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An Update On The Race For Space Supremacy

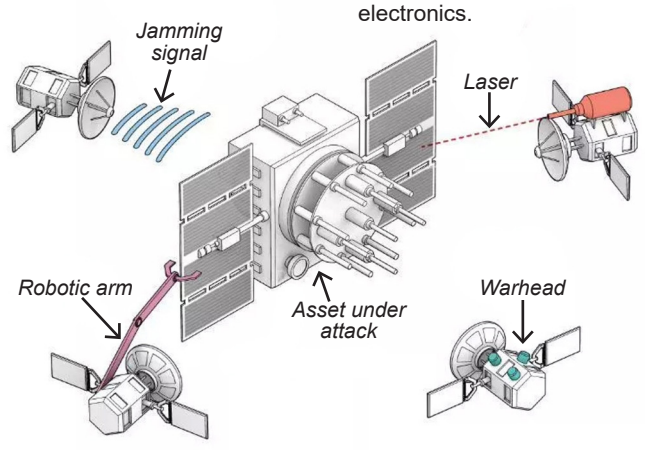
In a July report on space, we argued that China, Russia, and the U.S. are locked in a dangerously escalating race for space dominance.[1] We emphasized that rising geopolitical tensions, coupled with rapid advancements in various types of space weaponry, have transformed the notion of "space war" from science fiction to a tangible threat (**Chart 1**). With numerous Earth-based technologies relying on space assets, such as GPS navigation and critical communication networks, a space conflict could not only result in the loss of billions of dollars' worth of orbital equipment but also severely disrupt essential terrestrial infrastructure. Consequently, we underscored the importance of enhancing "space resilience" by fortifying infrastructure and adopting innovative technologies to address vulnerabilities both in space and on Earth.

Since our initial July memo, global competition in space has intensified (**Table 1**). Growing concerns around space security have moved to the forefront, exemplified by (1) the United Nations Security Council addressed space security for the first time this year, and (2) NATO launched a dedicated space branch. The re-election of Trump further accelerates global space competition, as he prioritized U.S. space dominance during his previous term. While Russia remains a significant player, particularly with its capabilities in kinetic space weaponry, China's expanding presence in space is creating fierce competition for valuable orbital positions needed for deploying satellite constellations, particularly for communication networks like Starlink. Without

1 Alpine Macro *Innovation Themes & Strategy Special Report* "The Intensifying Space Race: Key Insights For Investors" (July 10, 2024).

In This Report

Chart 1 Space Weapons Systems



Source: The Wall Street Journal

Table 1 Space Capabilities Expanding Globally

	U.S.	Russia	China	India	Australia	France	Iran		Japan	N. Korea	S. Korea	U.K.
LEO Direct Ascent	■	■	▲	■	●	●	●	●	●	●	●	●
MEO/GEO Direct Ascent	■	■	■	●	●	●	●	●	●	●	●	●
LEO Co-Orbital	■	▲	■	●	●	●	●	●	●	●	●	●
MEO/GEO Co-Orbital	■	■	■	●	●	●	●	●	●	●	●	●
Directed Energy	■	■	■	●	●	■	●	●	●	●	●	●
Electronic Warfare	▲	▲	▲	■	■	■	■	▲	■	■	●	●
Space Situational Awareness	▲	▲	▲	■	■	■	■	■	■	■	■	■

● None ■ Some ▲ Significant
Source: Secure World Foundation

enhanced cooperation and efforts to de-escalate, these rising tensions risk reaching a critical point.

Space is now seen as the "final frontier" and houses trillions of dollars' worth of untapped resources, including critical metals. Beyond its economic appeal, space has become vital in supporting a range of modern warfare capabilities. As a result, control over this domain carries substantial consequences for the global balance of power. This report serves as an update to our initial coverage, incorporating new developments and offering a deeper exploration of our space thesis.

