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China's space programme

A rising star, a rising challenge

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Foreword

These days, we talk often of Global China – a place which is the main trading partner for over 120 countries, and which has interests that stretch across the earth, reaching into even the most remote areas like the South and North Pole. But what is often forgotten is that China has strong, and very realistic, aspirations into outer space. That is the focus of this clear and timely paper, the second in the Lau China Institute Policy Paper Series.

China in outer space is not so dissimilar to the China we see in the unclaimed territory of the Antarctica. Here, the country is presented with a huge new opportunity, one bound by very broad treaties which have largely been untested because of the very few actors that have the capacity to launch operations. In the Cold War, the USSR and the US fought for a kind of domination in space travel and launching satellites, a battle that, after some early successes by the Russians, the Americans seemed to win when men were able to reach the moon and walk on it in 1969.

Since the 1980s, however, as NASA missions to the moon ceased, and other areas became a priority, China has been building up its capacity. Its Shenzhou programme, the fifth of which in 2003 saw the first Chinese national, Yang Liwei, fly in space, has been the backbone to this. These have figured as part of a narrative of national pride and strength – a sign that in an area traditionally only occupied by great powers, China is now a real player. The operations that have flowed from this area detailed succinctly in this report.

So too is the ambiguity around what China is doing. Yes, it conveys its operations as ones that advance human knowledge and understanding. But the technology is it developing and using, though presented as purely civilian, of course have military application. And while China in space might seem remote from more earthly concerns, it does give China access not only to symbolic power, but, beyond that, a real area in which to have satellites and other hard capacity that are all too easy to shift from benign to more unsettling uses.

China in outer space is an urgent and important topic. In a year in which a surveillance vehicle has been landed by NASA on Mars, sending back magnificent, clear images of the surface of the planet, it is clear why exploration of the solar system and perhaps even beyond remains something that captures the imagination of everyone. But the infrastructure that supports this sort of work, and the ways in which knowledge gained from it can be used back closer to home, are clearly very earthly, and deeply political, issues. That is something that this paper very clearly shows, along with the important implications that flow from this.

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Abstract

China's successful Chang'e 5 lunar mission last December has, again, highlighted the pace of the country's space programme. As the latest in a string of recent mission successes, it has inevitably led to warnings of an impending or ongoing space race.[1] Such warnings, however, are somewhat injudicious – scientific missions such as the Chang'e series may well have no relation to strategic competition. Nonetheless, the domain of space throws up very particular challenges in identifying the character and intent of any state's programme – space assets such as satellites are remote, and their capabilities can only be estimated. Most space platforms and technologies are dual-use (ie able to perform civilian or military tasks), which creates ambiguity. Additionally, military classification and secrecy permeate the history of the space era, reducing further the ability to obtain a clear understanding of the domain, and raising the potential for misperception. These characteristics combine to create substantial difficulties for strategic stability in the domain, particularly in a time where dialogue and diplomacy between global powers is limited. However, these are amplified by the nature of China's policy apparatus and a number of specific programmes. China's policy-making is notably opaque, while President Xi Jinping's 'military–civil fusion development strategy' obfuscates the distinction between military and civilian power throughout the spectrum of many leading technological areas, as well as in the expansion of infrastructure.[2] This intersects with particular US sensitivities derived from its critical dependence on space-based capabilities. The result is an environment ripe for miscalculation, with little in the way of a stabilising anchor. As more Chinese sources are translated, there is little to dispel those concerns, as a recent study by CNA for the China Aerospace Institute has concluded.[3] Having conducted a vast survey of Chinese sources, it notes that China views space as a barometer of US–China relations, and intends to overtake the US as the dominant nation in space in the next decades.[4] This creates part of a wider challenge to the US and the Western world. However, as more and more facets of modern life depend on access to space-derived capabilities, the space domain will have a particularly critical impact on strategic stability.

