TOFFLER ASSOCIATES

WHITE PAPER

Securing the Space Domain

Outpacing Adversaries in the 21st Century Space Race

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The Future of U.S. Superiority on the Final Frontier

Space, from Earth orbit to the Moon and beyond, is swiftly becoming a contested domain. The U.S. now faces a convoluted and fiercely competitive arena where superiority is far from guaranteed and the risk of strategic surprise is growing.

Competitors are investing heavily in their own space programs, some aiming to counter U.S. capabilities. Simultaneously, the commercial space sector introduces both opportunities and risks.

Recognizing the implications to national security, the Department of Defense (DoD) has made securing the freedom to operate in space a top priority. Despite significant efforts, including 2024's Commercial Space Integration Strategy, the pace of change and the scale of threats demand even bolder action that includes:

- Integrating commercial capabilities
- Building a resilient space architecture
- Cultivating strategic partnerships
- Leading global space security
- Investing in future space expertise
- Securing the space domain

This whitepaper examines the evolving challenges in space and provides the DoD recommendations to secure its position in this vital domain.

Guardians and airmen assemble a satellite communications dish at Peterson Space Force Base. Source: DVIDS

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ABOUT TOFFLER ASSOCIATES

Toffler Associates is a future-focused consulting firm dedicated to empowering organizations to thrive amid accelerating change. Our expertise lies in leveraging foresight to bring clarity to complexity for government and commercial clients. We use tailored insights and strategies to drive organizational success in an uncertain future. Our services include foresight, strategy, and resilience consulting focused on key areas like sustainability, security, technology, and workforce transformation.

Founded by renowned futurists Alvin and Heidi Toffler, Toffler Associates consultants harness a diversity of perspectives to overcome individual biases and derive innovative solutions. Our future-oriented strategies and unique methodologies prepare organizations to thrive in tomorrow's world.

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The Evolving Threat Landscape

Space might appear peaceful, but beneath the calm lies a simmering contest for superiority. Choices the DoD makes today shape the future of space—whether it remains a domain of peace or becomes a new battlefield.

Weaponizing Space

Both China and Russia are developing technologies designed to cripple U.S. reliance on satellites – including kinetic, radiofrequency, directed energy, and potentially even nuclear weapons. In 2020, China tested satellites capable of approaching and potentially interfering with other satellites, exemplifying the dual-use nature of such technologies.. Satellites seemingly launched for research, like China's Shijian series, could easily change roles during a conflict, becoming platforms for espionage or orbital sabotage.

Russia's resurgence in Anti-Satellite (ASAT) testing and its deployment of the highly maneuverable "Luch" satellite are further signals of intent. Beyond physical attacks, accusations of Russian cyber attacks and electronic jamming aimed at satellites highlight the multitude of ways space systems can be disrupted.

Meanwhile, these adversaries view U.S. development of maneuverable satellites and dual-use commercial communications and imaging constellations with growing suspicion.

