Prepared Statement of
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Chairman, Vice Chairman, and members of the U.S.-China Economic and Security Review Commission, thank you for the opportunity to participate in today's hearing. It is an honor to testify on an issue that is important to U.S. interests in peace and stability in the Indo-Pacific region. The evolving capacity of the People's Republic of China (PRC) to leverage space assets presents challenges for the United States, allies, and friends in the region. Today, China is second only to the United States in the number of operational satellites. In my presentation, I will address Chinese investment into military space and counterspace capabilities, and potential effects on the U.S. ability to project power in the Indo-Pacific region.

Buoyed by successes in its lunar exploration and manned space programs, the PRC is emerging as a leading space player. China's space enterprise is complex. It encompasses organizations in the People's Liberation Army (PLA), defense industry, and commercial sector. In early 2016, the PLA initiated an ambitious reform and reorganization program intended to mold a joint force capable of fighting and winning future wars. The restructuring has consolidated military space capabilities under a single command – the PLA Strategic Support Force (PLASSF). The PLASSF, supported by a robust defense industrial establishment, is gradually improving China's capacity to project military power vertically into space and horizontally beyond its immediate periphery. Senior civilian and military leaders view the aerospace sector – the space and missile industry -- as one aspect of a broad international competition in comprehensive national strength and science and technology (S&T).

The historical legacy of China's space and missile program, along with a record of success, underpins its space ventures. Its unique organizational and management system sets China's space program apart from other defense industrial sectors. Moreover, the special status of the space industry and military requirements of its primary customers—the PLASSF, PLA Navy, PLA Air Force, and PLA Rocket Force – are driving growing investment to sustain this burgeoning industry. With increasing access and ability to leverage technologies, Beijing is building up its space technology base to ensure a nuclear retaliatory capability, promote the legitimacy of the Chinese Communist Party (CCP), and enforce sovereignty and territorial disputes at lower cost.

Among the strategic drivers, perhaps most prominent is the ability to use force against Taiwan decisively and, by extension, complicate U.S. and other foreign intervention. China also is developing the capacity to enforce its territorial claims in the East and South China Seas. The PLA's ability to strike targets is likely restricted by the range of its persistent surveillance. To expand its battlespace awareness, the PLA is investing in space-based command, control, communications, computers and intelligence, surveillance, and reconnaissance (C4ISR) capabilities that could enable it to persistent situational awareness of activities in the Western Pacific, South China Sea, and Indian Ocean.

Space-based assets would serve as a critical component of a broader C4ISR architecture. China is fielding increasingly sophisticated electro-optical, synthetic aperture radar, and electronic reconnaissance capabilities. Additional data relay satellite systems or the expansion of ground stations abroad could further improve China's near-real-time targeting capability. The PLA also has been modernizing its satellite communications infrastructure, space-based survey, mapping, and navigation systems, and an increasingly diverse range of space launch vehicles.

In addition, a growing body of Chinese military-technical literature addresses a requirement for a counterspace capability. Technology demonstration testing of kinetic kill vehicles, high-powered lasers, co-orbital satellites, electronic jamming, and, possibly, cyber attacks reportedly have been carried out since at least 2005. The opacity of China's space programs suggests other clandestine counterspace weapons programs may also exist.

