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THE SPACE IMPERATIVE: A WHOLE-OF-NATION APPROACH TO A SUSTAINABLE, SECURE, AND RESILIENT SPACE DOMAIN

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EXECUTIVE SUMMARY

A whole-of-nation approach is needed to address the shared challenges of commercial, civil, and military space.

For over 60 years the United States has enjoyed unfettered access to space, which has allowed the U.S. to develop high-end military capabilities and, more recently, a burgeoning commercial space industry. As U.S.-led activity in space expands beyond its government-led roots to the commercial sector, new challenges have emerged, centered on the regulation and organization of U.S. efforts. Tied to this swiftly evolving space landscape, U.S. national and economic security are now inextricably intertwined and depend on the security, resilience, and sustainability of all U.S. space systems. Commercial, civil, and military stakeholders in space share challenges, including a lack of norms of responsible behavior, an outdated regulatory framework, and insufficient complementary technical infrastructure to assure the security, resilience, and sustainability of the U.S.-envisioned space environment. A collective and sustained effort of commercial, civil, and military stakeholders—in other words, a whole-of-nation approach—is required to tackle these shared challenges and take advantage of future opportunities.

In recognition of the space domain's importance to national and economic security, and the challenges of the changing landscape, MITRE and Aspen Digital, a program of the Aspen Institute, partnered to host a series of cross-sector space stakeholder sessions focused on securing space and maintaining U.S. technological advantage. Participants included industry, government, academia, non-profits, and federally funded research and development centers. The stakeholder sessions identified three overarching challenges, to which this report makes corresponding recommendations.

U.S NATIONAL AND ECONOMIC SECURITY ARE NOW INEXTRICABLY INTERTWINED, AND DEPEND ON THE SECURITY, RESILIENCE, AND SUSTAINABILITY OF ALL U.S. SPACE SYSTEMS.

Recommendation #1

Lead by example, declaring and enforcing norms of responsible behavior for U.S. operators that will serve as a precedent for other spacefaring nations.

The U.S. and the international community lack recognized norms of responsible behavior for operating in the space environment. In space, one action by any space operator can have a decades-long impact on the operations of other space stakeholders and can render parts of space inoperable for all stakeholders. Existing international guidelines do not provide enforceable, recognized standards to protect operators, or the space domain, from harm by the actions of others. Given the importance and increased use of the space domain by multiple actors, it is imperative that the international community establish a set of norms for responsible use of space. The U.S. can take a leadership role by declaring and enforcing norms of responsible behavior for U.S. operators.

Recommendation #2

Reform the existing space regulatory structure, naming a single federal agency responsible for authorizing and overseeing U.S. commercial space missions, to both streamline approvals and better manage risk in the space domain.

The U.S. governing structure and national policy objectives for space have not sufficiently accounted for, or kept pace with, the ever-evolving commercial competition. Currently, commercial space operators seeking approval of space operations must adhere to several distinct regulatory policies and procedures and must engage with several different government agencies, including the Federal Communications Commission, the Federal Aviation Administration, and the Department of Commerce. This reduces the speed and flexibility with which U.S. companies can bring innovative technology to bear. It also increases risks to space mission operations and to the space domain. The commercial sector needs a streamlined governing structure to enable improved speed of innovation and reduced risk. It also needs incentives and other tools to keep industry informed and prepared to deal with new risks.



Recommendation #3

Create a forum for sustained space stakeholder engagement to enable the National Space Council to reconcile commercial, civil, and military interests and coordinate developments of complementary space systems infrastructure.

Given the increasingly complex space environment and the numerous stakeholders involved, continued coordination on streamlined regulations and norms/standards development is not only critical but essential. In addition, coordination is needed to develop complementary space systems infrastructure. Without a sustainable, secure, and resilient infrastructure to support the nation's envisioned operations, including sustained human presence in space on stations and at lunar bases, the U.S. could lose its technological and strategic advantage. Commercial, civil, and military space sectors will continue to face new shared challenges and changing priorities, and these must be worked together. A sustained forum is needed to identify, prioritize, and collectively address challenges with unity of effort.

Through the above efforts, taken now and over time, the U.S. can retain its vital role as a leader in the international space community, set the conditions for a globally sustainable, secure, and resilient space operating environment, and establish the foundation for sustained economic growth and prosperity. This paper describes actionable steps to execute each recommendation.

