

# Reaping the rewards of the new space race

Commercial strategies and government policies may need to evolve to help ensure America fully capitalizes on the space industry's benefits

Brett Loubert, Adam Routh, Diane Ashley, and Thomas Cortez

#### **KEY TAKEAWAYS**

- America's space industry is poised to provide the nation with new scientific, economic, and military advantages. But preserving US leadership in the industry will likely require government to help address key challenges and further growth opportunities.
- Key industry challenges include shifting investor sentiment and environmental risks. As the space industry matures, so do investor perspectives and understanding. Addressing the challenges associated with space debris and orbital congestion will also necessitate serious government and industry attention.
- Space industry growth requires new technologies and markets. Industry growth in recent years has come from familiar space activities, but further progress will mean the creation of new technologies and new business linkages.

- Growing international competition among leading space-capable countries could affect industry opportunities and challenges. Growing markets and addressing environmental challenges such as space debris entail global cooperation, which can be hard to develop in a competitive environment.
  - To sustain US leadership of the space industry, the nation should align government and private investment strategies and work to improve international cooperation.

merica is the world leader in space technology and services, which has helped drive innovation in both the space sector and the US economy more broadly—producing numerous security, scientific, and commercial benefits.<sup>1</sup>

And there are more opportunities to both bolster and leverage US leadership, and enhance how investments in space technologies and services improve American lives. It's critical that the United States preserves its lead in space. Without US leadership, barriers such as inadequate access to new markets, geopolitical competition, and unsustainable space practices could threaten the space industry's growth and the many benefits it provides the US.

As the space industry grows in size and complexity, maintaining the leadership position may become increasingly difficult. Consequently, the federal government will likely need to adapt its approach to fostering industry growth, including developing new investment strategies, updating industry regulations, emphasizing international cooperation, expanding the talent pipeline, and bolstering space sustainability efforts.

#### The total value of global space activities has more than doubled between 2007 and 2022; by one estimate, it may reach nearly \$800 billion by 2027. -The Space Report 2023 Q2: E-Edition, The Space Foundation

#### What's now: A rapidly growing industry

A strong space industry is good for the United States (and everyone else)

US space innovations, like the global positioning system, have provided a powerful catalyst for driving global progress. The total value of global space activities has more than doubled between 2007 and 2022; by one estimate, it may reach nearly \$800 billion by 2027 (figure 1).<sup>2</sup> More than dollars spent, the number of objects lifted into space has skyrocketed in recent years to more than 10,000 (figure 2).

Many economic sectors depend on space technologies and services, including agriculture, finance, transportation, and insurance. The most accurate weather forecasts and more than half of all climate variables (long-term changes in weather patterns) can be measured only from space.<sup>3</sup> An advanced military requires satellite-based communications, navigation, and intelligence. Overall, a prosperous US space industry offers countless benefits, and the industry is poised to provide more.

### A growing commercial sector can offer even more benefits

Commercial innovation in space is improving knowledge and daily lives.

Space companies are connecting the world with globally accessible broadband internet provided by satellites. Pharmaceuticals, semiconductors, and even humangrade knee cartilage have been manufactured aboard the International Space Station by US companies partnering with NASA.<sup>4</sup>

#### Figure 1

#### The overall worth of worldwide space activities has more than doubled from 2007 to 2022

The surge in global space investment by category



Notes: All values of the Y axis are in US dollars; "e" refers to estimate. Source: The Space Foundation, "The Space Report 2024 Q2: E-edition," accessed Feb. 14, 2025.

### Partly because of the entry of private players in the space industry, the number of objects launched into low Earth orbit has soared in recent years

The number of objects launched into low Earth orbit witnessed a particularly steep spike between 2015 and 2020



Source: Jonathan's Space Pages, "Satellite Statistics: Satellite and debris population," planet4589.org, accessed Feb. 14, 2025.

Many technologies pioneered by NASA helped to spur the commercialization of the space industry. As evidenced by research conducted aboard the International Space Station, space is an important source of continued innovation and scientific development (figure 3).

The US commercial sector is reciprocating by providing government more affordable and innovative space services, such as crewed spacecraft and support for national security missions.<sup>5</sup> Space industry innovations already offer massive returns for the United States and other nations, and the future appears even more promising.

#### Beyond traditional space activities

US space companies have grown quickly, primarily through traditional space activities. Launch services, satellite communication, and manufacturing have seen the most investment and growth in recent years.<sup>6</sup> While these activities are expected to continue to be important,

#### The International Space Station has been a key source of in-space research for decades

ISS research projects, 2012 to 2023



Source: International Space Station National Lab, 2023 Annual Report, Jan. 2, 2024.

continuing US leadership will likely also require investments in entirely new technologies and services.