China Continues To Advance Towards "Juggernaut" Space Status

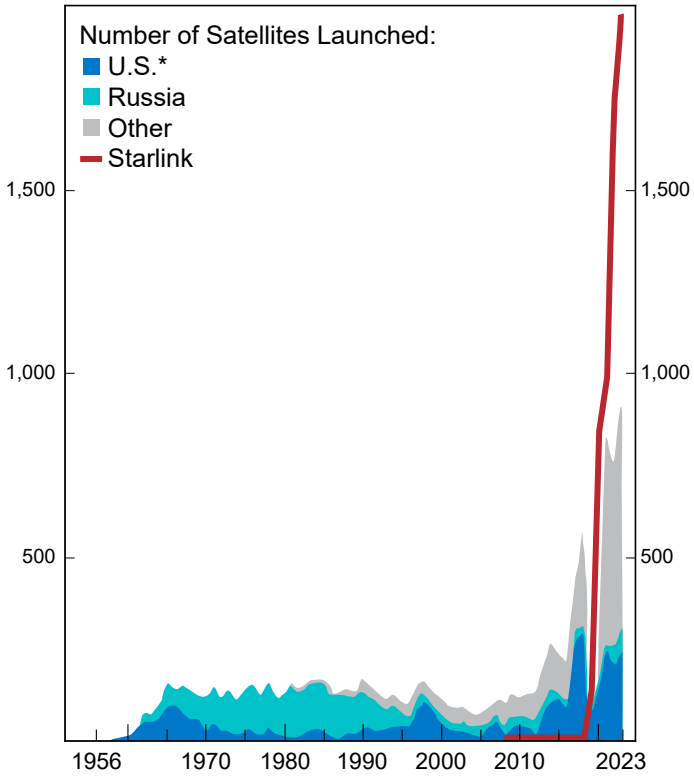
While approximately 90 nations have a presence in space, China's aspirations are turbocharging the modern space race. China's space sector is bolstered by significant investment which reached an estimated $14 billion last year with support from government-backed subsidies.[2] The robust investment is facilitating the buildout of supporting infrastructure to accelerate space tech breakthroughs, including a recently unveiled space-specialized supercomputing facility equipped with Nvidia A100 chips.

President Xi's vision of China becoming a "space power" is becoming a reality, much to the Wests' dismay. Earlier this month, U.S. Space Force Chief General Chance Saltzman described China's rapid military space advancements as "mind-boggling," emphasizing their threat potential.

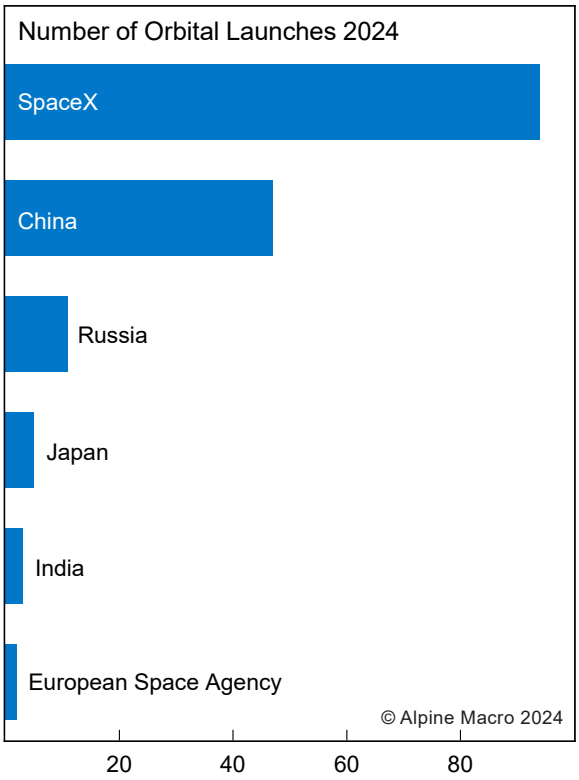
China's advances in its space program are directly tied to the nation effectively "switching places" with the U.S. in leading critical technology research.[3]