A NATIONAL IMPERATIVE FOR SPACE

As a result of the launch of Sputnik in 1957, and the beginning of the space race between the U.S. and the U.S.S.R, the U.S. government took a lead role in spurring innovation in the space sector. Six decades later, much of the innovation in space is now being driven by the commercial space sector. Commercial space companies have raised equity investments to develop space infrastructure at nearly twice the level of the NASA budget since 2012 [2], [3]. The commercial sector has become integral to maintaining U.S. global leadership and technical advantage in space [4].

This paradigm is underscored by China's ambition to encourage commercialization of cutting-edge technologies that will allow it to displace the U.S. as the primary global superpower. In January 2022, President Xi Jinping said it was China's "eternal dream" to "develop the space industry and build China into a space power" [5]. China's approach to bring together commercial enterprises, universities, and research institutes to boost public services from space is not surprising. The Chinese space program is actively pursuing opportunities to use space to advance emergency management and environmental protection, and is investing in technologies, research, and development to enable smart cities, smart agriculture, and autonomous vehicles.

With the U.S. commercial space industry dominating the scale of space operations and pace of innovation, our continued U.S. leadership in space is at a critical juncture. We must build the framework to ensure the U.S. commercial space sector maintains its innovation and technical advantage in space. This will require the collective and sustained efforts of commercial, civil, and military space sectors in a whole-of-nation approach that reflects the numerous stakeholders now integral to the future successful utilization of the space domain.

> "The United States will foster a policy and regulatory environment that enables a competitive and burgeoning U.S. commercial space sector."
>
> —United States Space Priorities Framework, December 2021 [1]

Recognizing the above, MITRE and Aspen Digital partnered to host a series of cross-sector space stakeholder sessions focused on securing space and maintaining a U.S. technological advantage. The stakeholder sessions included nearly 60 participants, with roughly a third from the government, a third from the space industry, and a third from not-for-profit organizations. A range of strategic challenges and potential solutions were discussed. The recommendations that emerged inform this report; they focus on actions such as the responsible management of space risk, creation of norms, authorization of commercial operations, and sustained coordination of cross-sector space efforts on space development.

CONTINUED U.S. LEADERSHIP IN SPACE IS AT A CRITICAL JUNCTURE; IT REQUIRES THE COLLECTIVE AND SUSTAINED EFFORTS OF COMMERCIAL, CIVIL, AND MILITARY SECTORS IN A WHOLE-OF-NATION APPROACH.

Recommendation #1

Lead by example, declaring and enforcing norms of responsible behavior for U.S. operators that will serve as a precedent for other spacefaring nations.

> "As we move forward, we will remain focused on writing new rules of the road to ensure all space activities are conducted in a responsible, peaceful, and sustainable manner. The United States is committed to lead the way and to lead by example."
>
> —Vice President Kamala Harris, April 18, 2022, remarks at Vandenberg Air Force Base [6]

The U.S. and the international community lack adopted norms of responsible behavior for operating in the space environment. This is significant since, in space, one action by a government or commercial stakeholder can have decades-long effects that interfere with the operations of others, or render part of space inoperable for all space operators. Space stakeholders shared concerns from recent incidents and near collisions, including the lack of clarity on basic behaviors, such as which spacecraft should yield the right-of-way, whether to pass on the left or the right, and how far in advance to communicate a change in intent.

Space stakeholders debated the merits of maritime or aviation as models with clear accountability for responsible transit across a global environment. The maritime model has long-standing norms of behavior that can be enforced by any nation on the premise of transparency when operating outside of sovereign waters [7]. The maritime model requires global agreement to norms so that any nation can monitor behaviors and enforce rules. The aviation model relies on national-level enforcement of global norms by agencies such as the Federal Aviation Administration or the European Union Aviation Safety Agency. In the aviation model, norms are adopted by each nation interpreting its requirements according to its national needs and administering them within its national boundaries [8]. Neither the aviation nor maritime model applies to the current space situation without some modification; a new model is needed.

The space community needs all operators to adhere to norms of behavior regardless of the area of space in which they are operating. The U.S., and nearly all spacefaring nations, have agreed to 21 United Nations Guidelines for the Long-term Sustainability of Outer Space Activities to support the development of national and international practices for conducting space operations [9].

