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China's Military-Civil Fusion in Space: Strategic Transformations and Implications for Europe

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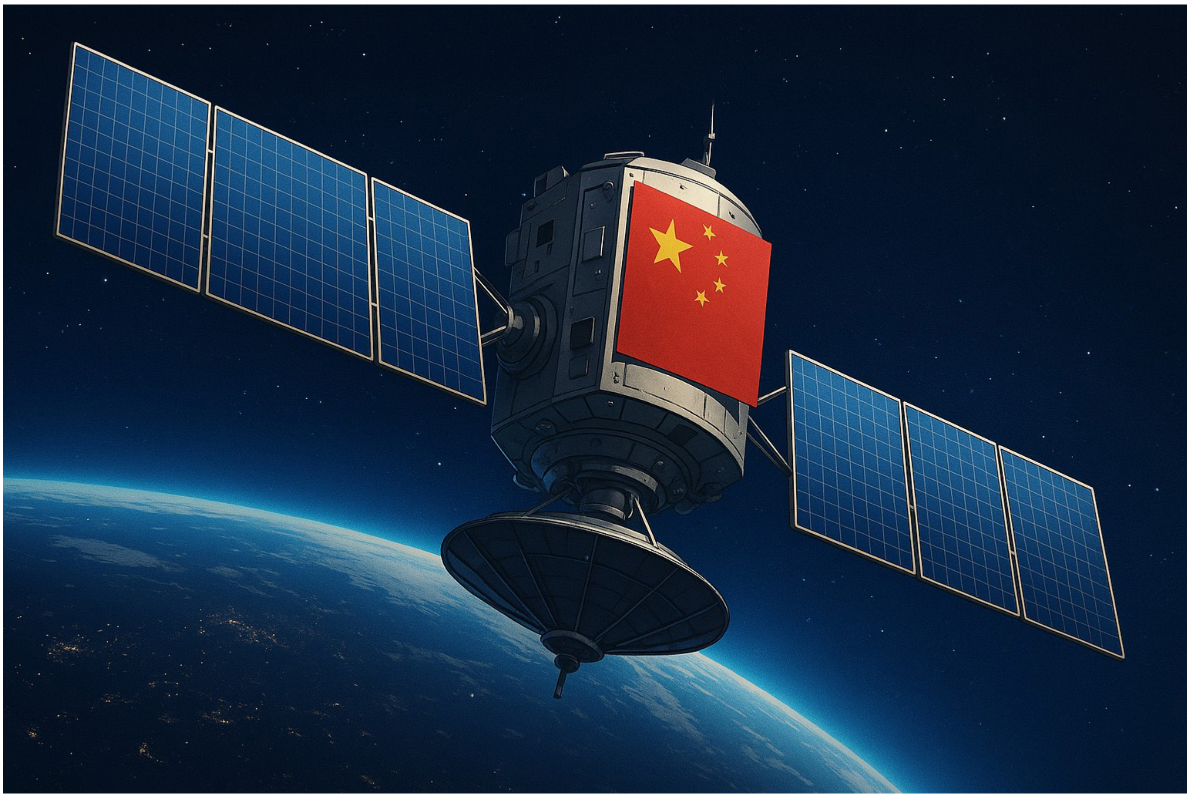
KEY TAKEAWAYS

- China's Military-Civil Fusion (MCF) strategy is a multi-purpose tool to enhance national power, accelerate technological innovation, and drive industrial and economic development.
- MCF has reshaped China's space sector, driving rapid innovation and fostering the rise of private commercial space actors aligned with national security and industrial goals.
- Europe has already been outpaced by both China and the U.S. in key space capabilities, weakening its defense posture and reducing its strategic influence in a domain that is increasingly shaping the broader geopolitical balance.
- Without credible capabilities, the EU risks being sidelined from setting the rules and standards in the space domain, limiting its ability to defend strategic interests and values.
- Dependence on U.S. space providers challenges the EU's strategic autonomy, undermining secure, independent access to space, at a time of growing uncertainty over the future of the transatlantic security alliance.
- Drawing lessons from China's model, the EU must accelerate innovation and better mobilize its private space sector to secure a competitive and autonomous position the global space race.