Emerging space activities such as in-orbit servicing, assembly, and manufacturing (ISAM), space traffic management, space debris remediation, new military capabilities, and civil space programs, such as the Artemis program, can lead to entirely new opportunities.<sup>7</sup> From larger space-based telescopes to manufacturing in orbit, what companies and governments can do in space is poised to change radically. As figure 4 shows, new space activities, like ISAM and space traffic management can help mature key business linkages within the space industry.<sup>8</sup> Innovation in these emerging activities can help maintain American space leadership.

Many emerging space activities may, in part, depend on policies and available funding to help them become commercially viable. They will require more space talent, and that talent should be driven by shared purpose and passion (see "I'm not mopping, I'm putting a man on the Moon!").<sup>9</sup> These commitments can help the American space industry flourish into the 2030s.

#### Figure 4

## The interdependent relationship between in-space servicing, assembly, and manufacturing (ISAM), space traffic management (STM), and satellite standards fosters a robust industry structure



Source: Adam Routh, Brett Loubert, Shalini Bhatia, and Alan Brady, "Navigating the space-industry inflection point," Deloitte Insights, April 11, 2023.

#### I'M NOT MOPPING, I'M PUTTING A MAN ON THE MOON!

There's a story told about a visit to NASA by President John F. Kennedy. During his trip, it's said JFK asked a janitor why he was working so late. The janitor's response: "I'm not mopping, I'm putting a man on the moon!"

### What's next: Growing pains and the role of continued US leadership

Preserving American leadership in the space industry's rapid growth—and the economic and societal benefits that can come with it—will require dedicated attention from both the government and the private sector. To maintain American leadership in the fast-growing space industry—and to capture its economic and societal benefits—both the government and private companies must commit to focused efforts. This collaboration will help develop policies, regulations, and funding strategies that address challenges like rising international competition, evolving investor attitudes, and an increasingly crowded and risky outer space.

#### **Overly optimistic investment?**

In recent years, private investment (such as venture capital and private equity) and government funding have flowed into the space industry, especially in 2021, when market conditions were better for investment risk (figure 5).<sup>10</sup> However, this rate and variety of space funding, at times,

#### Figure 5

### Private sector investment into the space industry has been on the rise over the last decade, but not without fluctuations

Space industry investments from the private sector by year



Source: Space Capital, "Space IQ: Space Investment Quarterly," 2023.

mirrored characteristics of an immature industry, sometimes defined by overly optimistic forecasts and uninformed investment strategies.<sup>11</sup>

In 2022, private investments fell, reflecting a more riskaverse investment climate and a degree of disillusionment due partly to worse-than-expected financial performance and some company failures.<sup>12</sup> Private sector investment in the space industry bounced back in 2023, with \$12.5 billion raised, nearly \$3 billion short of 2021 investment highs.<sup>13</sup> The recent contraction and partial recovery in space industry investments may indicate that investors are beginning to better understand the specific activities involved and how they affect the broader space industry. It also reflects the government's increased space sector investments (figure 6). The space industry will need sustained and increasing investments to reach its growth goals, including the often touted \$1 trillion valuation.<sup>14</sup>

#### Figure 6

### Governments have been increasing space budgets to account for the growing space industry and its many innovations

Government space budgets in recent years have grown 8%

Government	space	budgets,	2022
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Nation/agency	Spending	2021 to 2022 change	2021 to 2022 change (national currency)	Source
United States	\$69.5B	13.6%	13.6%	US government public filings
China	\$16.1B	0.7%	4.5%	Space Foundation estimate
ESA	\$5.4B	11.6%	0.1%	ESA, Eurospace
Russia	\$3.7B	19.7%	10.5%	Ministry of Finance of the Russian Federation
Japan	\$3.1B	11.8%	7.8%	Japan's Cabinet Office
European Union	\$2.3B	21.4%	11.0%	The European Commission, Eurospace
India	\$1.3B	20.6%	15.6%	India's Ministry of Finance
Germany	\$1.2B	6.6%	5.8%	Germany's Federal Ministry of Finance
France	\$1.1B	9.5%	2.5%	Centre National d'Études Spatiales
EUMETSAT	\$1.0B	77.0%	100.5%	EUMETSAT, Eurospace
Italy	\$0.6B	30.3%	47.6%	Agenzia Spaziale Italiana
South Korea	\$0.6B	3.7%	18.5%	All Public Information In-One
Canada	\$0.3B	1.6%	5.5%	Canadian Space Agency
United Kingdom	\$0.2B	21.7%	38.2%	UK Space Agency
Additional countries	\$1.4B	6.5%	6.5%	Respective government agencies
Non-US military	\$10.8B	14.9%	14.9%	Space Foundation estimate
Total	\$118.6B	8.1%		

Notes: Data for ESA excludes income from the European Union; data for Germany, France, EUMETSAT, Italy, Canada, and the United Kingdom excludes ESA and EUMETSAT contributions; all monetary values are in US dollars.

