account for this new-type competition and power. That will require updating traditional metrics in a manner informed by platform economics. Beijing sees modern power as a function of relative dependence and relative influence; a combination of the ability unilaterally to strip the adversary of his resources and to shape the way he uses those he has. This interaction-defined function is measured in rate statistics rather than counting ones. The role of networks and linkages demands an emphasis on scope and scale rather than mass and proximity, the ability to access resources, not to produce them. And Beijing's MCF orientation demands that this type of power be benchmarked across military and civilian domains. That is how China is assessing itself. And the United States cannot compete unless it updates for the adversary's conception of the battle.

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