NEARLY ALL SPACEFARING NATIONS HAVE AGREED TO 21 UNITED NATIONS GUIDELINES FOR THE LONG-TERM SUSTAINABILITY OF OUTER SPACE ACTIVITIES. HOWEVER, THE U.S. HAS NOT YET PROVIDED ITS INTERPRETATION AND APPLICATION OF THE GUIDELINES.

However, these internationally accepted guidelines are voluntary, with member states left to interpret the details of their application and implementation [10]. The U.S. has not yet provided its interpretation and application of the guidelines.

There is an urgent need for the U.S. and other spacefaring nations to clarify their positions and seek agreed-upon international norms to regulate the domain. However, the U.S. can no longer wait for a critical mass of nation-states to act. The U.S. must take the lead and declare the standards and norms to which it will hold U.S. operators accountable. By publicizing its interpretation and application of the guidelines to U.S. authorized operations, the U.S. would set a precedent for other spacefaring nations to do likewise and would establish a model that other nations could replicate.

The first action the U.S. should take is to *define U.S. expectations and norms of responsible behavior to be used in mission authorization*. Space stakeholders observed that the starting point for any government trying to lead international norm development should be to establish agreement on norms domestically first. Defining the U.S. norms should involve those stakeholders who must authorize commitment to the policies, those who will be affected or constrained, and those who must publicize the guidance and the actions that uphold it [11].

Actions Needed to Achieve This Recommendation

1. Define U.S. expectations and norms of responsible behavior to be used in mission authorization.
2. Establish increased transparency for space traffic coordination and oversight of norms.
3. Collaborate with like-minded spacefaring nations to create and promote international norms based on mutually beneficial practices.

To define the risks that it intends to manage, the U.S. should convene public and private experts in a working group. The group should clarify which agencies are accountable for monitoring and enforcement and identify the interpretable elements and risks the guidelines will address. Existing efforts could be leveraged, such as the Consortium for Execution of Rendezvous and Servicing Operations (CONFERS), which has proposed norms for rendezvous and repair missions [12]. Following these efforts, the U.S. should publish and promote those interpretations as acceptable behaviors and commitments designed to keep space safe and sustainable.

To encourage administration of norms, the U.S. must also *establish increased transparency in space traffic coordination and oversight of norms.* This includes developing interoperability standards for automated space traffic coordination efforts

and creating metrics to define effective space traffic coordination practices [13]. In addition, this effort should extend to transparency in launch and early orbit, and end-of-life disposal phases of operation. Even if spacefaring nations have different interpretations of norms, transparency is necessary to manage risk, including the possible misunderstanding of intent as a hostile act.

After the U.S. has declared norms and a means for establishing domestic rules and the related enforcement mechanisms, it should *collaborate with like-minded spacefaring nations to create and promote international norms, based on mutually beneficial practices.* Several spacefaring nations and for-profit space companies intend to establish space traffic coordination functions; these functions could reinforce norms of responsible behavior [14]. Using the NASA Artemis Accords as a foundation, the U.S. can collaborate with emerging spacefaring nations to train and develop good behaviors [15]. This form of U.S. leadership and cooperative development across the international community will build trust through transparency and shared responsibility.

Recommendation #2

Reform the existing space regulatory structure, naming a single federal agency responsible for authorizing and overseeing U.S. commercial space missions, to both streamline approvals and better manage risk in the space domain.

The U.S. governing structure and national policy objectives for space have not sufficiently accounted for, or kept pace with, the ever-evolving commercial space competition. Currently, U.S. commercial space operators seeking approvals of their space missions must adhere to several distinct regulatory policies and engage with several

> “Authorization and supervision of nongovernmental activities in outer space serve a range of vital national interests including public safety, safety of property, national security, and foreign policy.”
>
> —The U.S. Imperative for Mission Authorization and Supervision of Commercial Space Activities [16]

different government agencies on different technical aspects of their operation. This lack of a holistic government approach to approvals inadvertently puts the U.S. space industry at a competitive disadvantage. It reduces the speed and flexibility with which space companies can bring innovative technology to market.

