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# RESEARCH BRIEF

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## Defense Science and Technology Innovation Teams: Mechanisms and Indicators for Indigenous Innovation in China

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National-level science and technology (S&T) innovation teams possess unique characteristics and high-level support that allows them to break through bureaucratic and technical bottlenecks while also providing them with the means to cultivate the next generation of talented scientists. This policy brief investigates these teams as a mechanism for innovation within China's defense S&T system. The ensuing discussion provides evidence that defense-related S&T innovation teams are a vital piece of China's approach to developing indigenous innovation capabilities. A window into examining the evolution, selection, and impact of these teams is through policy documents issued by central level agencies, such as the State Council and line ministries. This brief reviews several of these policy documents that are responsible for fusing the innovation team concept into China's national and defense innovation systems.

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## INTRODUCTION

China is sparing no expense to overcome its lack of indigenous capability to develop innovative technologies within its defense industry. This deficiency stems from a rigid bureaucracy and a lack of reform and modernization before the 1990s. One innovation mechanism being implemented to cultivate and catalyze innovation while simultaneously bridging the gap between research and development (R&D) and manufacturing is the use of defense-related, national-level science and technology (S&T) innovation teams (科技创新团队).

China's top leaders have pointed to the role that S&T innovation teams play in promoting the country's S&T development. To support indigenous innovation and research, former Chinese President Hu Jintao stated in speeches from 2007, 2008, and 2011 that China should promote the establishment of innovation teams (创新团队). This sentiment has been reiterated by President Xi Jinping, who has called for the development of internationally competitive scientists, engineers, and innovation teams.

S&T innovation teams like those responsible for the development of the Tianhe II, the world's fastest super-computer, are hailed as "models of innovation" for emulation. The People's Liberation Army (PLA) has taken this concept to heart, as demonstrated by the General Armament Department's (GAD) establishment of S&T innovation teams within the country's military regions.

National-level S&T innovation teams possess unique characteristics and high-level support that allows them to break through bottlenecks—both bureaucratic and technical—that stifle innovation while also providing them with the means to cultivate the next generation of talented scientists. As a study by China's National University of Defense Technology (NUDT) on S&T innovation team notes, innovation teams are a mechanism for encouraging lateral cooperation and effective administration. A foundational precept behind the innovation team concept is that they can,

through institutional and mechanism innovation, break through

the stove piping that occurs between administrative departments, localities, higher education institutions, and even within [academic/research] departments.

A window into examining the evolution, selection, and impact of these innovation teams is through policy documents issued by central level agencies, such as the State Council and line ministries. This brief reviews several of the policy documents that are responsible for fusing the innovation team concept into China's national and defense innovation systems.

## THE CONCEPT OF NATIONAL-LEVEL S&T INNOVATION TEAMS

Chinese innovation teams come in several forms. National-level S&T innovation teams fall into one of a handful of innovation team systems. Table 1 details the characteristics of the earliest of these systems. The first innovation teams originated from a funding plan specifically defined to support the development of innovation research groups by the National

**TABLE 1.** Patterns and characteristics of China's innovation team-funded projects, 2001–2006

Innovation Team Funding Program	Funding Institution	Start Date	Purpose	Team Size	Funding Period	Number Funded	Funding Level
Innovation Research Groups Science Fund Research Plan	National Natural Science Foundation	2001	Support for basic research; cultivate persons and groups with innovative potential	~10	3 years	~30	\$604,594 per team (math & admin. science teams on average received \$422,705)
China Academy of Sciences Innovation Team Plan	China Academy of Sciences	2002	Encourage basic and applied research in cutting-edge or interdisciplinary fields; form outstanding teams and aggregate resources	10+	3 years	~10	>\$725,638 per team
Yangtze River Scholars and Innovation Team Development Plan	Ministry of Education	2004	Aggregate and consistently provide support for innovation teams to improve the ability and competitiveness of higher-education S&T innovation teams	10+	3 years	~60	\$365,900 per team
National Defense S&T Innovation Team Plan	COSTIND	2006	Increase level of indigenous innovation for defense S&T; increase team activity/facilitate cohesion	10–25	2 years	~40	\$125,470 per program

Natural Science Foundation (NNSF) in 2001. This was quickly followed by the Chinese Academy of Sciences (CAS) with its Innovation Team Plan in 2002. The Ministry of Education adopted a similar plan to cultivate innovation teams, after which the Commission for Science, Technology and Industry for National Defense (COSTIND) established an innovation team plan in 2006.