Source: The Space Foundation, "The Space Report 2023 Q2: E-edition," accessed May 21, 2024.

With a clearer sense of how the private sector plans to invest in space technologies and services, the US government can consider investing in complementary ways. While industry focuses on familiar space activities, government could, for example, fund novel projects that are not quite ready for commercialization. Investments in ISAM, in-space infrastructure, and similar activities could seed important innovations until the private sector is ready to invest more, just as NASA catalyzed private investments and industry innovations through its Commercial Crew and Commercial Low Earth Orbit Destinations programs.<sup>15</sup>

#### Complexity in the regulatory environment

America's complex web of space industry regulations can struggle to keep pace with private innovation (figure 7). Process friction, such as lack of clarity around which regulator is responsible for which activities and difficulty understanding how (if at all) new space innovations may pose risks to citizens, the environment, or national security, can jeopardize innovation and commercial growth.<sup>16</sup> Regulatory systems often face pressure when dealing with rapidly changing technology, and due to recent space industry growth, space regulators and companies are dealing with that strain.<sup>17</sup>

### The US space industry's regulatory environment is complex, in part because the regulations haven't kept pace with new space technologies and activities

This US space industry regulatory map represents key regulations and government organizations with various responsibilities according to the regulatory text



Reaping the rewards of the new space race

The space industry presents unique challenges for US regulators due to its specialized nature and the importance of its associated technologies. Rockets, satellite communications, imaging, and other technologies and services can serve both military and civilian purposes. Additionally, testing new systems can affect communities in ways that may potentially require government oversight. For the United States, these concerns are often more pronounced due to the scale and significance of its commercial space sector, which is a global frontrunner in space innovation and activity.<sup>18</sup> Indeed, the largest satellite operator worldwide is a US company.<sup>19</sup> The nation has led the world in annual orbital launches for the last four years, and 2023 represented more than half of the global total (figure 8).<sup>20</sup> As a result, the US regulatory system can influence global markets and broader space competition.

#### Figure 8

### The number of total orbital launches has been increasing dramatically in recent years due to a growing space industry

Total orbital launches by year with a focus on 2023



Source: Jonathan's Space Pages, "Satellite Statistics: Launches," planet4589.org, accessed Feb. 14, 2025.

Some policymakers and space industry groups are attempting to develop new regulatory practices, particularly for emerging activities such as satellite refueling, servicing, and human spaceflight.<sup>21</sup> But regulatory reform won't be a one-time fix given this fast-evolving industry.

Instead, the space industry should consider an agile regulatory system that combines formal regulation with "soft law" tools, such as industry standards and best practices, which can be shaped by both industry and government.<sup>22</sup> For instance, a new mission authorization framework approach, which industry groups and Congress are advancing, aims to help evolve formal space regulation. Such frameworks could be complemented by new soft law tools. The ability of US regulations to keep pace with industry innovations can help determine how the space industry enhances American lives, businesses, and national security.

#### Preserving access to space should be a high priority

While growth in the space industry is generally positive, it also poses challenges, including space debris and orbital congestion, which can put spacecraft at risk. Preservation of the space environment, such as critical earth orbits, is essential to the industry's growth. As a space sector leader, the United States can have a vital role and ample motivation to lead in sustainable space practices and international cooperative efforts to help preserve the space environment.

#### Trash in orbit

Space debris is a pressing concern. It comprises all human-made objects in orbit that no longer function (such as defunct satellites or rocket engines) or have never functioned (such as debris from satellite breakups). There are *tens of thousands* of pieces of debris in orbit, and more than half of it is in low Earth orbit (LEO), where most commercial space activities occur.<sup>23</sup>

Challenges from trash in orbit can lead to business and national security challenges. In early 2024, for example, two defunct satellites missed colliding by mere meters; a collision would have created thousands more pieces of space debris that would have posed a significant threat to the satellites in LEO.<sup>24</sup> As demonstrated in figure 9, the Earth's orbits are becoming increasingly crowded, and the trend is expected to continue.

### Earth's orbits—especially low Earth orbit—are increasingly congested with space debris, a trend that poses a risk to space sustainability



Source: American Enterprise Institute, "Space debris trends," accessed May 2024.