2 CIA's World Factbook
3 Australian Strategic Policy Institute

Chart 2 U.S. Maintains Launch Supremacy



*Number of U.S. satellites excluding Starlink
Source: Jonathan Mcdowell



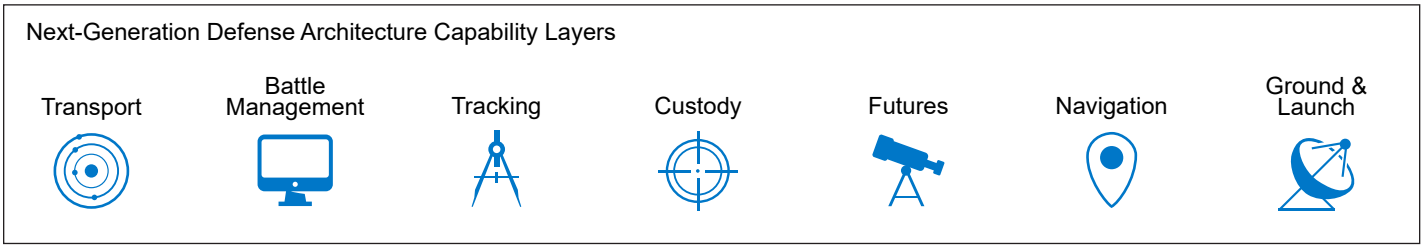
Note: Total doesn't include test flights for rockets under development; source: BNN Bloomberg, SpaceX, Planet4589.org

Between 2003 to 2007, the U.S. was the world leader across 60 of 64 critical technologies. However, in an alarming leadership change, China now leads in 57 of those technologies (including gravitational sensors and space launch) and has a monopoly in all 24 technologies denoted as "critical". Technologies labeled critical are essential for next-generation defense systems. This shift in leadership is enabling China to challenge and potentially surpass American space communication and defense supremacy.

According to U.S. intelligence, China's space program is focused on developing "dual use" assets, serving both military and civilian purposes. This broadens capabilities and makes potential threats harder to detect, as they can appear benign. For instance, the Shijian-21 satellite, designed for space-debris cleanup, could potentially be used to "re-direct" adversary satellites. Although the U.S. has many more critical assets in-orbit, China's global lead in non-kinetic satellite weaponry, including grappling arms, poses a large risk to U.S. military capabilities in the event of U.S./China combat.

While China's launch activity continues to greatly lag the U.S. due to SpaceX's dominance (**Chart 2**), momentum is building. Earlier this fall, China successfully launched the second group of 18 satellites for the planned 14,000-satellite constellation Qianfan that aims to rival Starlink. It has also opened a commercial launch complex that can accommodate over 10 types of rockets and conduct more than 30 launches annually.

Chart 3 Future Defense Capabilities Are Space-Dependent



Source: Space Development Agency

The U.S. Is Bracing For Space War

As highlighted in last week's report on unconventional warfare, we believe that any escalation could potentially target critical space infrastructure.[4] Emphasizing the urgency of the situation, U.S. defense branches are using an all-hands-on-deck approach to counter this threat. For example, the U.S. Army has expressed interest this year for the first time in developing offensive capabilities to disrupt adversaries' surveillance satellites during conflicts.[5] The Pentagon is also growing increasingly focused on threats as China's presence in-orbit expands and Russia develops technology capable of destroying satellites indiscriminately.