Keywords
Military-Civil Fusion
Space Security
Aerospace
Dual-use Technology
Strategic Autonomy
Technological Competitiveness
China-EU



Introduction: Understanding China's Military-Civil Fusion Strategy

In 2015, President Xi Jinping elevated Military-Civil Fusion (MCF) to a national-level policy, transforming it from a narrow, compartmentalized effort into an in-depth, system-wide strategy at the center of China's national development agenda.

While the idea of drawing on civilian technology for military purposes - and vice-versa – is not new, Xi's vision for MCF has sought to go further, aligning national defense capabilities with broader economic and social development, technological, and security objectives. [1] On the one hand, this entails a strategic push to "coordinate economic construction and national defense construction," [2] with both serving as interdependent and mutually reinforcing engines of national power. On the other hand, MCF supports the broader goal of building a "techno-security state", positioning cutting-edge technology as central to China's military strength, strategic advantage and global influence. Within this approach, MCF is positioned as a key instrument to transform the People's Liberation Army (PLA) into a world-class, high-tech force able to operate in informatized conflict environments. [3] [4]

Under the direction of the Central Commission for Integrated Military and Civilian Development (CCIMCD), Xi's MCF strategy has sought to effectively break down institutional barriers between civilian and military sectors; leverage civilian innovation for military modernization; accelerate dual-use and multi-use technology in critical emerging fields and encourage private sector participation in defense-related R&D. As such, MCF goes well beyond the traditional notion of “dual-use”. It deliberately blurs the lines between military, civilian and commercial domains, creating an integrated ecosystem designed to advance China’s goals on multiple fronts: strengthening military capabilities, driving technological self-reliance [5], fueling economic growth, and expanding China’s global influence.

The space domain has become a key area where this fusion strategy plays out. Through MCF, China is harnessing commercial innovation to expand its space capabilities, with private companies now playing a pivotal role in developing dual-use technologies that advance national security interests.

These shifts carry important implications for the European Union (EU), raising urgent questions about strategic autonomy, technological resilience, and Europe’s ability to shape the norms and power dynamics of the evolving space domain.

China’s MCF in the Space Domain: Shifting From State-led to Commercially Driven

China’s leadership views space as an increasingly decisive domain for national security and a key emerging arena for strategic competition. [6] Leadership in space is considered critical not only to achieving operational superiority, but also to adapting military power to the demands of informatized warfare and reinforcing strategic deterrence. Science and technological innovation in the space and aerospace sectors have thus become integral to the country’s MCF efforts. [7]

Traditionally, large state-owned enterprises (SOEs), notably China Aerospace Science and Technology Corporation (CASC) [8] , China Aerospace Science and Industry Corporation (CASIC) [9] have formed the backbone of China’s space sector. The space ecosystem also integrates key government agencies, including the China National Space Administration (CNSA) [10] and the State Administration for Science, Technology and Industry for National Defense (SASTIND). [11] Academic institutions such as the Harbin Institute of Technology [12] and Beihang University [13] have similarly become major research hubs, contributing to advancements across fields ranging from satellite design to space-based weapons systems. [14] In line with the broader goals of the MCF strategy, major SOEs and their subsidiaries tend to operate at the intersection of civilian and military development. [15] For instance, CASC functions under the direction of State-owned Asset Supervision and Administration Commission of the State Council (SASAC) [16] but also maintains close operational ties to the Central military Commission (CMC) [17] through the Equipment Development Department. This ecosystem has enabled the development of critical space infrastructure and technologies that are designed for multiple overlapping applications across military, commercial and civilian domains.

Among these, satellites stand out as the most vital space assets, enabling secure communications, intelligence gathering and precision targeting – capabilities that have become essential in modern warfare. Notably, a critical pillar of China's satellite infrastructure is the Beidou Navigation System (BDS) – a global satellite-based network used for positioning, navigation and timing (PNT) services. Illustrating the MCF strategy, Beidou -primarily developed by CASC and its subsidiary Chinese Academy of Science and Technology (CAST) - serves a broad range of civilian applications including precision agriculture, smart cities and intelligent transportation. Yet, it also plays a central role in China's military modernization efforts under the MCF strategy, enabling enhanced joint combat, battlefield intelligence and weapon precision strike capabilities through improved positioning and time synchronization. [18] Starting in 2027, China plans to deploy an upgraded generation of Beidou satellites, offering enhanced real-time positioning and timing services. This improved system is expected to strengthen civilian applications while significantly boosting the PLA's ability to conduct precision strikes, unmanned operations, and networked joint missions. [19] Beidou's growing sophistication and global reach could gradually challenge U.S. dominance in satellite navigation by offering an alternative to the GPS system.