Big Moves from Smaller Actors

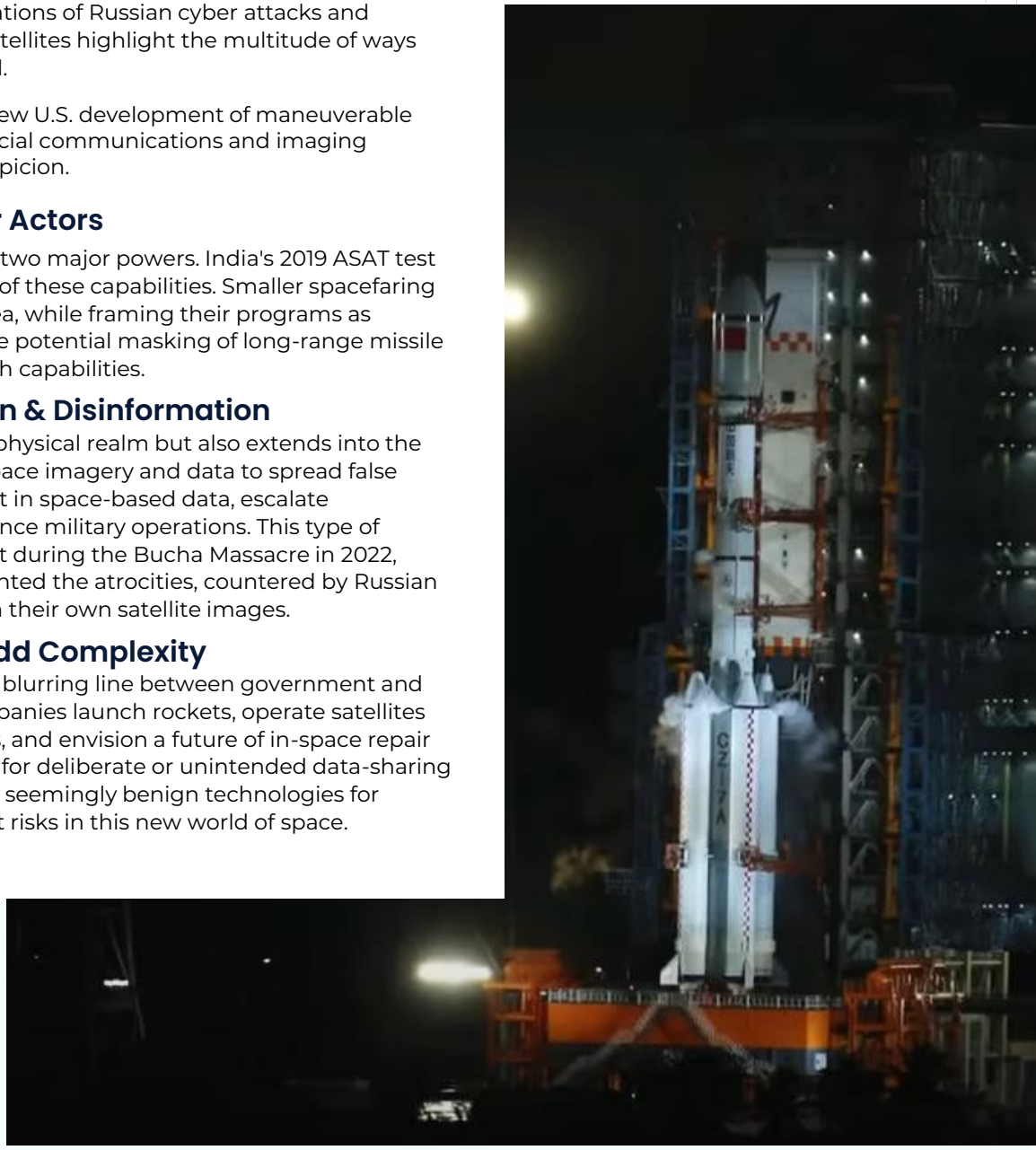
The threat isn't limited to these two major powers. India's 2019 ASAT test demonstrated the proliferation of these capabilities. Smaller spacefaring nations like Iran and North Korea, while framing their programs as civilian, raise concerns about the potential masking of long-range missile development within their launch capabilities.

Satellites for Information & Disinformation

The battle isn't confined to the physical realm but also extends into the informational one. The use of space imagery and data to spread false narratives can erode public trust in space-based data, escalate geopolitical tensions, and influence military operations. This type of information warfare was evident during the Bucha Massacre in 2022, where satellite images documented the atrocities, countered by Russian attempts to discredit them with their own satellite images.

Commercial Entrants Add Complexity

Adding to the complexity is the blurring line between government and commercial space. Private companies launch rockets, operate satellites filled with sophisticated sensors, and envision a future of in-space repair and construction. The potential for deliberate or unintended data-sharing with adversaries or repurposing seemingly benign technologies for harmful ends creates significant risks in this new world of space.



Shijian-23 prior to launch from Wenchang SLC
Source: China News Service

Technological Acceleration in Space

Space is not a static domain; it's a laboratory where the logic of warfare is tested and technology pushes the boundaries of what's possible. Maintaining the DoD's competitive edge means investing in cutting-edge technologies and adapting doctrine and training to the unique demands of space warfare.

Hypersonic Threat

Hypersonic glide vehicles are a prime example of fantasy becoming reality, and a strategist's nightmare. Think of Russia's Avangard or China's DF-17 missiles capable of blazing through the atmosphere at speeds exceeding Mach 5 while weaving unpredictable trajectories. Traditional missile defenses, designed for ballistic arcs, struggle against these maneuverable weapons. The DoD urgently needs to develop counter-hypersonic capabilities and rethink early warning systems that rely on outdated assumptions.

Space Surveillance Revolution

Meanwhile, space-based surveillance is undergoing its own revolution. Imagine constellations of smaller satellites providing relentless, near-real-time views of the entire globe, or sensors able to pierce camouflage with advanced imaging or infrared detection. Adversaries will find it harder to hide, forcing the DoD to adapt tactics and countermeasures designed for an era where concealment was easier.

Opportunity in Orbit

The dream of on-orbit servicing and refueling is becoming reality as well. Companies like Northrop Grumman have demonstrated satellite refueling with their Mission Extension Vehicles (MEVs), extending the lifespan of valuable assets and increasing freedom of maneuver in orbit. Projects underway explore the possibility of in-space assembly of structures. This logistical revolution has huge military implications, but also introduces challenges for the DoD: new policies for in-space activities, security protocols to safeguard orbital infrastructure, and stringent scrutiny of supply chains involved in this critical domain.