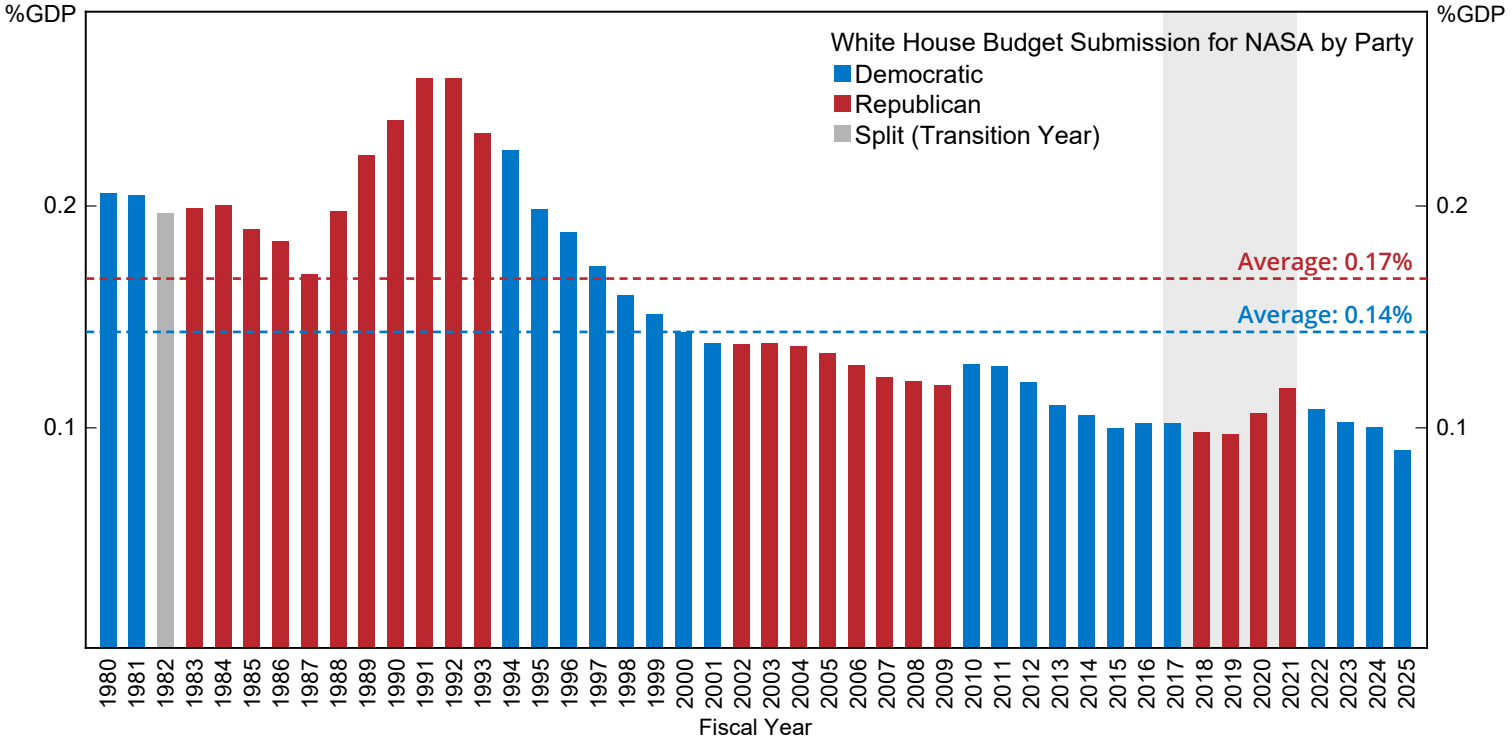
Space has become a central part of the Joint Warfighting Concept (JWC) – a strategic vision for how the US military will operate and fight as an integrated joint team across all domains. Critical to this strategy is the buildout of the seven-layer Proliferated Warfighter Space Architecture, PWSA (**Chart 3**). PWSA is now essential to the U.S. Department of Defense initiative aimed at connecting military sensors, communications, and weaponry systems across all warfighting domains, known as Joint All-Domain Command and Control. Creating redundancy in missile defense and sensing capabilities has become a central part of this plan. Aside from novel missile detection satellites included in PWSA, the Space Force is also developing advanced early warning satellites in various orbits to form a layered approach, known as the Next-Generation Overhead Persistent Infrared (OPIR).