Recognizing that space-based intelligence and information dominance are critical enablers for modern warfare, China has also prioritized the development of high-resolution remote sensing satellites in its MCF strategy. [20] Remote sensing refers to using satellites equipped with cameras and sensors to collect images and data about the Earth's surface from orbit, without needing physical contact or observation on the ground. These systems are a core source of Geospatial Intelligence (GEOINT), which support the detection, mapping and monitoring of terrain, infrastructure and military activity. China's Yaogan and Gaofen remote sensing satellites use advanced imaging technologies (Synthetic Aperture Radar), enabling detailed observation including at night and through cloud or smoke. Their high resolution allows for the identification of objects as small as military vehicles or equipment, giving China a powerful tool for Intelligence, Surveillance, and Reconnaissance (ISR). For instance, Gaofen-4&7 satellites can provide real-time, high-resolution images enabling the military to monitor foreign military bases, track troop and vehicle movements, follow naval vessels, detect missile sites, and map critical infrastructure. [21] The Yaogan-30 satellite cluster complements these capabilities by collecting electronic and signal intelligence (ELINT/SIGINT), [22] helping to locate radar systems, communication networks, and other electronic military signals. [23][24]

Furthermore, the ability to repair, refuel or reposition satellites in orbit (in-orbit servicing) as well as to manoeuver satellites into close proximity with others (rendezvous and proximity operations) is becoming essential for ensuring the resilience of critical space infrastructure and maintaining operational continuity in a conflict. China has been actively developing these capabilities, particularly through its Shijian satellites series. The Shijian-21 satellite demonstrated the ability to dock with and relocate another satellite using a robotic arm-moving a defunct satellite to a graveyard orbit. [25][26] Although part of a debris removal operation, concerns have been raised about the potential counterspace implications of such capabilities to disrupt or disable adversary satellites in a conflict scenario. [27]

The effectiveness of satellites depends on the ability to launch and sustain them into orbit. Launch capabilities are therefore critical to maintaining space superiority, enabling the deployment, replacement, and long-term sustainment of space infrastructure. China has focused on developing robust launch systems and vehicles. [28] The Long March rocket series forms the core of its state-developed launch capabilities, supporting a wide range of missions from the deployment of civilian space infrastructure to the launch of military payloads. [29]

Despite notable progress, China has early on recognized that state-led capabilities alone were insufficient to meet the scale, speed and cost-efficiency required to compete in today's space environment. Building and expanding space infrastructure – particularly large-scale satellite constellations – is both financially demanding and technically complex. These challenges have driven China to increasingly leverage private sector participation and commercial innovation to accelerate breakthroughs in space technology and reduce costs. Following Beijing's 2014 decision to open the industry to private capital [30] , the MCF strategy played a critical role in fostering the rise of private commercial space actors, aligning their growth with national industrial and security priorities. [31]

The success of U.S. firms, particularly SpaceX, further accelerated this paradigm shift, reinforcing China's efforts to integrate private space development with national security objectives. The company's breakthroughs in rocket recycling technology, heavy lift launch vehicles and low Earth orbit (LEO) broadband satellite constellation, notably, have served as a benchmark in the industry. [32] The role of Starlink in the Ukraine War has shed light on the rising strategic value of LEO constellations in modern conflict, particularly in securing communications, supporting unmanned operations, and ensuring information resilience against cyber and electronic warfare threats. [33]

Building on these developments, China has increasingly focused on the deployment of its own LEO constellations. The "Guowang" project - planned to include 13,000 satellites - represents the state-led component, while the private sector is advancing parallel efforts through initiatives such as GalaxySpace's Qianfan (Spacesail) mega-constellation. It has set ambitious targets including the launch of 648 satellites in 2025, global coverage by 2027, and the deployment of 15,000 satellites by 2030. [34] The expansion of such constellations has intensified competition over finite space resources critical to satellite communications, particularly orbital slots and radio-frequency spectrum. [35]

Beyond broadband communication, China's private sector is also advancing its Earth Observation (EO) capabilities. For instance, Chang Guang Satellite Technology (CGST) has developed the Jilin-1, currently the world's largest commercial sub-meter EO constellation.