The PLA Space/Counterspace Ecosystem

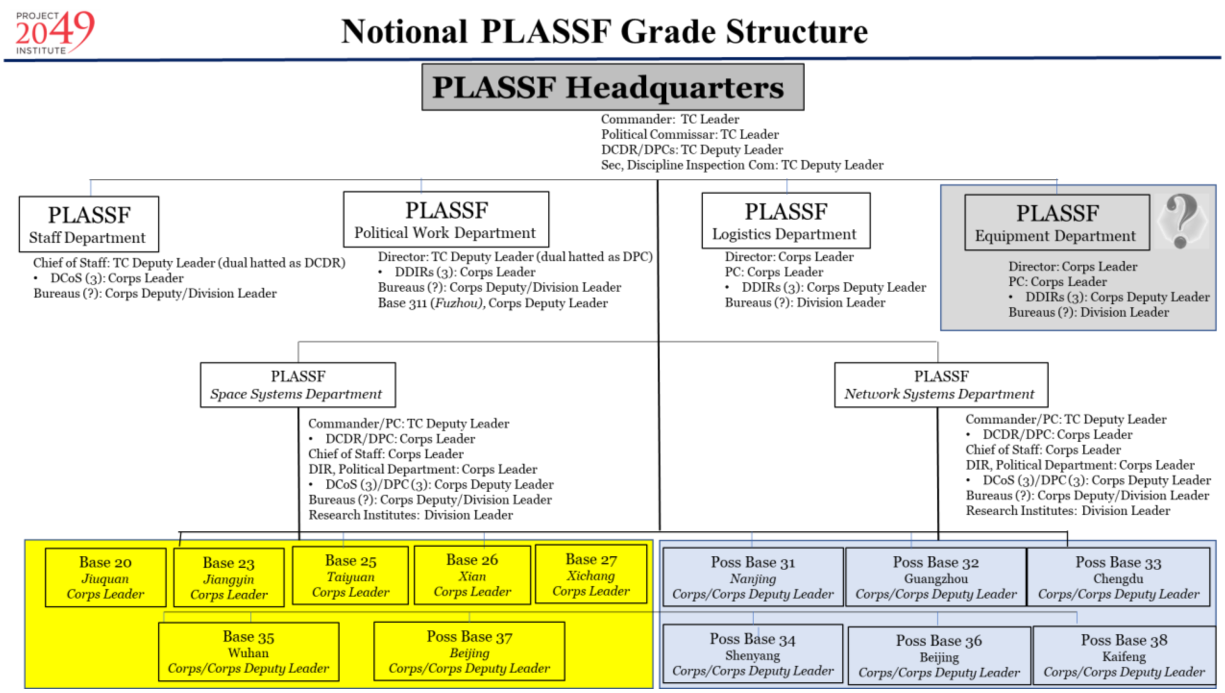
The PLASSF, established in December 2015, is central to China's ability to compete in space. The PLASSF's first-level departments — Staff, Political Work, Logistics, Space Systems, and Network Systems — are responsible for structural integration of space and network operations. The PLASSF Space Systems Department was created through the merger of the former General Armaments Department (GAD) China Launch and Tracking Control General (CLTC) and space-related organizations previously under the General Staff Department (GSD) Operations Department and GSD Intelligence Department.[1]

The Space Systems Department oversees at least six corps or corps deputy leader-grade operational commands responsible for space launch, tracking, and control. The PLASSF tracks and controls space assets through the Xian Satellite Control Center (Base 26) and the Beijing Space Command and Control Center in the northern suburbs of Beijing, which integrates space tracking data from ground- and sea-based units. Three corps leader-grade space launch base commands in Jiuquan (Base 20, aka Shuangchengzi), Taiyuan (Base 25, aka Wuzhai), and Xichang (Base 27). Base 27 probably oversees the launch complex on Hainan Island. These space

[1] For background on the PLASSF, see Kevin L. Pollpeter, Michael S. Chase, and Eric Heginbotham, *The Creation of the PLA Strategic Support Force and Its Implications for Chinese Military Space Operations* (RAND Corporation: Wash DC, 2017); Elsa Kania, "PLA Strategic Support Force: The 'Information Umbrella' for China's Military," *The Diplomat*, April 1, 2017; Rachael Burton and Mark Stokes, "The People's Liberation Army Strategic Support Force Leadership and Structure," Project 2049 Occasional Paper, September 25, 2018, at https://project2049.net/wp-content/uploads/2018/09/180925_PLA_SSF_Leadership-and-Structure_Stokes_Burton.pdf; John Costello and Joe McReynolds, "China's Strategic Support Force: A Force for a New Era," *China Strategic Perspectives* (Issue 13), October 2, 2018, at https://ndupress.ndu.edu/Media/News/Article/1651760/chinas-strategic-support-force-a-force-for-a-new-era/.

launch centers also support ballistic missile and kinetic space interceptor testing. The end user of anti-satellite (ASAT) kinetic kill vehicles remains unclear.

Other base commands are responsible for space tracking and control. The Xian Satellite Tracking and Control Center (Base 26) is a corps leader grade organization responsible for ground-based space tracking, telemetry, and control. Although unconfirmed, Base 26 may oversee the Beijing Space Flight Command and Control Center and its subordinate entities. The China Satellite Maritime Tracking and Control Department (Base 23, Jiangyin) is a corps leader-grade organization that is responsible for sea-based satellite tracking, control, and launch vehicle transportation to Hainan.