1 For instance, see Arjun Kharpal, 'China brings moon rocks back to Earth in a first for the country as space race with U.S. heats up'. *CNBC*, 16 Dec 2020. Available at: cnbc.com/2020/12/17/china-brings-moon-rocks-back-to-earth-in-a-first-for-the-country.html; Sadamasa Oue, 'Can Japan keep up in the 21st-century space race?' *The Japan Times*, 10 Dec 2020. Available at: japantimes.co.jp/opinion/2020/12/10/commentary/japan-commentary/japan-space-race/; Ludovic Ehret, 'China launches Mars probe in space race with US'. Phys.org, 23 Jul 2020. Available at: phys.org/news/2020-07-china-mars-probe-space.html; Danil Bochkov, 'In the new space race with the US, how far can China's cooperation with Russia go?' *South China Morning Post*, 30 Dec 2020. Available at: scmp.com/comment/opinion/article/3115660/new-space-race-us-how-far-can-chinas-cooperation-russia-go

2 For an English translation of the Chinese Ministry of Science and Technology's plan, entitled 'The "13th Five-Year" Special Plan for S&T Military-Civil Fusion Development', see Georgetown University's Center for Security and Emerging Technology's version, 24 Jun 2020. Available at: cset.georgetown.edu/research/the-13th-five-year-special-plan-for-st-military-civil-fusion-development/

3 Kevin Pollpeter, Timothy Ditter, Anthony Miller, and Brian Waidelich, *China's Space Narrative: Examining the Portrayal of the US–China Space Relationship in Chinese Sources and its Implications for the United States*. China Aerospace Studies Institute/CNA, Montgomery, AL, Sep 2020

4 Pollpeter et al, p. 16.

China's achievements

The space domain has been host to remarkable progress, and indeed expansion in recent years, across the military, commercial and civilian sectors. The scale of space operations and the number of nations that have begun space programmes in recent years, alongside many new commercial operators, are beginning to transform the domain. Reusable launch stages have become familiar sights, satellites are shrinking to miniscule dimensions, reducing costs and introducing new potential to a wider array of operators, and functions such as on-orbit rendezvous, servicing and manufacturing capabilities driven by developments in autonomy and robotics are just beginning.

Amongst the achievements and advances, however, China's space programme stands out as particularly impressive, with the last two years alone exhibiting developments that eclipse many nations' entire accomplishments in space.

The Chang'e 5 mission noted above is the latest phase in China's Lunar Exploration Program, and was its first to collect and return samples of the lunar surface. Indeed, this was the first lunar sample return mission since the last Soviet mission of 1976. The Chang'e 5 landed on the moon on 1 December 2020 and returned to Earth with approximately 2 kilograms of lunar material on 16 December. The 23-day mission consisted of a complex set of manoeuvres and technologies, including four components: a lander, an orbiting body, an ascender and the final re-entry vehicle – all of which will pave the way for future robotic exploration. Its success allows Chang'e 6, the backup mission, to be re-tasked for a landing towards the lunar south pole.[5] Missions 7 and 8 will begin to verify technologies that will enable a lunar scientific base.

Chang'e 5 also marked the fifth successful launch of the Long March 5 rocket, which is one of the most powerful launch vehicles ever produced, currently second only to the Falcon Heavy. Though this rocket was first launched