CGST plans to network 300 satellites by 2027, significantly enhancing China's capacity for persistent surveillance, dynamic target tracking, and real-time ISR operations. [36] The constellation's strategic relevance was already demonstrated in 2016, when Jilin-1 satellites captured high-definition images of U.S. naval vessels at the Philadelphia Naval Shipyard. [37]

Another key area of focus for private companies is the development cost-effective and/or reusable launch vehicles [38] - a critical capability to strengthen strategic leverage by reducing launch costs, increasing operational flexibility and enabling a rapid reconstitution of space assets in a conflict scenario. [39] Space X has set the standard for reusability in 2017, when it successfully launched and landed a previously flown Falcon 9 booster, marking the first reuse of an orbital-class rocket. [40] This has allowed the company to significantly reduce costs compared to traditional expendable systems and achieve a higher launch frequency. For instance, Falcon 9 launches are priced at around USD 62 million, whereas traditional expendable rockets such as the Atlas V or Europe's newly introduced Ariane 6 are estimated at approximately USD 150-200 million and EUR 75-115 million respectively. [41] In 2024, SpaceX also achieved a record-breaking 133 successful orbital launches using the Falcon series, against 20 for other U.S. space actors and only 2 for European firms. [42] Besides developing medium-lift vehicles, which offer more flexible use and faster deployment, Space X is also investing in super-heavy launch vehicles critical to build satellite constellations. Its Starship rocket [43] - still under development- aims to be fully reusable and capable of carrying over 100 tons to LEO - which would represent a game-changing increase compared to traditional rockets.

Although China's private sector still lags behind the U.S. in launch reusability, operational speed and heavy-lift capabilities, it is advancing at a fast pace to emulate Space X's model. Galactic Energy has demonstrated consistent launch performance with its Ceres-1 [44] and is now developing a reusable medium-lift rocket (Pallas-1). [45] Space Pioneer is developing a partially reusable medium-to-heavy lift rocket targeting a 17-ton payload to LEO (Tianlong-3). [46] Meanwhile, LandSpace became the first company to orbit a methane-fueled rocket in 2023 (Zhuque-2) [47] and is now developing a fully reusable heavy-lift vehicle (Zhuque-3) to support rapid constellation deployments. [48] With this momentum expected to grow further - driven by strong state policy support and financial incentives [49] , China's private space sector is likely to significantly lower its cost of access to orbit, speed up satellite deployments, and strengthen the resilience of its space infrastructure - with important implications for the future balance of power projection in space.