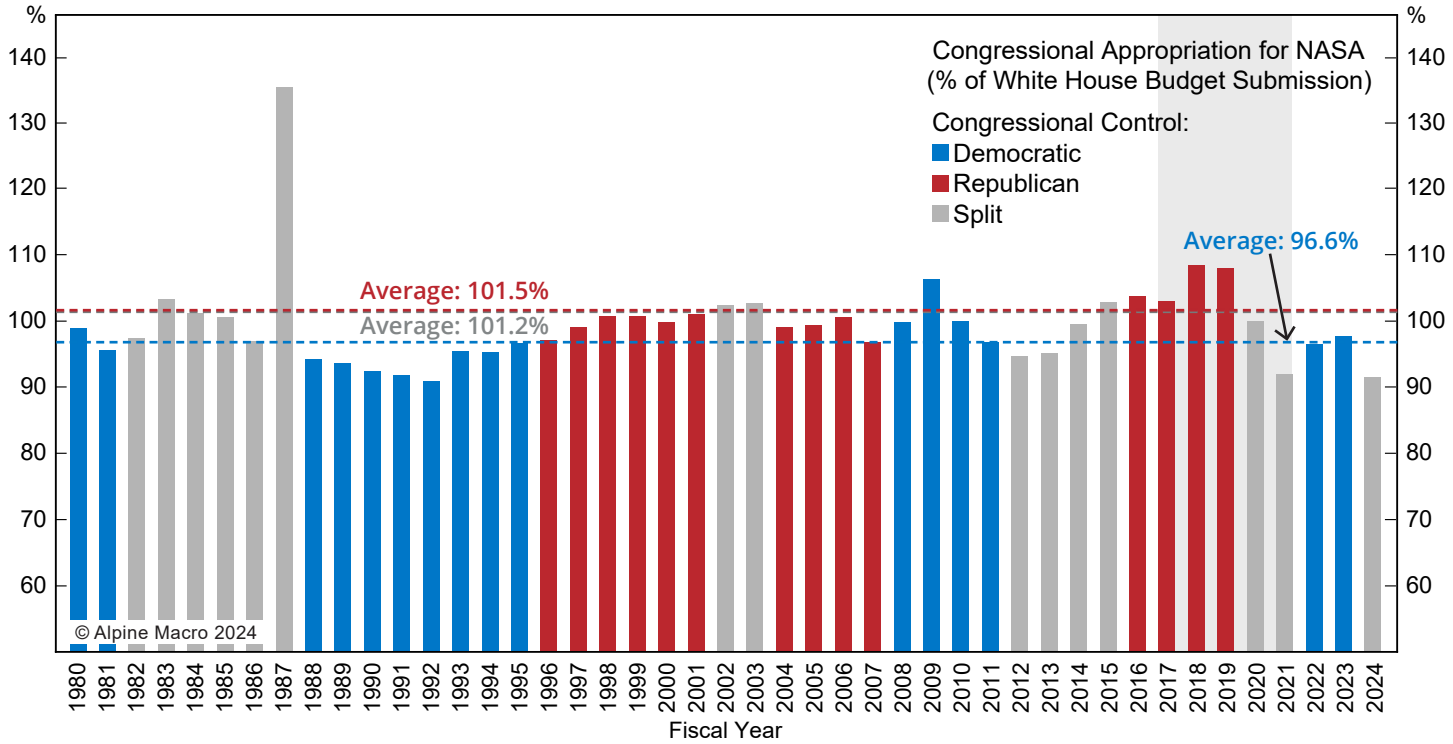
Trump's return is a significant boost for U.S. defense-oriented space initiatives. While NASA's budget as a percentage of GDP has declined since the 1990s, Trump was the first president since Reagan to increase NASA's budget share during his term (**Chart 4**). In addition, a Republican majority in Congress has historically approved NASA's budget requests at slightly higher rates. Notably, NASA and the Space Force, which the latter was established under Trump, have separate budgets. Today, roughly 25% of the $29.4 billion of the Space Force's budget is proposed for "space superiority," which prioritizes "responsible counter-space" – defending against and countering hostile actions in space while managing escalation responsibly. It is important to note that the budget has nearly doubled since its creation under Trump in December 2019. Although this year marks the first blip in YOY budget growth, this will likely reverse under Trump.