The Evolving Space Battlefield

And that's not all. Satellites with edge compute capabilities could analyze vast data or orchestrate complex maneuvers, increasing the speed and autonomy of orbital operations. Directed energy weapons in space, once the stuff of sci-fi, could threaten satellites with beams capable of disabling sensitive electronics.

The challenge for the DoD isn't just about developing these groundbreaking technologies but doing so before adversaries beat them to the punch. This means doctrinal overhauls, training focused on the unique aspects of space warfare, and ditching mindsets rooted in traditional land, sea, and air-based conflict. This technological race is high stakes, and the US cannot afford to be left behind.

Law and Leadership

Imagine space as a new Wild West, a vast frontier where the sheriff's badge is tarnished, and the rulebook feels more like a dusty relic than a law of the land.

Conventions like the Outer Space Treaty now seem woefully inadequate. Its focus on cooperation is well-intentioned, but it has failed to contain the militarization of space. Even the 1972 Space Liability Convention, meant to address damages caused by space objects, says little about deliberate acts of aggression.

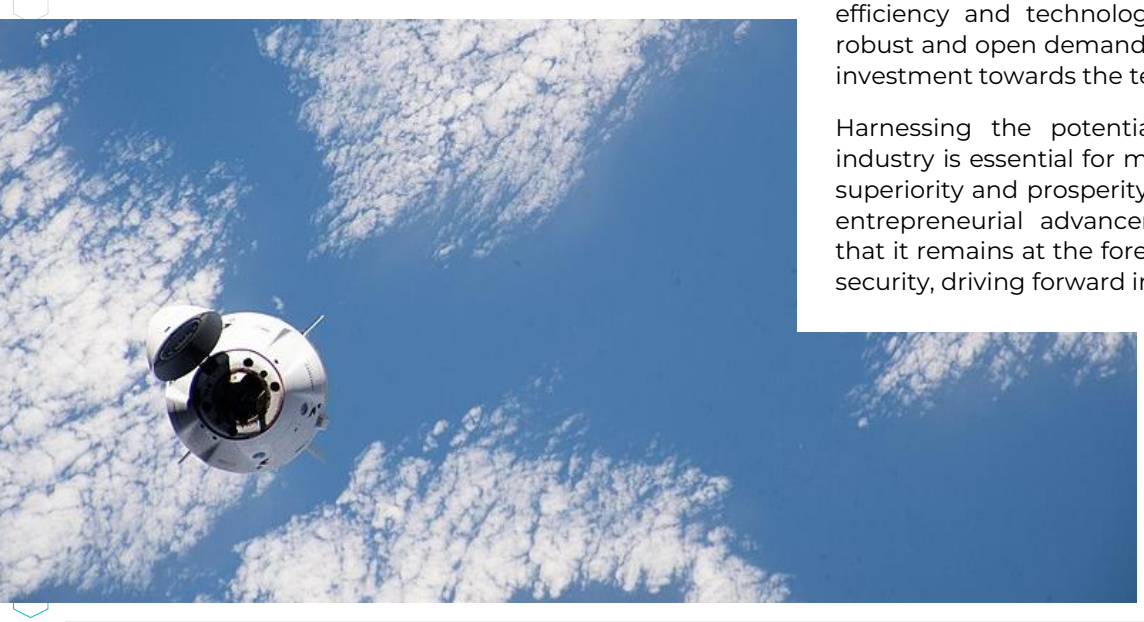
No Man's Space

Ambiguity is the word of the day. A seemingly innocent satellite launched for 'scientific purposes' might carry sensors and capabilities raising alarms about its dual-use potential. When one country's satellite maneuvers near another's, is it an innocent calibration or a prelude to an attack? Can nations stake a claim on orbits, militarizing sections of the sky? And when satellites collide, like in the 2009 Iridium-Kosmos event, it's like a cosmic car crash, littering orbits with cascading debris.

Right now, it feels like a lawless vacuum up there. We urgently need new norms, definitions, and rules of the road. What exactly counts as a 'space weapon'? How close is too close when it comes to maneuvers in orbit? And what do we do with the growing menace of orbital debris – a threat to all spacefaring nations?

Into the Vacuum

This is where U.S. leadership plays an indispensable role. Working with allies, the U.S. can spearhead a framework for space, one that balances security with the freedom of exploration that's been humanity's guiding star for decades. The alternative is to cede this rulemaking to others, potentially adversaries, whose vision of space might be one the U.S. would rather avoid.



The Axiom-1 private spaceflight approaches the International Space Station, source: NASA Johnson Space Center

Collaboration as a Catalyst for Growth

The commercial space revolution is the catalyst propelling us into a new era of innovation. It's akin to Silicon Valley among the stars, breaking down cost barriers and accelerating technological advancements at an unprecedented pace.