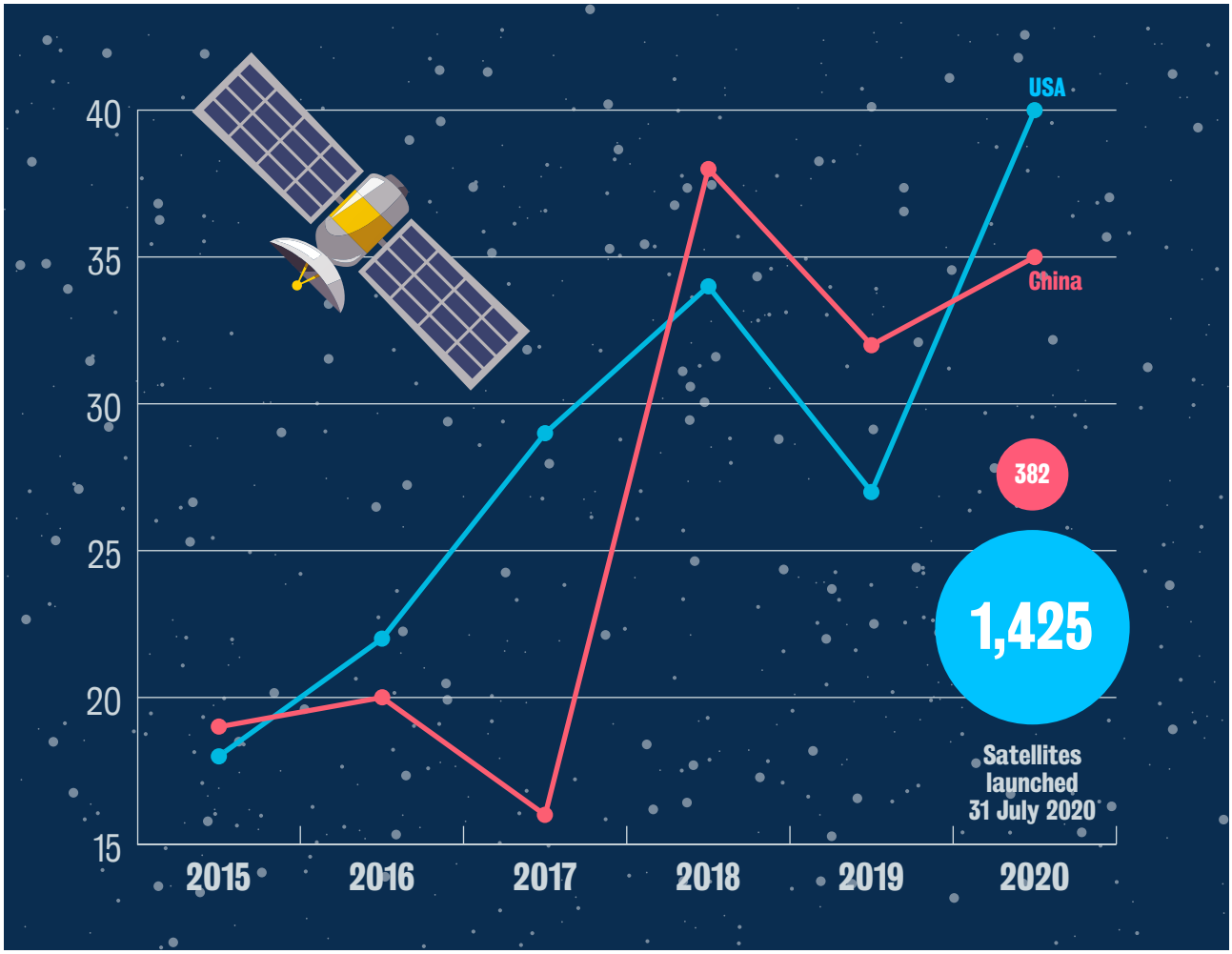

Figure 1. Successful launches by China and USA between 2015 and 2020, Union of Concerned Scientists Satellite Database

5 Andrew Jones, 'China recovers Chang'e-5 moon samples after complex 23-day mission'. *SpaceNews*, 16 Dec 2020. Available at: spacenews.com/china-recovers-change-5-moon-samples-after-complex-23-day-mission

only in 2016, China has also developed the Long March 7 and 8 rockets, with the Long March 9 – a super-heavy launch vehicle – in development.[6]

The predecessor of the Chang'e 5 mission, the Chang'e 4, achieved mankind's first landing on the far side of the moon in January 2019, which marked the second Chinese lunar landing. Interestingly, the mission was also notable for the level of cooperation between China and the US, with the latter conducting surveillance of the intended landing area via NASA's Lunar Reconnaissance Orbiter to provide data for the landing.[7]

China has also entered the small commercial launch sector, with two private companies recently successfully launching satellites. i-Space launched the Hyperbola-1 rocket in July 2019, making it the first Chinese private company to achieve orbit.[8] This was followed in November 2020 by Galactic Energy launching the Ceres-1.[9] Both companies have stated that they intend to make their rockets reusable in the future.