There are noteworthy differences in the nature of innovation teams funded by research and ministry-level organs. The teams supported by NNSF and CAS are smaller in number and on average receive significantly larger allocations than ministry-backed teams.

### ***COSTIND's Innovation Team System***

COSTIND was the primary supporter of S&T innovation teams involved in national defense activities during the 11th Five Year Plan (FYP) between 2001 and 2006. The concept of a national defense S&T innovation team system played a central role in COSTIND's approach to establishing a backbone of new human talent during this period. For example, a COSTIND work meeting was held in June 2006 on the "Work of National Defense S&T Industry Talents" (国防科技工业人才工作) in which the implementation of an innovation team system was discussed.

COSTIND's strategy for establishing and regulating innovation teams relied on an approach that it summarized as "rooted in people, focused on innovation, guidance from top-notch leadership, and promoting development" (以人为本、着力创新、高端引领、促进发展). In line with this strategy's focus on using talent to promote innovation, COSTIND issued two policy documents concerning the rigorous selection criteria for the teams. While the criteria for the first set of defense S&T innovation teams is not publicly available, COSTIND announced another set of criteria

for the second group of innovation teams in 2007 titled "Announcement Concerning the Organization of and Application for the Second Set of COSTIND's National Defense S&T Innovation Teams" (关于组织申报国防科工委第二批国防科技创新团队的通知). This document was issued in line with the Defense Medium and Long-term Science and Technology Development Plan (2006–2020), which listed strengthening the innovation team system as one of eight primary tasks.

### ***CASIC's Innovation Team System***

China Aerospace Science and Industry Corporation (CASIC) offers another model of the development of innovation teams. As the premier developer and manufacturer of China's missile systems and one of China's ten state-owned defense conglomerates, CASIC's creation of an innovation team system is significant for the influence that this mechanism has within the defense industry.

Between 2006 and 2010, CASIC established four national defense S&T innovation teams along with other levels of innovation teams in order to achieve its goals during the 11th FYP. Xu Dazhe, the general manager of CASIC at the time, stated that these teams were established with the intention of forming a backbone of talent that could transform and raise the level of innovation within the company. The involvement of CASIC's innovation teams in high-priority, national-level projects underscores their importance in the development of key technologies in the defense industry. The majority of projects carried out by CASIC's innovation teams are related to the National High-Tech R&D Program (863 Program), advanced research projects, and national S&T support projects, in addition to CASIC's own indigenous innovation programs.

While little information is publicly available concerning the specific work of CASIC's innovation

teams, several of the innovation teams are mentioned in association with awards they have received. The "Cruise Missile Penetration Technology Innovation Team" was one of three teams in the entire country to be awarded the "2012 National Science and Technology Improvement Award," and Tianjin's Science and Technology Commission designated CASIC's "High Technology Aerospace Fastener Industrial Technology Innovation Team" with the honorific title of "Key Area Innovation Team."

Xu Dazhe summed up the significance of CASIC's innovation teams for China's defense S&T development when he wrote:

In recent years, while facing the urgent needs of China's enterprise restructuring and development, CASIC has filled in numerous gaps within China's missile weapons systems, especially by achieving breakthroughs in some military high-end technology research and development, through leveraging the key role of innovation teams in corporate restructuring and upgrading. This has allowed China to be equipped with new strategic deterrents and "assassin's mace" weapons that can effectively counter powerful enemies.

## **NATIONAL S&T INNOVATION TEAMS AND CHINA'S S&T MEGAPROJECTS**

S&T innovation teams are identified as a vital mechanism to promote innovation in China's 2006–2020 Medium and Long-Term Science and Technology Development Plan (MLP). This evidence is manifested in multiple state-level policy documents related to the MLP that stress the central role of S&T innovation teams. They are responsible for resolving key issues that obstruct progress in cutting-edge technologies. The success of these teams provides an important indicator for how successful

China’s approach to developing indigenous S&T innovation capabilities is for key strategic fields.