In addition, the commercial industry suffers from a U.S. governing structure that does not provide the continued oversight of space operations that the Outer Space Treaty requires. Industry must then monitor and address evolving threats and risks on its own. Space stakeholders identified an urgent need to reform existing governing functions and clarify processes for jurisdiction, control, authorization, and continuing supervision for commercial space operations [16].

SPACE OPERATORS SEEKING APPROVAL MUST ADHERE TO SEVERAL DISTINCT REGULATORY POLICIES, PUTTING THE U.S. SPACE INDUSTRY AT A COMPETITIVE DISADVANTAGE.

Actions Needed to Achieve This Recommendation

1. Designate a single agency with responsibility and funding to authorize and oversee U.S. commercial missions.
2. Identify incentives and other tools to keep industry participants informed and prepared to deal with new risks.
3. Reform existing space regulatory structure with the agility needed to enable innovation and grant approvals on established timelines.

The U.S. should *designate a single agency with responsibility and funding to authorize and oversee U.S. commercial missions.* This agency should also have the authority and funding to review a commercial space operator's plan for managing unique risks, coordinate with other agencies as needed on technical aspects of the approval, fulfill the oversight obligations, and issue U.S. national mission authorization. The designated agency would function as the central body to oversee implementation of the mission authorization, coordinate licensing, and provide timely responses on specific technical aspects of the mission and would address industry's call for a "one-stop shop" to coordinate all approvals [16]. Defining a U.S. mission authorization process would streamline approvals and serve as the basis for oversight consistent with Outer Space Treaty Article VI obligations [17].

In addition, an improved mission authorization process would coordinate the operator's licensing functions and could parallel the operator's planning process for the mission. This is preferable to a complex set of regulations that focus on specific technologies. The approach should provide timelier approvals by relying less on licensing all the details up front and more on continued oversight and performance monitoring [18]. The mission brings many operations under a single umbrella; for example, authorizing a commercial space station for research would include operations over many years, or a constellation would include multiple spacecraft and a connecting network [19]. The individual operations would still be licensed and would follow the protocols and risk management procedures of the mission as a whole.

An enhanced mission authorization would also build on our first recommendation to adopt U.S. norms of responsible behavior by applying those norms, standards, and best practices as criteria for the authorization. For reference, the U.S. Department of Homeland Security and MITRE developed a preliminary set of risks to the space domain and a framework for industry self-management of these critical risk events [20].

Even as government and industry discussions unfold on the possibility of space systems being designated as critical infrastructure, an improved mission authorization process would address risks unique to a space mission. It would provide a tiered response to address specific innovations and challenges, whether the planned mission is a high-school research project or a large satellite constellation to be in service for years.

While the mission authorization process focuses space operators on risks to be managed for their

specific operations, they may still need assistance to manage the range of emerging threats and risks. The designated agency should work with non-profit organizations or public-private partnerships to *identify incentives and other tools to keep industry participants informed and prepared to deal with new risks.* As a starting point for those discussions, a set of tools are suggested in a self-assessment methodology for commercial operators to manage their risk to space [21].

Lastly, as a component of this streamlined mission authorization process, the U.S. should *reform existing space regulatory structure with the agility needed to enable innovation and grant approvals on established timelines.* Major delays in responding to requests for licensing or regulatory action may disincentivize prospective space companies from seeking U.S. mission authorization. Space session stakeholders observed that the Federal Aviation Administration developed launch licensing regulations that deliver timely answers to regulate launch without impeding any of the groundbreaking advances that are being made every day [22].

Recommendation #3

Create a forum for sustained space stakeholder engagement to enable the National Space Council to reconcile commercial, civil, and military interests and coordinate developments of complementary space systems infrastructure.

Given the conditions for a secure, resilient, and sustainable space operating environment will evolve with the globally competitive environment, continued coordination on streamlined regulations and norms/standards development is not only critical but essential. The infrastructure to support the nation's envisioned operations, including sustained human presence in space, is the foundation of a technological advantage in space. The majority of space-based systems—whether for commercial, civil, or military purposes—share common supporting infrastructure requirements. There is no cost-effective infrastructure available to safely manage and integrate the proposed constellations into the current space framework [24]. In addition, new shared challenges will continuously arise for space stakeholders to collectively resolve.