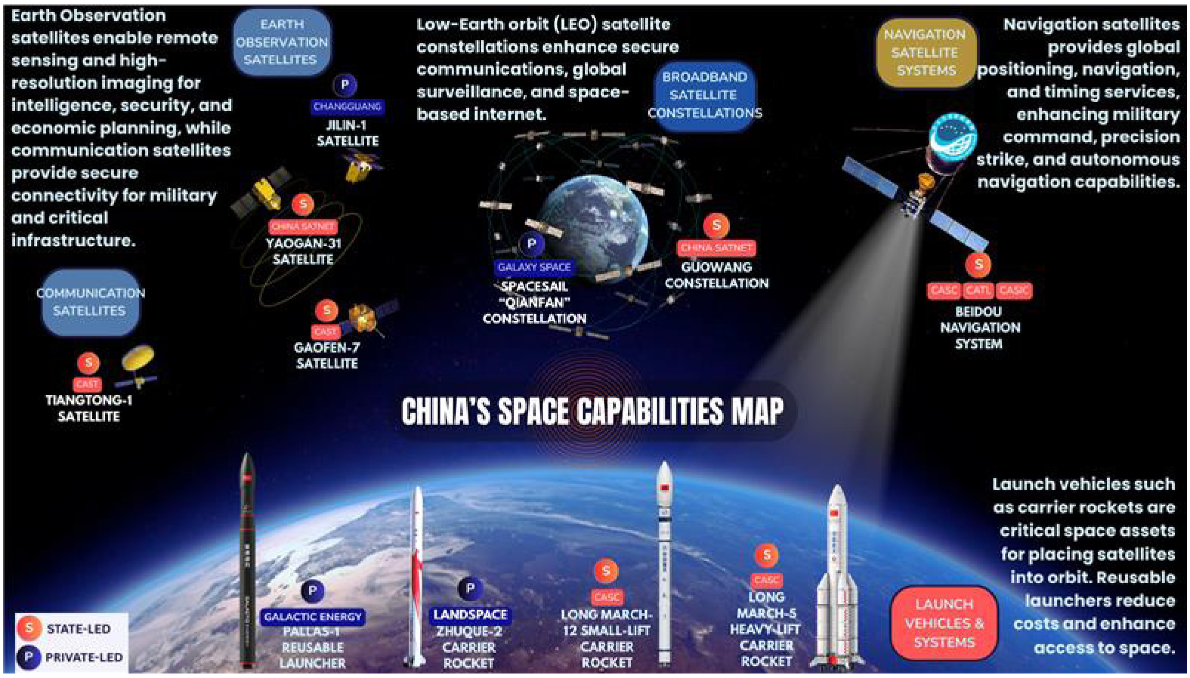


Figure: Overview of China's Space Capabilities

Strategic Implications for Europe

China's rapid advances in the space domain and its efforts to catch up with the United States carry important implications for Europe's future space power and strategic autonomy. While the U.S. is likely to retain overall leadership in the near term, China's accelerating progress - particularly in launch services, satellite constellations, and operational tempo - is steadily narrowing the gap and reshaping the competitive landscape. [50]

In contrast, Europe's capabilities are increasingly falling behind both China and the United States, raising concerns about its ability to maintain autonomous access to space and safeguard critical space-based infrastructure. This is due in part to structural limitations. The European space sector remains fragmented across national and institutional lines, underfunded relative to its ambitions and lacking private sector involvement.

Without significant investment and innovation, Europe risks deepening its strategic dependence at a time when space capabilities are becoming central to defense, crisis management, and technological sovereignty.

Control of space assets - including communications, intelligence, surveillance, and positioning systems - will be critical for future warfare. Space superiority will directly impact operational effectiveness, resilience in conflict scenarios, and the ability to sustain independent decision-making. A continued erosion of Europe's space capabilities would not only weaken its defense posture but also reduce its strategic influence in a domain that is increasingly shaping the broader geopolitical balance.

As technological competition intensifies, leadership in space will also determine who sets the norms, standards, and rules that govern future activities in this domain. Without credible space capabilities, Europe risks being sidelined from these critical discussions, limiting its ability to shape an international order aligned with its interests and values. Meanwhile, China has been expanding space cooperation with countries in Africa and Latin America through the Belt and Road Initiative (BRI), strengthening its geopolitical influence and role in shaping global space governance.

Besides these considerations, China's rise in space highlights the urgent need for Europe to boost its space capabilities and technologies to secure strategic autonomy. The conflict in Ukraine has demonstrated that space assets - particularly satellite communications, intelligence, and surveillance are critical for modern warfare and national resilience. Notably, satellite communications were among the first targets in the early stages of the war. [51] EU Defence and Space Commissioner, Andrius Kubilius, emphasized the importance of securing Europe's autonomy in space, warning that "In times of crisis, we cannot afford to be too dependent on countries or companies from outside the EU." His advocacy around the "White Paper for European Defence - Readiness 2030" reflect the growing integration of space into the EU's common defense agenda.