Another key area in which these national-level S&T innovation teams are active within the MLP is their participation in some of the sixteen S&T “megaprojects” (重大项目) that are listed in the plan. These megaprojects, vanguard programs intended to catalyze China’s development of S&T in select high-priority fields, are China’s “major carriers of uplifting indigenous innovation capacity.”

Megaprojects with noted involvement from innovation teams include precision manufacturing, the Tianhe-series supercomputers, the Shenzhou manned spaceflight and Chang’e lunar exploration programs, the C919 airliner program, and the high-resolution Earth observation system program. Innovation teams are also associated with work in at least two megaprojects that are classified. Chinese blogs suggest three areas as likely candidates: the Shengguang inertial confinement fusion laser project, the second-generation Beidou satellite navigation system, and an unnamed hypersonic vehicle technology project. The selection of the innovation teams to work on China’s highest-priority S&T projects may be due to their DARPA-like characteristics: small teams of highly-qualified indi-

viduals provided with large amounts of funding and the ability to surpass bureaucratic obstacles.

NUDT’s Tianhe High-performance Computing (HPC) Innovation Team (天河高性能计算创新团队) is a prime example of what innovation teams are capable of accomplishing due to their unique characteristics and ability to overcome the aforementioned obstacles (see Figure 1). This team has reportedly overcome numerous (although unspecified) bottlenecks to now dominate the TOP500 super-computer rankings. This seems to be largely due to direct access to funding and to having autonomy granted at the institution level (in this case, NUDT) rather than being handled at the national or military-wide level. Reports indicate that the HPC innovation team lead, Liao Xiangke, has additional autonomy due to his role as the current dean of NUDT’s School of Computer Science, his positions as the deputy chief designer of the Tianhe-1 and chief designer of the Tianhe-2, and his numerous national- and military-level awards for his work in HPC.

These national-level innovation teams should not be confused with the myriad array of innovation teams at the provincial, corporate, city, county, and even district levels. These lower levels of innovation teams do not necessarily have structured re-

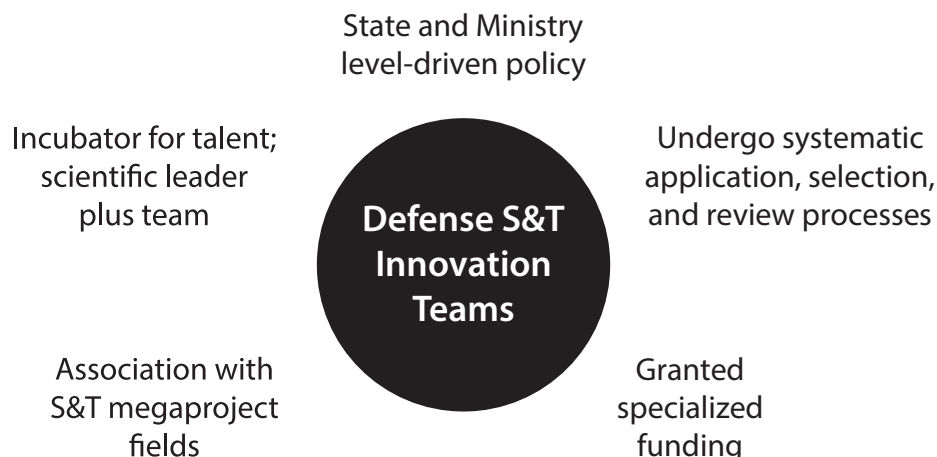
quirements for selection and review, nor do they often possess a systematic mechanism for funding and support. While some may work in areas related to the megaprojects, these lower-level teams are not sanctioned by any national-level government organ to do so. Therefore, they do not possess the unified characteristics and significance that would allow them to be classified as anything more than a concept or individual team, nor something that is part of a broader systematic approach.

### S&T INNOVATION TEAMS DURING THE 12TH FIVE-YEAR PLAN (2011–2015)

By the beginning of the 12th FYP, the term “National Defense S&T Innovation Team” started to appear much less frequently than during the 11th FYP. This is likely due to the loss of a centralized, state-level defense S&T innovation team plan following the downgrading of COSTIND to the State Administration for Science, Technology, and Industry for National Defense (SASTIND) under the Ministry of Industry and Information Technology (MIIT).