While removing satellites from critical orbits at the end of their operational lives is increasingly common, there's currently no viable way to remove debris. In 2013, a group of national space agencies found that LEO was at risk of becoming unusable due to growing debris and orbital congestion,<sup>25</sup> a finding that predated the recent and enormous growth in the number of objects in LEO (figure 9). The problem is broadly acknowledged, at least. A United Nations–proposed ban on debris causing anti-satellite weapons tests is gaining international support<sup>26</sup> and ongoing US commercial and governmental efforts aim to develop debris mitigation and remediation solutions.<sup>27</sup>

Notably, the technologies needed to remediate debris are very similar to those needed for ISAM systems, meaning investments in debris removal promise to aid the development of ISAM as well.

#### Busy highway, no traffic rules

Orbital congestion due to the rapidly growing population of satellites poses another problem, particularly in the absence of agreed-upon rules for traffic management; increased space traffic increases the risk of collisions and debris.

The risks stemming from this lack of traffic management are expected to get worse. The number of active satellites is skyrocketing, with nearly 9,500 active satellites in orbit.<sup>28</sup> In 2023, 2,912 orbital payloads were launched versus just 123 in 2000. The current number of active satellites in orbit represents over half of all payloads launched ever (18,201).<sup>29</sup> According to industry predictions, some 20,000 satellites could be in orbit by 2030.<sup>30</sup>

The risks of unmanaged space traffic can already be seen. Between 2021 and 2022, the number of predicted hazardous close approaches by satellites rose by 58%.<sup>31</sup> And as more satellites occupy Earth's orbits, the complexity of avoiding collisions increases.

Debris and orbital congestion threatens the viability of the space environment—and all the advantages space offers the United States and the global community. One challenge (and opportunity) facing the United States is leading the development of the technologies and orbital "rules of the road" needed to preserve the space environment for further development.

#### Increased international competition and cooperation

The space industry's growth and promise have led to increasing international competition in the military, civil, and private spheres. Government space budgets are on the rise (figure 10), as is cooperation—as well as competition—among countries.<sup>32</sup>

Competition can help spur government and industry investments in critical technologies and services, as it did during the Cold War space race. However, it can *also* lead to national security concerns, such as destructive anti-satellite weapons that can create hazardous space debris. Plus, it makes the development of norms of behavior, such as space traffic management, more complex as countries push their preferred models.<sup>33</sup>

Talent—the need for skilled expertise—is also a component of competition. The Cold War space race led to a rise in science education and student funding opportunities,<sup>34</sup> and the current growth of the space industry and associated competition could likely do the same today with a combination of government and commercial support.

American leadership in space offers a pathway to harness international competition for industry growth. The United States possesses by far the largest portion of the space economy, including commercial, civil, and military spending, and has long been an advocate of space cooperation. It can, therefore, help lead on these efforts. The Artemis program and its associated Accords, which call for leading practices in space activities, represent an increasingly popular US-led international effort that will collaboratively return humans to the moon and set principles for cooperation in exploring space.<sup>35</sup>

US leaders should consider the development of international partnerships that help fuel the growth of the commercial space sector. But this cooperation will likely require concerted government and industry actions to create a large community of like-minded partners.

#### Pursuit of military advantage through space

Space offers militaries key strategic capabilities, including communication, intelligence, early warning, and navigation. Space systems will likely continue to be a defining factor of military dominance. For decades, US military space technologies have enjoyed a relatively low-risk, high-reward environment since few nations pose significant threats.<sup>36</sup> Today, however, these systems have become vulnerable to advancements by other militaries seeking to develop their own capabilities and diminish US space superiority.<sup>37</sup> Threats to military space assets range from electronic warfare capabilities that can temporarily disable or degrade satellites, to missiles that can target and destroy satellites in orbit.<sup>38</sup> Some non-state actors have even used cyber tools to interfere with satellites.<sup>39</sup>

A challenge the United States faces in this arena is twofold: first, to preserve its military advantages by developing more resilient space systems by, for instance, using lower-cost and more easily replaced satellites;<sup>40</sup> second, to prevent the increasing global competition for the military use of space from making critical earth orbits unusable—using some anti-satellite weapons, for instance, could ruin the space environment for all.<sup>41</sup>

#### Figure 10

### Across the space industry, military space spending is on the rise due partly to increasing international competition



US and non-US military space spending, 2018 to 2022

Note: All monetary values are in US dollars. Source: Space Foundation, "The Space Report 2023 Q2: E-edition," accessed May 21, 2024. To help address these challenges, the United States should continue growing the commercial space sector so that the global benefits space provides exceed the military ones. For the former, the commercial potential of space is clear; again, many believe it will be a trillion-dollar industry by the end of the decade.<sup>42</sup> While the economic value of space can't *guarantee* a prohibition on using anti-satellite systems, it could increase the risk threshold for using some anti-satellite systems since nations may be reluctant to hurt a key source of economic growth.