> "The New Space Race seeks to achieve nothing less than the permanent establishment of the first off-planet, human settlement propelled and sustained by a thriving to-, in-, and from-space economy. It will be forged from a Cislunar industry that knits together the physical, digital and power infrastructure required to support the future needs."
>
> —State of the Space Industrial Base, August 2022 [23]

Currently, the National Space Council, which provides policy advice to the president, is responsible for coordinating space interests across the federal government. The Council engages commercial space expertise through individuals on a User Advisory Group. However, the current User Advisory Group authority is insufficient to

THE INFRASTRUCTURE TO SUPPORT THE NATION'S ENVISIONED OPERATIONS, INCLUDING SUSTAINED HUMAN PRESENCE IN SPACE, IS THE FOUNDATION OF A TECHNOLOGICAL ADVANTAGE IN SPACE.

support collaboration on commitments to national infrastructure development or prioritization of challenges for policy action.

To better enable collaboration across commercial, civil, and military space sectors, NASA should extend its authority under the Space Act Agreements [25] to the National Space Council. This would allow the National Space Council to *convene a cross-sector engagement forum at the leadership level for resolution of issues, concerns, and priorities.*

Space stakeholders observed that NASA creates effective multi-level engagements to work a wide range of issues and coordinate developments on challenges and actions similar to the recommendations in this report [26]. The forum should engage with different stakeholders along three lines of effort: a policy line for setting the priorities and challenges to enabling industry; a business line for aligning developments in the compatible infrastructure; and a technical line for developing interoperable infrastructure. This should include the ability to share classified information where appropriate.

In addition, the forum should *create a rallying vision around which to build this complementary resilient infrastructure.*

> Space stakeholders noted that the persistent human presence in space could provide a focus to this vision. That presence includes routine lunar operations by U.S. commercial space operators who plan to build space stations and lunar bases for permanent space habitation [27], [28], [29].
>
> Space stakeholders suggested capturing the infrastructure plans in a hybrid architecture of national space capability. The shared vision and architecture could incentivize industry to contribute supporting infrastructure to this architecture in areas where others have service needs, provided that interoperability is designed in during development.
>
> Space stakeholders also noted that the industries that depend on space to capture economic opportunities (such as smart cities, smart agriculture, and autonomous vehicles) do not yet understand or appreciate the fragile nature of, and need for, resilience in our space capabilities. Thus, periodic involvement by these communities in the forum would be beneficial and align to the state-of-the-industry assessment [23].

Actions Needed to Achieve This Recommendation

1. Convene a cross-sector engagement forum at the leadership level for resolving issues, concerns, and priorities.
2. Create a rallying vision around which to build complementary resilient space infrastructure.
3. Lay the foundation for sustainability by accelerating space traffic coordination development through the most expeditious means, whether commercial or governmental.

Finally, the purpose of the sustained engagement is to develop complementary resilient infrastructure. One of the most pressing infrastructure needs is space traffic coordination [13]. Although the Department of Defense has existing space traffic management activities, and there are ongoing efforts to transition those activities to the Department of Commerce, progress on a modernized space traffic coordination infrastructure is not keeping pace with increasing space congestion and evolving mission needs. At a national level, we must quickly address these challenges. The U.S. should *lay the foundation for sustainability by accelerating space traffic coordination development through the most expeditious means, whether commercial or governmental.*

CONCLUSION

Unlike the space race between the U.S. and the Soviet Union during the Cold War, today's space competition and innovation rely more heavily on the commercial space sector. Aspen Digital and MITRE, through discussion with representatives from across U.S. space sectors, have shaped a whole-of-nation approach with three complementary recommendations. Together, these recommendations create the means to support the commercial operator innovations necessary to maintain continued U.S. technological advantage.

This approach provides the necessary framework for space-based services, leveraging U.S. commercial, civil, and military sector developments and infrastructure. Each recommendation is supported by practical steps to maintain the U.S.'s competitive position. Declaring U.S. norms and establishing mission authorization and oversight will reaffirm U.S. space leadership in global efforts. In addition, creating a forum for sustained space stakeholder engagement will enable commercial, civil, and military space sectors to consistently reconcile their interests and ensure the nation's success.

Now is the time to act on these concrete steps. Doing so will ensure the security, resilience, and sustainability of U.S. space systems, and the space operating environment, today and in the future. It will position the U.S. as the global leader in providing the space-based services needed to fuel a 21st-century economy.

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