An amount of uncertainty surrounds another probable breakthrough in 2020: the launch of a reusable space plane.[10] Little is known beyond the very brief press reports given by China's official Xinhua News Agency, which noted simply that a Long March 2F rocket had inserted a 'reusable experimental spacecraft' into orbit and that the launch and landing were successful.[11] There were no images shown, though a commercial imaging satellite operated by US company Planet possibly caught the craft on the runway after landing. While the mission came as a surprise, there had been hints of work in this field previously. In 2007, the Chinese media revealed a small spaceplane called *Shenlong* (Mandarin for 'Divine Dragon') attached to the underside of a Xian H-6 bomber. It was not seen subsequently, and it may have been an early technology demonstrator for the craft making the September 2020 flight.

Collectively, these developments will help underpin China's crewed spaceflight programme, which is similarly ambitious. A key element of this is China's new modular space station, the core section of which – to be called *Tianhe* ('Harmony of the Heavens') – is expected to launch in March 2021, as well as their crewed mission to Mars that could be launched in the next decade. Notably, the space station will become operational at a time when the International Space Station is nearing the end of its service life.

These are only the most conspicuous and newsworthy aspects of China's development of space capabilities. Another aspect that is extremely important but often largely overlooked is the ground-based segment, consisting of radars and communications facilities that enable the operation of satellites, the receiving and disseminating of the data the satellites collect, and the generating of space situational awareness (SSA) or space domain awareness (SDA).12 These functions are central to commercial, civilian and of course military space operators. China's development of this segment is less well known, but it is expanding rapidly.

Notably, this element of China's space programme is extending beyond its borders. Given China's increasing political and economic ties, and thus leverage, this has aided the establishment of satellite operating centres that not only allow the more effective operation of its own space assets but also monitor that of other countries. These are dispersed over 14 countries, including a number of Western states. Of course, this is not without controversy. For example, in 2020, Sweden's state-owned space company, which has a contract allowing China access to a number of stations globally, said that it was suspending its contract with China and would not accept new contracts with Chinese businesses due to 'changes in geopolitics'.[13] A ground station in Western Australia generated particular concern given Australia's close defence ties with the US, and the proximity to a ground station used by the US.[14]

The ambiguity of space, the enigma of China

These latter examples illuminate a fundamental characteristic of the space domain: its ambiguity. Most

6 See Andrew Jones, 'China reveals details for super-heavy-lift Long March 9 and reusable Long March 8 rockets'. Space.com, 08 Jul 2018. Available at: space.com/41102-china-reveals-details-for-super-heavy-lift-long-march-9-and-reusable-long-march-8-rockets.html

7 Andrew Jones, 'Chang'e-4 spacecraft enter lunar night time, China planning future missions, cooperation'. *SpaceNews*, 15 Jan 2019. Available at: spacenews.com/change-4-spacecraft-enter-lunar-nighttime-china-planning-future-missions-cooperation

8 Andrew Jones, 'Chinese iSpace achieves orbit with historic private sector launch'. *SpaceNews*, 25 Jul 2019. Available at: spacenews.com/chinese-ispace-achieves-orbit-with-historic-private-sector-launch. Their second attempt at launch on 1 Feb 2021 failed, however.

9 Stephen Clark, 'New Chinese rocket successful in debut launch'. Spaceflight Now, 08 Nov 2020. Available at: spaceflightnow.com/2020/11/08/new-chinese-rocket-successful-in-debut-launch

10 Rui C. Barbosa, 'China launches experimental spaceplane'. NASASpaceFlight, 04 Sep 2020. Available at: nasaspaceflight.com/2020/09/china-launches-experimental-spaceplane

11 See 'China launches reusable experimental spacecraft'. Xinhua News Agency, 04 Sep 2020. Available at: xinhuanet.com/english/2020-09/04/c_139342598.htm; 'China's reusable experimental spacecraft back to landing site'. Xinhua News Agency, 06 Sep 2020. Available at: xinhuanet.com/english/2020-09/06/c_139346803.htm

12 Although often conflated, SSA refers essentially to the passive observation of the space domain, while the term SDA has been introduced to indicate actively characterising objects, by the integration of Intelligence, with the primary goal of identifying hostile behaviour or intent.