The United States should also continue to explore efforts to advance international cooperation. Such efforts could, for example, include the proposed moratorium on testing anti-satellite weapons that generate debris.<sup>43</sup> Also important are agreements that set norms of behavior for space activities that not only provide a safer orbital environment for commercial development, but also reduce the possibility of military miscommunication or miscalculation leading to military crises.

#### Pathways to flourishing: Strategies for leading renewed competition in space

The United States should consider taking several steps to help preserve its leadership in the space industry and create additional benefits for Americans and the world, including the following.

#### Use complementary investment approaches to accelerate industry growth

Industry and government investment can function in synergy. While private funds are gravitating toward more traditional space activities, government investment can help spur innovation in emerging areas often seen as too risky to private investors. Such investments could include:

- Space traffic coordination and management via new sensors, data standards, and rules of the road
- Debris remediation (or ISAM activities broadly) via government research and development efforts or the encouragement of industry innovation programs
- In-space infrastructure such as space stations that provide a setting for industry innovation

Where the private sector cannot yet invest with confidence, the government should consider doing so.

### Drive international cooperation for innovation and norms development

International cooperation provides a vital opportunity for the United States to preserve its role within the space industry. By developing new global partnerships and commercial relationships for space technologies and services, such as satellite communications and observation, space traffic management, debris remediation, ISAM, and civil space exploration, the United States can catalyze new industry innovations and help shape international norms and laws for the space sector.

#### Adapt and improve regulations on an ongoing basis

An agile regulatory system that can keep pace with ever-changing space technology and services is important for industry growth and continued production of the benefits that enhance the lives of American citizens, businesses, and national security. Agile regulation requires constant learning and regulatory adaptation through trial and error and better use of soft law tools.

America's decades-long leadership in space has helped our nation flourish, but the space industry's spiraling growth will require the United States to adapt, which includes furthering international cooperation and adjusting investment strategies and regulations. It will take more than just one small step but the US can still produce giant leaps for humankind.

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### **About the authors**

#### **Brett Loubert**

bloubert@deloitte.com

Brett Loubert is a principal within Deloitte Consulting LLP's Government & Public Services practice and currently leads Deloitte's US Space practice. He has over 20 years of experience working with leaders in the defense, national security, and civilian sectors to engineer, modernize, and operate IT systems and services. Most recently, he has led the development and expansion of Deloitte's Space practice and related offerings.

#### **Adam Routh**

adrouth@deloitte.com

Adam Routh is the defense and space research lead for Deloitte's Center for Government Insights and the eminence lead for Deloitte's Space practice. His research areas include the future of warfare and emerging space activities. His work has been featured on *ABC News*, *The John Batchelor Show*, and *I24 News* and published in *National Review*, *The Hill, The National Interest, SpaceNews*, and *The Space Review*, among others.

#### **Diane Ashley**

diashley@deloitte.com

Diane Ashley is a managing director within Deloitte's Government & Public Services practice, focused primarily on the United States Space Force. She has extensive experience in IT modernization for federal, defense, intelligence, and state/local customers. She received a dual bachelor's degree in systems engineering and engineering management from the United States Military Academy and a master's degree in space operations from the University of Colorado.

#### **Thomas Cortez**

tcortez@deloitte.com

Thomas Cortez is a second-year analyst within Deloitte's Government and Public Services practice. He has keen interest in space including space governance and international cooperation, and has written multiple papers on international economic cooperation, space defense technology, and colonization. In 2023, he also presented ideas for US-Southeast Asian space cooperation to the state department as part of his practicum.

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#### **Brett Loubert**

Principal | Deloitte Space +1 213 593 4694 | bloubert@deloitte.com

Brett Loubert is a principal within Deloitte Consulting LLP's Government & Public Services Industry and currently leads Deloitte's US Space practice.

#### The Deloitte Center for Government Insights

#### William D. Eggers

Executive director | Deloitte Center for Government Insights | Deloitte Services LP +1 571 882 6585 | weggers@deloitte.com

William D. Eggers is the executive director of Deloitte's Center for Government Insights, where he is responsible for the firm's public sector thought leadership.

### Contributors

**Editorial:** Kavita Majumdar, Sayanika Bordoloi, Pubali Dey, and Arpan Kr. Saha

Creative: Jim Slatton, Sofia Sergi, Molly Piersol, and Natalie Pfaff

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