However, S&T innovation teams continue to exist as a mechanism for developing cutting-edge military technology with the support of other

**FIGURE 1.** Defining characteristics of S&T innovation teams



state-level organizations such as the Ministry of Science and Technology (MOST), the Ministry of Education (MOE), and the NNSF. They are now referred to as “S&T Innovation Teams,” “Key Field Innovation Teams,” or a variety of other titles tied to the national-level programs they are linked to.

According to documents issued by the State Council in line with the 11th and 12th FYPs, a primary goal for the innovation teams is to cultivate new talent that will continue to spur on China’s S&T innovation capability. In January 2013, the State Council issued the “National Plan for Building Indigenous Innovation Capabilities in the 12th Five-Year-Plan Period.” This official document emphasizes the role of innovation teams as a mechanism for strengthening and cultivating talent. It also stresses that the intention behind national-level initiatives for recruiting global talent is to bring in individuals as well as S&T innovation teams:

The overall implementation of plans for recruiting talent such as the “1,000 Talents Plan” is to establish innovation and entrepreneurial bases in areas of cutting-edge technology and emerging industries for overseas high-level talent. These provide the necessary research and development conditions for scientists, science leaders, and outstanding innovation teams that are at the forefront of global S&T development strategy.

A policy document titled “Implementation of the Plan for Promoting Innovative Talent” includes MOST’s strategy for developing S&T innovation during the 12th FYP and lays out the requirements for talents and innovation teams looking to apply for its programs. The document also specifies the requirements for

the institutions supporting the applicants, support/funding mechanisms for those selected, and application procedures. In 2014, the implementation of this document resulted in the creation of 267 Young S&T Innovation Leading Talents, 242 S&T Innovation Industry Talents, 67 Key Field Innovation Teams, and 38 bases to be used for the cultivation of individual of innovative talent.

MOST and NNSF laid out their collaborative approach to enhancing innovation for basic research during the 12th FYP in a document entitled “Special Planning for the Development of Basic Research in the 12th Five-Year Plan.” According to this document, which was issued in February 2012, innovation teams are mentioned briefly as a mechanism for improving China’s basic research. This document associates innovation teams, which it refers to as “innovation teams for key fields,” with strategic national-level S&T programs such as the “megaprojects,” the National S&T Plan, and national-level key S&T facilities.

## CONCLUSION

As this brief shows, defense-related S&T innovation teams are a vital piece of China’s approach to developing indigenous innovation capabilities. These national-level teams continue to possess the backing of the highest levels of China’s government. Their role in China’s defense innovation system shows no sign of slowing down.

According to a document posted on SASTIND’s website regarding the “Several Opinions of the State Council and Central Military Commission Concerning Establishing and Perfecting the Combining of Civil and Military Needs and Locating Military Potential in Civilian Capabilities for the Weapons

Research and Production System” (国务院中央军委关于建立和完善军民结合寓军与民武器装备科研生产体系的若干意见), SASTIND is responsible for implementing the National Defense Innovation Team Plan. Implementation of this plan involves participation from MIIT, MOE, CAS, and the GAD General Armaments and General Logistics Departments. Thus, SASTIND has continued where COSTIND left off in 2008 in facilitating the continuation of these teams, albeit with the support of these other institutions. And in 2013, the application of innovation teams as a mechanism for innovation took an interesting turn with the Central Military Commission’s issuance of “Several Provisions for Strengthening Talent for Military S&T Innovation Teams” (加强军队科技创新团队人才建设若干规定). This document has essentially laid the foundation for the PLA to form its own innovation team system.

S&T innovation teams have been deeply integrated into China’s defense innovation system and play a large role in developing technologies deemed essential for defense S&T development. Their successes are an indicator for how China’s defense innovation system is progressing in cutting-edge technical areas, and they provide researchers with one way to scope their work by focusing on specific sets of data related to these teams. Hence, the work of these teams provides a useful analytical window into how China organizes and focuses elite teams of scientists and researchers to work on select research and development projects that are deemed of the highest national priority.

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