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Space in the 21st Century Conflict: Calibrating Risks, Tailoring Strategies

R. M. Genzoli

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Space in 21st Century Conflict: Calibrating Risks, Tailoring Strategies

Annotated Bibliography

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Annotated Bibliography for the Workshop:

Space in 21st Century Conflict: Calibrating Risks, Tailoring Strategies

An unclassified workshop convened by the
Center for Global Security Research, Lawrence Livermore National Laboratory
January 9-10, 2018

Mary Gullett and Ryan Genzoli

Key questions for the workshop:

1. What role can we expect the space domain to play in the conflicts the United States and its allies are likely to face in the next decade or two?
2. How can we encourage a shift in focus: from a focus on the elements of space military strategy to a focus on the role of space in broader defense and deterrence strategies?
3. In such a broader strategic approach, what roles can other stakeholders play?
4. What implications follow for the policies, strategies, and capabilities of the United States and its allies?

Panel topics:

1. Reviewing the Policy Baseline
2. The Trump Administration's Approach to Military Space Strategy
3. Understanding Adversary Approaches to Conflict in Space and Space in Conflict
4. Exploring the Place of Space in U.S. Views of Future Conflict
5. Exploring Space in Integrated Strategic Deterrence
6. Strengthening the Role of U.S. Allies in Space Defense, Deterrence, and Competition
7. Identifying the Interests of the Private Sector in Space Defense, Deterrence, and Competition
8. Lessons Learned

Panel 1: Reviewing the U.S. Policy Baseline up to 2017

Key questions:

- **What were the main developments in U.S. military space strategy from 1990 to 2016?**
- **Was the "cross domain" excursion helpful or not? Why?**

National Security Space Strategy, Unclassified Summary (January 2011).

- https://www.defense.gov/Portals/1/features/2011/0111_nsss/docs/NationalSecuritySpaceStrategyUnclassifiedSummary_Jan2011.pdf

The strategy, developed in 2011, describes the space domain as "increasingly congested, contested, and competitive." To illustrate the congestion, it says DoD tracks approximately 22,000 man-made objects in orbit and suggests there may be as many as hundreds of thousands of additional pieces of debris too small to track with current sensors. The document explains that potential adversaries are seeking to exploit perceived U.S. space vulnerabilities. It indicates the U.S. competitive advantage has decreased as market-entry barriers have lowered and that U.S. suppliers are at risk. It asserts that U.S. space capabilities will continue to be fundamental for national security and identifies three national security space objectives: 1) strengthen safety, stability, and security in space; 2) maintain and enhance the strategic national security advantages afforded to the United States by space; and 3) energize the space industrial base that supports U.S. national security. To meet these objectives, the document outlines the following five strategic approaches: 1) promote responsible, peaceful, and safe use of space; 2) provide improved U.S. space capabilities; 3) partner with responsible nations, international organizations, and commercial firms; 4) prevent and deter aggression against space infrastructure that supports U.S. national security; and 5) prepare to defeat attacks and to operate in a degraded environment.

Douglas Loverro, "Statement of Douglas Loverro, Deputy Assistant Secretary of Defense (Space Policy) Before the House Committee on Armed Services, Subcommittee on Strategic Forces, on Fiscal Year 2016 National Defense Authorization Budget Request for National Security Space Activities," House Armed Services Subcommittee on Strategic Forces (25 March 2015).

- http://docs.house.gov/meetings/AS/AS29/20150325/103106/HHRG-114-AS29-Wstate-LoverroD-20150325.pdf

Then-Deputy Assistant Secretary of Defense (DASD) for Space Policy Loverro said US national security as of 2015 was inextricably linked to US space-based systems and services. He stressed the importance of space mission assurance, noting that DoD had shifted from focusing primarily on providing capability in space to also assuring and defending space capabilities against the aggressive and comprehensive counterspace programs of others. He said a recent strategic portfolio review of space within DoD found that the United States was not adequately prepared for a conflict that might extend to space and noted some DoD efforts underway in response. One such effort was the development of a Memorandum of Understanding to create a Combined Space Operations (CSpO) initiative, which he described as an announcement to the world that if someone wanted to deny the

United States the use of space services, they would have to take on more than just the United States. He also discussed how engagement with commercial partners could help ensure the security of US space architectures.