13 For the last 10 years, the Swedish Space Corporation has had contracts giving Beijing access to its stations in Sweden, Chile and Australia. See 'China downplays role of Australia ground station in space programme'. Reuters, 22 Sep 2020. Available at: reuters.com/article/china-space-australia-sweden-int-idUSKCN26D160

14 Cameron Stewart, 'Chinese Military "Using WA Station" Exclusive'. The Australian, 16 Nov 2011.

technologies, and most platforms in space, have dual-use potential. This is the case for all the main categories of space systems – launch, satellite platforms and tracking. For instance, synthetic-aperture radar on Earth observation satellites is useful for a range of remote-sensing activities for environmental monitoring, but equally it is an excellent tool for the identification and surveillance of military targets. A satellite used for one purpose could be indistinguishable from one used for the other, or indeed tasked with both functions. Thus, gaining a clear picture of how a potential opponent is configured in space, and what intentions underpin those configurations, is fraught with uncertainty. This is amplified by the difficulty in attribution in space given its remoteness, and the hazy regulations of what is permissible in space. Space, then, in many respects is a natural grey zone.

While military secrecy has been a long-standing facet of space operations by all the main space-faring nations since the Cold War, China's policy-making – in space and more broadly – is notably difficult to penetrate, and this further increases uncertainty within the domain. Judgement of the country's ambitions in space often has little on which to base itself other than the outward form of the programmes themselves.

China maintains that its ambitions in space are peaceful. Beginning in 2002, China began work with Russia to formulate a treaty to prevent weaponizing space. This resulted in the draft Treaty on the Prevention of the Placement of Weapons in Outer Space, the Threat or Use of Force Against Outer Space Objects (PPWT) in 2008, updated in 2014.[15] However, other actions undermined its peaceful credentials. Most notorious was its 2007 direct ascent anti-satellite (ASAT) missile test, a weapons type that the draft PPWT notably did not cover. In 2013, China launched a rocket on what was apparently a high-altitude test mission – official statements suggested it was 'to obtain first-hand data regarding the space environment at different altitudes'.[16] However, rumour at the time and subsequent analysis suggests this was probably a high-altitude ASAT missile. Though Chinese media claimed the test only reached an altitude of approximately 10,000 kilometres, the missile was tracked to the altitude of geostationary orbit (roughly 36,000 kilometres).[17] If true, this test marks a first for ASAT technology, and creates the possibility that satellites in geostationary orbit are now within range of such weapons.[18]

Military–civil fusion

A broader trend that illuminates the difficulties in distinguishing military from commercial capabilities is the Chinese Communist Party's policy of military–civil fusion (MCF), unveiled in 2016. This is an expansive and comprehensive national strategy with the central goal of enabling the People's Republic of China to drive innovation on both sides. To achieve this, the main partitions between China's civilian, commercial and military research are made as transparent and porous as possible, facilitating communication and coordination between scientific research institutes, universities, commercial enterprises and the military, particularly in the areas of big data, semiconductors, 5G, advanced nuclear technology, aerospace technology, and artificial intelligence. This has extended to the reform of the Academy of Military Science, and the recruitment of civilians into scientific research by China's military.[19] Over 61 universities are now supervised by China's defence industry agency.[20] One of the goals of the programme is termed 'the fundamental domain resource sharing system', designed to enmesh military requirements into civilian infrastructure such as roads, railways and communications networks – some of them in other countries. Increasingly, this extends to space and information networks.[21] Undertakings such as this create inevitable concerns of growing military capabilities shrouded in wider technological or commercial progress. When considering the space domain, policy options such as MCF further obfuscate the inherent difficulty in identifying military capabilities or intent due to dual-use technologies, and the ambiguity of the domain due to its remoteness, creating an unstable fabric where the opportunity for misperception and instability is heightened.

Given these characteristics, China's dynamic rise in space generates extreme sensitivities within the US. The level of investment in and reliance on space by the US – far

15 For the 2008 draft submitted to the Conference on Disarmament, see CD/1839, 29 Feb 2008. Available at: documents-dds-ny.un.org/doc/UNDOC/GEN/G08/604/02/PDF/G0860402.pdf?OpenElement. For the 2014 draft, see CD/1985, 12 Jun 2014. Available at: documents-dds-ny.un.org/doc/UNDOC/GEN/G14/050/66/PDF/G1405066.pdf?OpenElement