Russia's increased efforts to coordinate with China in the space domain adds to Europe's strategic concerns. While cooperation on satellite navigation predates the war, Western sanctions on Russia's aerospace sector have made such partnerships more strategically relevant. In 2022, the two countries agreed to construct a Chinese ground station in Russia's Obninsk as part of broader efforts to align the Beidou and GLONASS navigation systems. [52] This could enhance Russia's operational resilience in conflict scenarios and complicate efforts to disrupt its space-enabled military capabilities. [53]

There have been recent efforts to boost EU space resilience, including the notable announcement of the IRIS² multi-orbital satellite constellation involving around 290 satellites in December 2024. The deployment is set to start in 2029 with up to 13 Ariane 6 launches, while services provision is scheduled to start in 2030. [54]

Yet Europe's ability to deliver on these ambitions faces real risks. Persistent delays in the Ariane 6 program and the grounding of Vega-C have exposed critical gaps in Europe's launch capabilities. [55] Europe currently operates only expendable launchers and lacks a reusable system, putting it at a disadvantage. [56] This has already forced the bloc to turn to non-European providers, including a €180 million agreement with SpaceX to launch four Galileo satellites - an arrangement that will expire in 2027. [57] Without credible launch options, Europe risks deepening its reliance on U.S. capabilities for access to space, with direct consequences for the continuity of essential programs like Galileo and the timely deployment of IRIS².

Initiatives like MaiaSpace's partially reusable launcher [58] , ESA's Themis program, Space Rider, and the CALLISTO demonstrator are important first steps. Yet, bridging the strategic gap will require not only technological progress but also sustained political will and accelerated investment. As China's rapid development of a competitive commercial launch sector showed, mobilizing a broader, more dynamic private sector will be crucial for Europe to build the resilient, independent space access it needs. This also calls for more integrated EU-level approaches, including common procurement policies and harmonized priorities among Member States to enhance the coherence, scale and competitiveness of the EU's space sector.

Category	Usage	State-Led Projects	Commercial/ Private-Projects	Why it matters for Europeans?
SATELLITES				
Earth Observation Satellites (EO)	**Satellites that take pictures/ videos of Earth for monitoring military, environment, disasters, agriculture.**	**Gaofen satellites (CAST)**	**Chang Guang (Jilin-1), Genesat, MinoSpace, ADA Space**	**Expands China's global surveillance. • Europe faces ISR and commercial EO competition (e.g., vs. Copernicus).**
Communications / IoT Satellites	**Satellites providing internet, mobile, or IoT connections across wide areas.**	**Zhongxing (ChinaSat), Tiantong mobile systems**	**GalaxySpace (Qianfan LEO), Commsat, MinoSpace, ADA Space**	**Strengthens China's communications resilience Challenges. • Europe in broadband/IoT markets; raises dual-use risks.**
Navigation / Positioning Satellite Systems	**Satellite systems like GPS, used for precise location, timing, and guidance.**	**BeiDou global system (CAST, CASIC, CETC)**	**X**	**Gives China military and civilian navigation independence. • Europe must secure Galileo's global role**
Space Environment (SSA) Satellites	**Satellites tracking space weather, radiation, and debris to protect other satellites.**	**Space debris/ weather monitoring (SOEs)**	**Emposat**	**Improves China's space awareness, protecting its assets. • Europe needs strong SSA to safeguard orbits and monitor Chinese activities.**
On-orbit Services / Operations	**Systems that can repair, refuel, upgrade, or deorbit satellites while in space.**	**Early R&D by CASC, CAST**	**Few private players yet, but emerging startups**	**Enables longer satellite life, flexible military operations. • Europe needs to monitor dual-use potential and develop its own capabilities for resilience.**
Launch Vehicles				
Small/Medium Launchers	**Rockets that launch small or medium satellites; fast, flexible access to space.**	**Long March 6/11 (CASC), Kuaizhou (CASIC)**	**Space Pioneer (Tianlong-2), Galactic Energy (Ceres-1), i- Space, Ming Kong**	**Boosts China's ability to quickly launch/replace satellites. • Europe must improve fast-launch capacity for resilience and military readiness.**
Reusable Launchers	**Rockets designed to land and be reused, lowering costs and increasing launch speed.**	**Early research at CASC**	**Galactic Energy (Pallas-1), i-Space (Hyperbola-2), Deep Blue Aerospace (Nebula-1)**	**Cuts China's costs, increases operational speed. • Europe needs investment in reusability to stay competitive and secure flexible space access.**

Heavy-Lift / Advanced Fuels	**Large rockets that carry heavy payloads or use cutting-edge fuels like methane.**	**Long March 5/7/9 (CASC)**	**LandSpace (Zhuque-2, methane), Orienspace (Gravity-1 heavy-lift)**	**Supports strategic payloads, lunar and military missions. • Europe needs Ariane upgrades and/or joint heavy-lift programs to match capabilities.**

Table: Main Chinese Space Assets and Strategic Relevance for European Competitiveness in Space

[1] See, “军民深度融合发展意见” (Ministry of National Defense of the People’s Republic of China, 20 October 2017; http://www.mod.gov.cn/gfbw/jmsd/4817612.html ; last accessed on 03 April 2025).