Rather than building everything from scratch, the DoD can harness this entrepreneurial energy. New launch providers are driving down prices and improving flexibility, putting responsive space access within reach. Need high-resolution imagery on demand? Companies like Planet Labs and Maxar provide these services without the need for costly military satellites. Seeking a resilient communication network? SpaceX's Starlink internet constellation provides strength in numbers, with thousands of satellites in low Earth orbit.

Unprecedented Power

Among the most significant commercial projects is SpaceX's Starship launch vehicle – the most powerful rocket ever built. Full, rapid reusability and enormous capacity has the potential to reduce launch costs, loosen payload mass and form factor constraints, and improve the agility of space operations. This rocket could revolutionize the DoD's approach to deploying and maintaining space assets, providing unmatched capability at a much lower price point.

Leading and Following

For the DoD, the growing commercial industry is a national asset that enables faster, cheaper access to cutting-edge space capabilities. By tapping into the innovation and agility of the commercial space sector, the DoD can significantly enhance its operational efficiency and technological edge – and by sending robust and open demand signals, DoD can steer private investment towards the technologies it critically needs.

Harnessing the potential of the commercial space industry is essential for maintaining and advancing U.S. superiority and prosperity in space. By leveraging these entrepreneurial advancements, the DoD can ensure that it remains at the forefront of space exploration and security, driving forward into a new era of possibilities.

Recommendations for the DoD

The future of American superiority and prosperity in space hangs in the balance. To secure that future, the DoD cannot afford the luxury of complacency. The recommendations below offer a starting point, but success requires more than good intentions. Swift implementation and strategic investments ensure America maintains its edge in this vital domain.

1
Strategically Integrate of Commercial Capabilities

Leverage the innovation of the commercial space sector while instituting robust controls to safeguard sensitive technologies.

2
Build a Resilient Space Architecture

Develop a distributed, redundant, and rapidly replenishable space infrastructure to ensure operational continuity.

3
Cultivate Strategic Partnerships

Streamline processes for collaboration with commercial entities, ensuring swift and efficient acquisition of critical capabilities.

4
Lead Global Space Security

Spearhead the creation of international norms and standards for space activities, promoting stability and deterring aggression.

5
Invest in Future Space Expertise

Foster a highly skilled workforce equipped with cutting-edge knowledge in space technologies and operations.

6
Secure the Space Domain

Implement comprehensive cybersecurity measures to protect the hybrid space network from emerging threats.

Adversary initiative, ambitious commercial activity, shifts in the technology and cost curves that shape space operations – DoD faces an environment of growing complexity. Linear planning models fall short, and the risk of strategic surprise grows.

Embracing **scenario planning** provides the DoD a powerful approach to developing strategies that are resilient to surprise. Through scenario planning, the DoD can test the viability and consequences of assumptions about the space environment and improve the agility of strategic planning for the final frontier.

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Navigating the Space Landscape

Why Toffler?

Building upon our work with NASA, the Air Force Research Laboratory, and multiple aerospace companies, we offer capabilities that help the government effectively leverage the dynamic commercial space market, address emerging challenges, and maintain leadership in this strategic domain.

Here's how we can help:

Tech Scouting and Market Intelligence:

- Identifying early-stage technologies and players with disruptive potential, offering an edge in anticipating market shifts.
- Deep dives into specific technology areas (e.g., launch vehicles, on-orbit servicing, AI-enabled constellations) to provide detailed assessments.
- Continuous monitoring of the global competitive landscape, highlighting potential technology or business model innovations of concern.

Strategic and Operational Advisory

- Developing comprehensive strategies to integrate commercial space capabilities into existing architectures and programs.
- Optimizing procurement models (SBIRs, OTAs, etc.) to incentivize innovation while ensuring value for the taxpayer and mission success.

Investment Decision Support:

- Data-driven analysis of market segments and trends to support long-term funding decisions and research prioritization.
- Risk assessment frameworks balancing potential returns against the inherent uncertainties and technical challenges of space ventures.

Human Capital Advisory:

- Workforce development strategies aligning with anticipated industry demand, ensuring a pipeline of talent for the expanded space sector.
- Talent identification and mapping services to help government agencies recruit individuals with cutting-edge commercial space expertise.
- Building bridges between public and private sector workforces to foster knowledge exchange and cultural adaptation.

From Countdown to Liftoff: Charting Your Course for Success

For 27+ years, we've guided government agencies through uncertainty. Our foresight expertise equips leaders to make resilient decisions and lead with confidence. We help agencies stress-test against multiple futures and develop flexible strategies for mission success.

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