16 Mike Wall, 'China launches high-altitude rocket on apparent science mission'. Space.com, 15 May 2013. Available at: space.com/21161-china-suborbital-rocket-launch.html

17 Office of the Secretary of Defense, Annual Report to Congress, Military and Security Developments Involving the People's Republic of China 2015

18 For a wider assessment of China's counterspace capabilities and plans, see Todd Harrison, Kaitlyn Johnson, and Thomas G. Roberts, 'Space Threat Assessment 2019', Apr 2019; and Brian Weeden and Victoria Sampson, eds., 'Global Counterspace Capabilities: An Open Source Assessment', Apr 2019. Counterspace capabilities that have been observed are direct-ascent kinetic-kill vehicles such as those used in the 2007 ASAT test, co-orbital satellites, directed-energy weapons, jammers, and cyber capabilities.

19 Kai Lin Tay, 'China's military looks to civilians to boost innovation'. IISS, 07 May 2020. Available at: iiss.org/blogs/analysis/2020/05/china-civil-military-innovation

20 Alex Joske and Charlie Lyons Jones, 'China's military–civil fusion policy has far-reaching implications for universities'. *The Strategist*, Australian Strategic Policy Institute, 27 Nov 2019. Available at: aspistrategist.org.au/chinas-military-civil-fusion-policy-has-far-reaching-implications-for-universities

21 Alex Stone and Peter Wood, *China's Military-Civil Fusion Strategy: A View from Chinese Strategists*. China Aerospace Studies Institute, Jun 2020, p. 54.

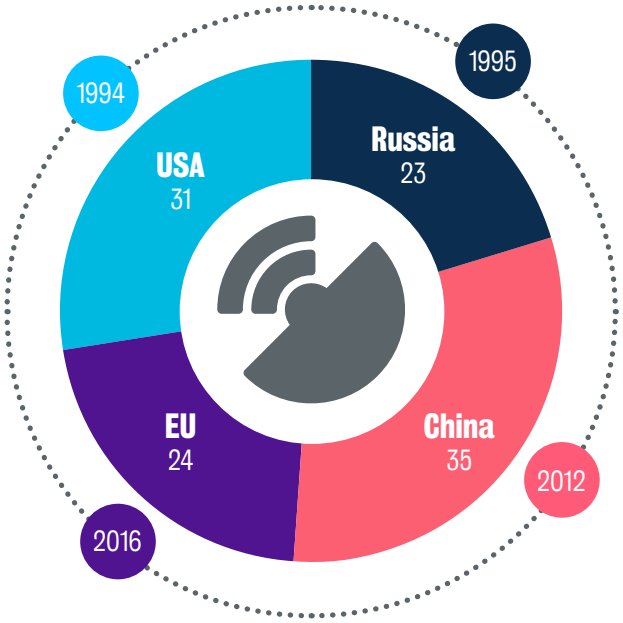

Figure 2. Global positioning, operational satellites

more than any other nation – as well as the symbolic value of space in the bilateral competition with the USSR during the Cold War will mean that changes to this domain have a particular impact on Washington's strategic concerns.

Even though the US possesses unparalleled capabilities in space, providing it with extensive services and information – and, in particular, tremendous military advantages – these assets are simultaneously virtually defenceless, and demonstrate profound vulnerability. This generates a significantly different dynamic than other elements of military power. Such defencelessness is an inherent characteristic of space platforms in that satellites must be lightly constructed and are therefore difficult to protect, but this is exemplified given the current distribution of power in space, and compounded by the ease of sub-threshold (or 'grey zone') tactics.

This results in an asymmetry of vulnerability, or a vulnerability gap, describing the liability derived from the dependence of the US on these assets despite the advantage it gains from its space capabilities relative to other states. This gap, it can be argued, may create the temptation in certain opponents to attack and disrupt US space capabilities. Opponents might plan to prosecute an attack in an early phase of a conflict, hoping to cause surprise and perhaps disarray and a disproportionate advantage.

Such opponents might also calculate that, if those early attacks on US space assets do not create an existential threat, there would be minimal risk of retaliation and the attack would be considered worth the risk. An adversary might also calculate that even if the attack were attributed, and the US responded in a way that destroyed a much greater number or proportion of the enemy's space assets, that adversary would regardless benefit from the action, since overall US military capability would be disproportionately impaired given its dependence on space assets. This creates a strong temptation for asymmetric, pre-emptive attack.