[2] See, “推进新型举国体制 打好关键核心技术攻坚战” (People’s Daily, 11 March 2023; http://opinion.people.com.cn/n1/2023/0311/c223228-32641981.html ; last accessed on 03 April 2025).

[3] See, “国务院办公厅关于推动军民融合深度发展的意见” (State Council of the People’s Republic of China, 15 September 2017; https://www.gov.cn/xinwen/2017-09/15/content_5225216.htm; last accessed on 04 April 2025).

[4] See, “China’s New Military Strategy: Winning Informationized Local Wars” (Jamestown Foundation, 2015; https://jamestown.org/program/chinas-new-military-strategy-winning-informationized-local-wars/; last accessed on 03 April 2025).

[5] See, “中国梦：新时代的航天强国之路” (China Today, 20 October 2017; http://www.chinatoday.com.cn/spc/2017-10/20/content_749004.htm; last accessed on 04 April 2025).

[6] See, “推进军民融合深度发展” (Qiushi Theory, 07 March 2019; http://www.qstheory.cn/llwx/2019-03/07/c_1124202138.htm; last accessed on 04 April 2025).

[7] See, “习近平：加强军民融合发展战略” (Xinhua News Agency, 16 July 2018; http://www.xinhuanet.com/politics/2018-07/16/c_1123133733.htm; last accessed on 08 April 2025).

[8] See, “China Aerospace Science and Technology Corporation,” (CASC; http://english.spacechina.com/ ; last accessed on April 08 2025).

[9] See, “China Aerospace Science and Industry Corporation,” (CASIC; http://www.casic.com.cn/n12377448/index.html ; last accessed on 8 April 2025).

[10] See, “China National Space Administration,” (CNSA; https://www.cnsa.gov.cn/ ; last accessed on 8 April 2025).

[11] See, “State Administration for Science, Technology and Industry for National Defense,” (SASTIND; https://english.www.gov.cn/state_council/2014/10/06/content_281474992893468.htm ; last accessed on 8 April 2025).

[12] See, “Harbin Institute of Technology,” (HIT; https://en.hit.edu.cn/ ; last accessed on 8 April 2025).

[13] See, “Beihang University,” (Beihang; https://is.buaa.edu.cn/en / ; last accessed on 8 April 2025).

[14] See, “Deciphering China’s Military Space Program and Its Global Strategic Components” (ResearchGate,2024;https://www.researchgate.net/publication/389299554_Deciphering_China’s_Military_Space_Program_and_Its_Global_Strategic_Components ; last accessed on 08 April 2025).

[15] See, “2021年中国卫星导航产业发展回顾” (The Paper, 05 January 2021; https://www.thepaper.cn/newsDetail_forward_10671777; last accessed on 08 April 2025).

[16] See, “State-owned Assets Supervision and Administration Commission of the State Council,” (SASAC; https://en.sasac.gov.cn/ ; last accessed on 8 April 2025).

[17] See, “Equipment Development Department of the Central Military Commission,” (CMC; https://www.sastind.gov.cn/history/n6195634/n6195706/n6195716/n6427848/n6427940/n6759613/c6798229/content.html ; last accessed on 8 April 2025).

[18] See, “2021年中国卫星导航产业发展回顾” (The Paper, 05 January 2021; https://www.thepaper.cn/newsDetail_forward_10671777 ; last accessed on 08 April 2025).

[19] See, “China to Launch Next-Generation BeiDou Satellites in 2027” (SpaceNews, 28 November2024; https://spacenews.com/china-to-launch-next-generation-beidou-satellites-in-2027/; last accessed on 08 April 2025).

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[22] See, *[14]*.