The PLASSF Space Systems Department integrates the launch, tracking, and control of satellites with the services these systems provide. New corps deputy leader-grade base commands responsible for space applications have been formed in Beijing and Wuhan. These bases may have integrated ground segment operations managed by division leader-grade units previously subordinate to the General Staff Department, including the former GSD Intelligence Department (GSD Second Department, or 2PLA) Space Reconnaissance Bureau. Roughly analogous to the U.S. National Reconnaissance Office, the former Space Reconnaissance Bureau is responsible for processing and distributing downlinked electro-optical (EO) and synthetic aperture radar (SAR) imagery. The bases may also have absorbed portions of the former GSD Operations Department Survey and Mapping Bureau (including the Beidou ground segment), former GSD Operations Department Weather and Oceanography Bureau, GSD Informatization Department satellite communications (SATCOM) command, and the former GAD Data Relay Satellite Control Center.

Potentially supporting counterspace missions, the PLA and supporting defense industry appear to have tested systems capable of space rendezvous and proximity operations. For example, the Shijian-12, boosted by a Long March-2D from Jiuquan on June 15, 2010, is believed to have carried out a space rendezvous mission. Shijian-15 and Shiyan-7 satellites, launched from Taiyuan on a Long March-4C on July 20, 2013, reportedly carried out space debris mitigation testing. The Aolong-1 "Roaming Dragon" was launched from Hainan on a Long March-7 on June 25, 2016. The Shijian-17 was boosted by Long March-5 from Hainan to a geosynchronous orbit on November 3, 2016. In addition to demonstrating new technology as a communications platform, the satellite also is capable of space-based optical observation of space debris.

The PLASSF Network Systems Department is central to China's counterspace mission. The Network Systems Department incorporated the former GSD Electronic Countermeasures and Radar Department (also known as the GSD Fourth Department) and former GSD Technical Reconnaissance Department (GSD Third Department). Before the reorganization, the former GSD Fourth Department oversaw two electronic countermeasures (ECM) brigades and a satellite ECM command headquartered in Beijing's northern suburbs. The two ECM brigades consisted of subordinate battalions distributed throughout eastern China. Technical articles published by members of the satellite ECM command suggest the unit, at least in part, is responsible overseeing research, development, and acquisition of electronic counterspace systems. The command oversees at least one regimental-level unit on Hainan Island. The former GSD Third Department oversaw a division leader-grade unit, headquartered in Shanghai, responsible for intercept of SATCOM and SAR transmissions. Equipped with at least one large phased array radar system, the unit presumably supports China's space surveillance network.

The Network Systems Department possibly may have established a new PLASSF corps deputy or division leader-grade base command in Henan's Kaifeng City. While speculative, the base could integrate the two former GSD Fourth Department ECM brigades, satellite ECM command, directed energy counterspace capabilities, and testing and training functions. Within the next five years, the PLASSF is expected to field a ground-based directed energy system capable of dazzling electro-optical reconnaissance satellites in low earth orbit. The former GAD Base 21's New Technology Testing Department was responsible for R&D and testing of advanced directed energy systems, including high powered microwave and lasers. The PLASSF Electronic Equipment Test Center (former GAD Base 33), headquartered in Luoyang, has been noted carrying out research into advanced technologies for countering U.S. early warning satellites.

Counterspace operations at the theater level remains unclear. PLA Army, Air Force, and Navy components under each of the five Theater Commands oversee ECM brigades. Specialized battalions under Theater Command ECM brigades, trained and equipped for counterspace missions, are possible. In addition, the PLA manages offensive cyberspace capabilities that could support military operations against space-based assets.

Space/Counterspace Command and Control

The Central Military Commission (CMC) presumably exercises control over PLASSF space/counterspace operations through the CMC Joint Operations Command Center. The CMC Joint Staff Department Operations Bureau probably manages the center's day-to-day operations.

However, PLASSF officers reportedly perform rotational duty within the Joint Command Center. Operations duty officers would be responsible for transmission of operational orders and coordination with PLASSF Command Center duty officers in Beijing. The PLASSF Command Center is probably staffed by the PLASSF Staff Department, with a deputy chief of staff serving as the chief duty officer. Officers from the PLASSF Space Systems Department Staff Department probably man an intermediate command center. While unclear, the PLASSF Space Systems Department Command Center likely would be separate and distinct from the PLASSF Beijing Space Flight Command and Control Center.