4 Alpine Macro *Innovation Themes & Strategy* "The Unseen Battle: The Growing Unconventional Warfare Threat" (November 6, 2024).

5 U.S. Army Space Vision

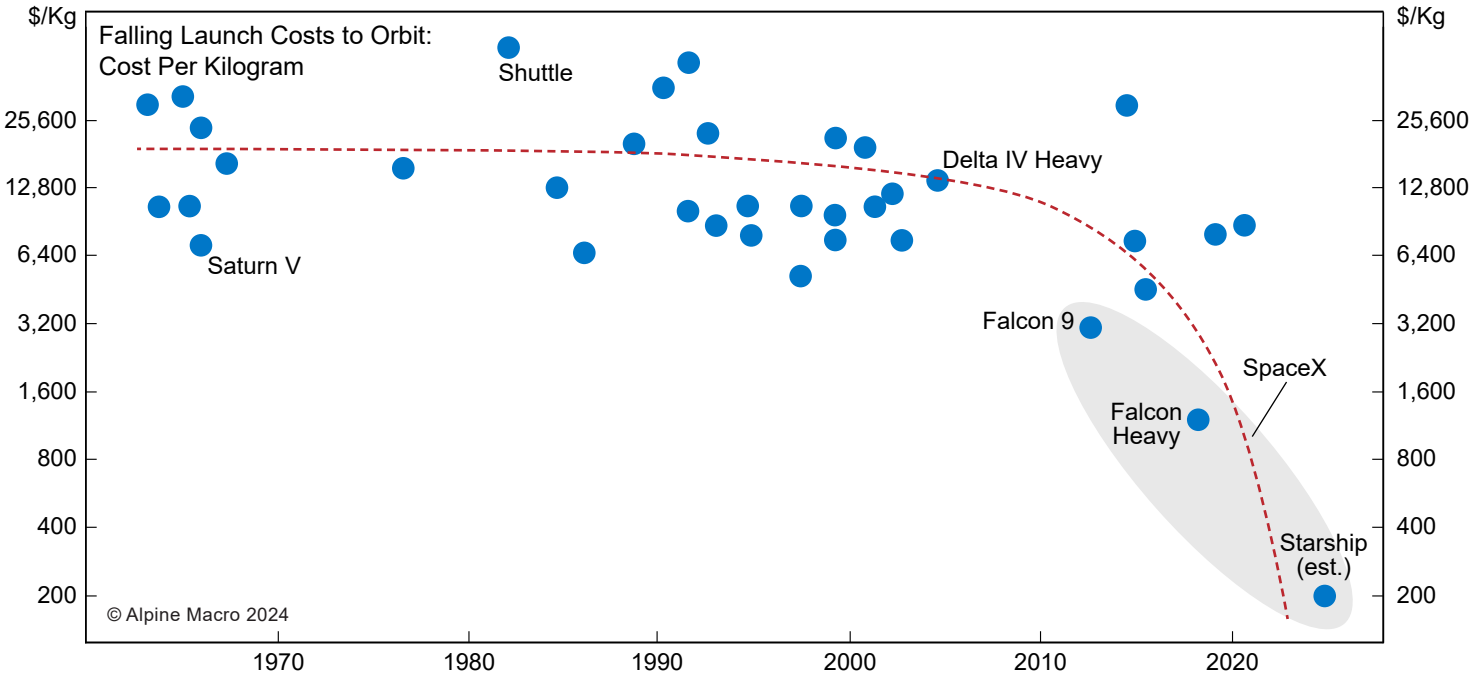
Chart 4 Trump And Republican Control Bullish For U.S. Space Budgets





Note: Shaded areas denote Trump presidency; the budget for a given fiscal year is generally passed by Congress in the preceding year. Congressional control for a fiscal year's budget is considered 'split' if one party controls the House and the other controls the Senate.
Source:The Planetary Society, NASA