[23] See, “China’s Space Dream: No Limits, No End” (Institut Montaigne, February 2025; https://www.institutmontaigne.org/ressources/pdfs/publications/china-trends-22-chinas-dream-space-no-end.pdf; last accessed on 11 April 2025).

[24] See, “Deciphering China’s Military Space Program and Its Global Strategic Components”(ResearchGate, 2024;https://www.researchgate.net/publication/389299554_Deciphering_China's_Military_Space_Program_and_Its_Global_Strategic_Components ; last accessed on 11 April 2025).

[25] See, “China’s Space Station’s Giant Robotic Arm Sparks Concerns in US” (South China Morning Post, 20 May 2021; https://www.scmp.com/news/china/diplomacy/article/3134500/china-space-stations-giant-robotic-arm-sparks-concerns-us; last accessed on 14 April 2025).

[26] See, “China’s Shijian-21 Spacecraft Docked with and Towed a Dead Satellite” (SpaceNews, 26 January 2022; https://spacenews.com/chinas-shijian-21-spacecraft-docked-with-and-towed-a-dead-satellite/ ; last accessed on 14 April 2025).

[27] See, “Chinese Satellite Pulled Another Out of Orbit” (Natural News, 25 February 2022; https://www.naturalnews.com/2022-02-25-chinese-satellite-pulled-another-out-of-orbit.html; last accessed on 14 April 2025).

[28] See, “China’s Military-Civil Fusion Strategy: A View from the Inside” (Secrss, 2023; https://www.secrss.com/articles/7736 ; last accessed on 14 April 2025).

[29] See, “China’s Space Launch Activities” (ChinaPower, 2023; https://chinapower.csis.org/china-space-launch/; last accessed on 14 April 2025).

[30] See, “Guiding Opinions on Innovating Investment and Financing Mechanisms in Key Areas to Encourage Social Investment” (State Council of the People’s Republic of China, 26 November 2014; https://www.gov.cn/zhengce/content/2014-11/26/content_9260.htm ; last accessed on 14 April 2025).

[31] See, "China Releases 2023 White Paper on Space Activities" (China National Space Administration, 20 January 2023; https://www.cnsa.gov.cn/n6758823/n6758838/c6803460/content.html; last accessed on 14 April 2025).

[32] See, "What We Can Learn from SpaceX" (The Paper, 13 December 2024; https://m.thepaper.cn/kuaibao_detail.jsp?contid=25627183&from=kuaibao; last accessed on 18 April 2025).

[33] See, "Emerging Technologies in Conflict: The Impact of Starlink in the Russia-Ukraine War" (ResearchGate, 2024; https://www.researchgate.net/publication/381758551_Emerging_Technologies_in_Conflict_The_Impact_of_Starlink_in_the_Russia_-_Ukraine_War; last accessed on 18 April 2025).

[34] See, "China's Rocket Breaks Apart: Can the 'Thousand Sail Plan' Challenge Starlink?" (Radio Free Asia, 22 August 2024; https://www.rfa.org/mandarin/duomeiti/bingjia-changshi/bjcs-chinese-rocket-breaks-08222024090053.html; last accessed on 18 April 2025).

[35] See, "Invisible Link: The Strategic Importance of Optical Communications in Space" (The Aerospace Corporation, 17 October 2024; https://csps.aerospace.org/sites/default/files/2024-10/06a_InvisibleLink_Allison_20241017.pdf; last accessed on 18 April 2025).

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[38] See *[21]*.

[39] See, "How SpaceX's Reusable Rockets Change the Game" (TelecomWorld101, 13 March 2024; https://telecomworld101.com/reusable-rockets-impact/; last accessed on 22 April 2025).

[40] See, "SpaceX Flies Rocket for Second Time in Historic Test of Cost-Cutting Technology" (Spaceflight Now, 31 March 2017; https://spaceflightnow.com/2017/03/31/spacex-flies-rocket-for-second-time-in-historic-test-of-cost-cutting-technology/; last accessed on 22 April 2025).

[41] See, "Restoring Europe's Space Independence: Everything You Need to Know About the Ariane 6 Rocket" (Universe Magazine, 2024; https://universemagazine.com/en/restoring-europes-space-independence-everything-you-need-to-know-about-the-ariane-6-rocket/; last accessed on 24 April 2025).

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