PLASSF officers may also provide critical command support functions at higher readiness levels. As part of the reform and reorganization, CMC Joint Operations Command Center leaders have direct authority over 10 cells, or groups (*dadui*) responsible for mission planning, battlespace situational awareness, survey and mapping, navigation (eg. Beidou), network/electronic countermeasures, spectrum management, airspace management, meteorology and hydrography, and communications. PLASSF officers presumably are assigned duty within these functional cells during higher readiness levels, or perhaps even under normal conditions. Newly established PLASSF corps-level units suggest possible direct operational support to Theater Command leaders in contingency.

Military Space/Counterspace Research, Development, and Production

The PLASSF military space and counterspace operations depend upon a research, development, and acquisition (RD&A) system capable of fielding increasingly sophisticated systems. The PLASSF's RD&A system is guided by general policies promulgated by the CMC Equipment Development Department (CMC/EDD) and supported by the CMC Science and Technology (S&T) Commission, Academy of Military Science (AMS), China Academy of Sciences, and the State Administration for Science, Technology, and Industry for National Defense (SASTIND). The CMC/EDD administers China's manned space program while SASTIND reportedly manages the lunar exploration program. The CMC Science and Technology Committee manages specialized space-related expert working groups, and guides technology development laboratories within the defense industry and academic institutions. Expert working groups have been increasingly able to leverage expertise from across China's S&T community and break down institutional barriers that have inhibited technological progress to date.

The PLASSF Space Systems Department Equipment Department is responsible for drafting of technical requirements for military space systems. However, the PLASSF relies heavily upon two state-owned defense industrial establishments engineering R&D and manufacturing of space and counterspace systems -- the China Aerospace Science and Technology Corporation (CASC) and China Aerospace Science and Industry Corporation (CASIC). CASC is China's primary supplier of satellites and large launch vehicles, while CASIC appears to serve as a lead systems integrator for tactical microsatellite and space intercept systems. The China Electronics Technology Corporation (CETC) likely supplies the PLA with satellite sensor sub-systems. Under joint CMC and State Council sponsorship, defense industry and civilian universities are exploring more advanced means of space transportation, such as trans-atmospheric vehicles.

CASC/CASIC academies may compete for PLA-sponsored R&D and manufacturing contracts. For example, the CASC First Academy (China Academy of Launch Technology, or CALT) and CASC Eighth Academy (Shanghai Academy of Space Technology) launch vehicle products (e.g., LM-2C and LM-4D) appear to compete for launch of small remote sensing satellites. The CASC Fifth Academy (China Academy of Space Technology, or CAST) and CASC Eighth Academy may compete on certain satellite programs. Specific research institutes with CETC may compete for counterspace R&D contracts. Competition may also drive defense industrial enterprises to seek cooperative ventures with foreign partners. Cooperation includes satellite sales and launch services, space-related technical exchanges between universities supporting military R&D, and establishment of ground stations overseas.

Presumably influenced in part by the U.S. Planning, Programming, and Budgeting System (PPBS) and Soviet design system, basic principles for China's space-related RD&A were established in the 1960s and, with some exceptions, appear to have changed little over time. How much China spends on military space/counterspace R&D remains unclear. Based on CMC/State Council planning, programming, and budget guidance, PLASSF-managed space systems R&D may consist of four phases, with variants of the same basic space system in the R&D cycle at any one time.

Preliminary research is focused on initial development of basic technologies that eventually could be applied to multiple programs. A strong preliminary research program helps reduce engineering R&D time and risk. Preliminary research can also focus on technologies applicable to a specific system, for instance, a movable spot beam antenna for a communications satellite or a new launch vehicle propulsion system. Funded in part through national-level technology development efforts such as the 863 Program, the CMC/EDD, CMC S&T Commission, PLASSF, and other end users function as important supervisory bodies for projects in this phase.

The PLASSF leverages universities and commercial enterprises to support basic and applied research on military space and counterspace systems. CMC/State Council military-civil fusion policies play a prominent role in facilitating collaboration. Among the most prominent civilian academic organizations supporting basic and applied research into space technology include the Nanjing University of Aeronautics and Astronautics, Harbin Institute of Technology, Northwest Polytechnical University, Beijing University of Aeronautics and Astronautics, and Huazhong University, just to name a few.