Limited transparency and a remote and ambiguous operating environment produce a tendency towards worst-case assumptions. Strategic dialogue that would help build greater trust and transparency has been slow in coming. A Civil Space Dialogue was established through the US–China Strategic and Economic Dialogue in 2015, and there were two subsequent meetings. However, China pulled out of the 2018 meeting and nothing was scheduled again until 2020. This rescheduled meeting had to be cancelled due to the COVID-19 pandemic. Given deteriorating relations generally, the future of these meetings is unclear. The US and other Western states have also been slow in translating sufficient documents to gain greater clarity. As attention turns from the Middle East and counter-terrorism, and pivots to the East, efforts are accelerating but are still limited.

The most recent and extensive report examining Mandarin sources is the CASI/CNA report *China's Space Narrative*. This has translated a vast selection of Chinese literature related to space, and many of its findings do not necessarily allay worst-case interpretations. Principally, it notes that China aspires to eclipse the US as the world's major space power, referring to official statements that set this goal for 2045.[22] The broad narrative is found to depict the US as a domineering space power, while, in contrast, China is represented as a peaceful actor committed to economic development and international cooperation with states 'regardless of political system and level of economic development'.[23] China views the competition between itself and the US as reflecting their wider relationship, and, as China seeks global power, space will be an important element of this course. The main driver is national security, which space will facilitate by enhancing its military capabilities while also denying the US access to space via a suite of counterspace capabilities. While national security is central, as China develops space-based capabilities it will gain economic and diplomatic leverage, further challenging the US across the spectrum of national power.

These various threads would probably be cleverly interlaced. China will be increasingly able to offer technical and scientific support to nascent space programmes in other countries, gaining political and diplomatic leverage. This could be followed by exporting certain aspects of technology, along with the construction of infrastructure. Finally, the creation of its own BeiDou Global Navigation

22 Pollpeter et al., p. 16.
23 Pollpeter et al., p. 23

Satellite System would allow China to further wean other states off US or Allied military systems. Facilitating this is the Asia-Pacific Space Cooperation Organization, created in 2008 to act as China's key instrument for international space cooperation.

Despite the integration of policy, the CASI/CNA report notes that there are still competing visions and, thus, there exists discrepancy. For instance, ambitious goals (of an enduring cislunar and lunar presence, and the industrialisation of the extraction of space resources) featured in plans set out by institutions such as the China Aerospace Science and Technology Corporation and the China Academy of Launch Vehicle Technology are not fully represented in the 13th Five-Year Plan and would certainly constitute a formidable challenge.[24] But, even so, it is clear that the Chinese leadership has identified space as a key area that will enable China to realise its great power ambitions and challenge for supremacy, and they are fully supportive of its development, maintaining consistent focus and investment.

Conclusion

China's increasing presence and capabilities in space are just one avenue by which the ruling party seeks to enhance the nation's strength, wealth and pride, yet the space programme is nonetheless viewed as an important manifestation of its technical prowess, enhancing all levers of national power – political, economic and military. These ambitions are not by themselves unusual – many states seek similar goals through similar plans. However, the scale and ambition of China's programme is notable in itself, but it also triggers significant reverberations across the domain and below. Space is now so crucial for key functions of modern states that any shift can create unease. The domain's remoteness means monitoring is difficult, while the rules governing space are hazy. Furthermore, dual-use technology applies to most capabilities in space. When overlaid with China's rather impenetrable policy formulation, other space-faring nations may arrive at pessimistic conclusions, particularly those with a great deal at stake in space. A greater understanding of China and its ambitions in space has been slow to materialise; however, as it does, it begins to reveal a highly competitive agenda, with the objective to eclipse the US in space by mid-century clearly laid out, all underpinned by a suite of counterspace capabilities. This constitutes part of a wider challenge to the US across the full spectrum of national power. However, the tensions that arise due to competition in space trigger particular sensitivities, and these will need careful management to avoid space becoming a domain of outright hostility.

24 Pollpeter et al., 2020, p. 66

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