Chart 5 Launch Costs Declining Exponentially



Source: CSIS Aerospace Security Project, PayloadResearch estimates, 2024

Reusable Rocket's Becoming Viable

While China and Russia have made strides in space weapon systems and have delivered payloads to the Moon and Mars, the U.S. currently remains the leader in reusable rocket technology. This was recently epitomized by SpaceX's recent success of "catching" the 20-floor high booster of Starship's fifth uncrewed test flight. This is arguably the largest American space accomplishment since the moon landing. Reusable rocket technology is a catalyst to usher in a new era in space transport defined by rapidly falling cost to launch objects into orbit (**Chart 5**). Starship is leading this charge, with launch cost soon expected to fall to $100/kg, driven by low cost propellant (~80% liquid oxygen and ~20% liquid methane).

On the current development trajectory, Starship will allow the U.S. to position assets deeper in space than ever before. The rocket is already 2x more powerful than the Saturn rocket used in the Apollo program. By 2027, SpaceX believes Starship will have over 10,000 metric tons of thrust (3x current levels) and will become operational for commercial and government launches in 2027.

Although trailing the U.S., China is advancing toward high-capacity, low-cost, frequent, and reusable space launches. The China Aerospace Science and Technology Corporation plans to launch multiple reusable rockets of varying sizes within the next two years. On the private side, LandSpace Technology Corp's Zhuque-3 recently completed a 10-kilometer vertical takeoff and landing test flight, which was partially successful despite an issue during engine shutdown. Deep Blue Aerospace also met 10 of 11 key test objectives in a recent vertical test flight. While the U.S. remains in the lead, China's progress indicates the nation could have access to viable reusable rocket technology sooner than previously expected.

Rapid Response And Satellite Servicing Will Become Essential

Unlike economic launch, which focuses on low-cost payload delivery and is dominated by SpaceX, responsive launch refers to the ability to launch satellites and spacecraft on demand to respond to threats or investigate objects. This capability is essential for the future of space operations. In a space conflict, responsive launch will be vital, as the nation capable of rapidly sustaining or rebuilding its in-orbit capabilities would hold a major strategic edge.

Importantly, China holds the edge over the U.S. in tactically responsive space launch capabilities.[6] While most launches take months to prepare for, responsive launches can occur in less than 24 hours. Chinese rocket development has prioritized mobility and speed, unlike the U.S.' focus on economic launch capabilities. However, the U.S. is quickly catching up due to key Space Force objectives. For example, under the Space Force's VICTUS NOX competition, Firefly Aerospace launched their Alpha Rocket within 24 hours of notification – scattering the old record of 21 days. Another initiative, named Victus Haze, is set to continue to test rapid response capabilities next year, tapping a wider range of space companies including Rocket Lab.

While nascent, in-orbit servicing is set to benefit from improving rapid response capabilities. Key areas of interest include in-orbit refueling and the potential of in-space repairs. The ability to refuel satellites in-orbit is highly valuable to the U.S. military, as extending the orbital lifespan of critical satellite assets is a top priority. However, beyond basic refueling, the military remains cautious about adopting other in-space servicing, assembly, and manufacturing (ISAM) services. However, while over 400 distinct ISAM capabilities have been developed, only a handful have reached operational deployment. Any adversarial incident involving satellites could quickly turn ISAM into a priority.

6 A study from Georgetown University's Center for Security and Emerging Technology (CSET)

Key Takeaways

As argued in our initial report on the space economy, we remain steadfast in our conviction in employing a strategy for the space sector focused on "space resilience". The developments highlighted above have bolstered our beliefs that space is growing increasingly intertwined with global security and economic stability. The threats posed by the space race, even baring an actual space conflict, are driving the required proactive strengthening of infrastructure both on Earth and in-orbit to prevent disruptions to critical systems. While global reliance on space systems is often overlooked, their failure would have significant consequences. Next-generation solutions tailored for space applications across communications, navigation, sensing, defense, and launch vehicles are positioned to benefit. Please reference our July report for specifics.

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