During the *concept development and program validation phase*, the PLASSF Space Systems Department and Network Systems Departments, working in conjunction with defense industry, identify key technologies, determines the feasibility of a program, and assesses alternatives that could meet basic operational and technical requirements. The program validation phase draws heavily on results from preliminary research projects. PLASSF research institutes, supported by a restructured AMS, appear to play a major role developing concepts and validating major space/counterspace R&D programs.[2] Major programs likely require CMC/State Council-level approval before investing in engineering R&D.

[2] PLASSF research institutes and centers supporting space/counterspace program validation may include the Space Equipment Integrated Technology R&D Center (former GAD Space Equipment Bureau); Weapons and Equipment Validation Research Center (former Beijing Institute of Systems Engineering; BISE); Beijing Institute of Tracking and

During the *engineering R&D phase*, CASC and CASIC support the CMC/State Council and PLASSF in the R&D and production of space and counterspace systems. CASC and CASIC research academies specialize in certain space-related core competencies, such as heavy lift launch vehicles, tactical solid fueled launch vehicles, and satellites. A research academy is roughly analogous to a US defense corporate business division. CASC/CASIC academies are organized into design departments (or systems engineering institutes); research institutes focusing on sub-systems, sub-assemblies, components, and materials; testing facilities; and manufacturing plants.

CASC is China's primary supplier of satellites and large launch vehicles, while CASIC appears to serve as a lead systems integrator for tactical microsatellite and space intercept systems. Other defense industrial enterprises, such as the China Electronics Technology Corporation (CETC), may supply sub-systems, such as space-based electronic reconnaissance receivers or data links. Increasingly accountable for profit and loss reporting, trends indicate growing competition between research academies in securing R&D and manufacturing contracts.

Engineering R&D programs are managed through a dual command system that divides administration and technical responsibilities. Administrative responsibilities reside with a program manager, while technical aspects of a program are the responsibility of the chief designer and his/her design team. The program manager, or literally *general commander*, ensures timeliness standards are being met, quality is assured, schedules testing, and manages the program budget. Program managers of major satellite and launch vehicle projects often are dual hatted as deputy directors of CASC research academies.

Members of the technical design team appear to have concurrent positions within an academy's design department and research institutes. For example, chief designers of major satellite programs usually hold concurrent positions within the CASC Fifth Academy General Design Department and CASC Eighth Academy's Institute of Satellite Engineering. Chief designers are also assigned for space launch vehicles, including those delivering anti-satellite kinetic kill vehicles. Chief designers of major electronic counterspace programs may reside within CETC's systems engineering department and specialized research institutes. To ensure requirements are met, PLASSF end users probably maintain industrial representative offices within CASC and CASIC design departments, research institutes, and factories.

During the *design finalization phase*, end users and industrial program managers evaluate whether a design satisfies operational and technical requirements. For major programs, a design finalization committee is comprised of members of the CMC and State Council (Premier or Vice Premier). A joint CMC-State Council standing office appears to support the design certification committee.

Telecommunications Technology (BITTT); Beijing Institute of Remote Sensing Information (under the former GSD Second Department Space Reconnaissance Bureau); Jiangnan Institute of Remote Sensing Applications (under the former GSD Third Department 12th Bureau); 54th Research Institute (North Institute of Electronic Equipment); 56th Research Institute (Jiangnan Institute of Computing Technology); 57th Research Institute (Southwest Institute of Technology Electronics and Telecommunications); Beijing Institute of Applied Meteorology; and the PLASSF Information Engineering University Geospatial Information Academy.

Conclusion

The PLA has the potential to rival the United States in key areas of space technology by 2035. U.S. space assets, including space command and control facilities, are or likely will be vulnerable to disruption by China. Counterspace operations may target the communications, reconnaissance, and global positioning satellites upon which U.S. depends for force projection. Chinese space systems may have the ability to rendezvous or physically interfere with U.S. space assets.

Given the PLA's ambitious military modernization and uncertain strategic intent, China's focus on space technology is of great concern to American strategists. In short, the PLA is embarked on a concerted effort to develop competitive advantages in selected high technology industries, and space in particular. While China has achieved successes in testing and deploying advanced space and counterspace systems, questions remain over the direction of its technology development and potential operational effects. An increasingly congested, contested, and competitive outer space underscores the need for a better understanding of the opportunities and challenges that arise from advances in expanding Chinese access to this unregulated global common. Furthermore, the United States' future as a leader in the Asia-Pacific region is linked with its ability to maintain a competitive edge in power projection capabilities that depend upon uninterrupted access to the space domain.