Space Domain Mission Assurance: A Resilience Taxonomy, Office of the Assistant Secretary of Defense for Homeland Defense & Global Security, White Paper (September 2015).

- http://policy.defense.gov/Portals/11/Space%20Policy/ResilienceTaxonomyWhitePaperFinal.pdf?ver=2016-12-27-131828-623

This white paper defines the Office of the Secretary of Defense (OSD) Policy perspectives on a "viable taxonomy for space mission assurance, and its conceptual origin." The authors note that efforts to identify future space system architectures and deployment strategies inevitably evolve into either capability or cost-driven comparisons, treating the need for resilience as an afterthought. Although such comparisons are necessary, the authors suggest they should not replace resiliency as the driving force behind any space planning or architecture analysis. Given this, an agreement on what resilience means must be reached.

Ellen Pawlikowski, Doug Loverro, and Tom Cristler, "Space: Disruptive Challenges, New Opportunities, and New Strategies," *Strategic Studies Quarterly*, (Spring 2012), 27-54.

- http://www.au.af.mil/au/ssq/2012/spring/pawlikowski.pdf

This article explores how the forces of disruptive change impact the direction of U.S. space power and recommends a set of responses to offset rising challenges. According to the authors, the two most critical disruptive forces influencing U.S. space strategy are the growth of space as a tactically vital resource and adversaries' apparent intent to make space both a nuclear and conventional contest. As such, the creation of a more resilient space capability is needed, with changes in space asset acquisition necessary to better allow and support resiliency efforts.

Maximilian Betmann, "A counterspace awakening? (part 1)," *The Space Review*, 22 May 2017.

- http://www.thespacereview.com/article/3247/1

The author identifies two triggers of what he says was a shift in U.S. national security space policy beginning in mid-2014: China's launch in 2013 of a rocket that the U.S. Defense Department claimed nearly reached geosynchronous orbit, and rendezvous and proximity operations of Russian and Chinese satellites around the same time frame. Quoting U.S. officials, he suggests the United States now views space as a warfighting domain in which it must contend with both environmental and hostile threats.

Maximilian Betmann, "A counterspace awakening? (part 2)," *The Space Review*, 30 May 2017.

- http://www.thespacereview.com/article/3250/1

The author continues a discussion of a perceived shift in U.S. national security space strategy beginning in 2014, focusing on U.S. steps to improve and protect its space situational awareness capabilities and make its space systems more resilient. He also discusses new U.S. organizational and management structures designed to support the implementation of the post-2014 U.S. approach to national security space.

James A. Vedda and Peter Hays, "Major Policy Issues in Evolving Global Space Operations," *Mitchel Institute Policy Papers*, Vol. 9 (December 2017).

- http://aerospace.wpengine.netdna-cdn.com/wp-content/uploads/2017/12/Space_PolicyPaper_interactive_3-19.pdf

This paper provides recent, timely assessments and policy recommendations of current space-related issues, including space traffic management, small satellites, proximity operations, orbital debris, counterspace threats, and norms of behavior. An overarching theme is that the United States should take the lead in determining the way forward because collective U.S. interests in space operations are the largest in the world. The paper draws on insights gleaned from more than 30 subject matter experts and a panel of senior reviewers. Important areas of consensus emerged in the following areas: 1) the United States should lead by example; 2) roles need to be clarified among the government, commercial, and international sectors of activity; 3) emerging technologies should be embraced, not obstructed, even if their proliferation carries some risk; 4) classification of space operations could be reduced to facilitate international and cross-sector collaboration; and 5) reform of international agreements should be approached with caution and patience to ensure that important provisions and understandings are not lost.

Panel 2: The Trump Administration's Approach to Military Space Strategy

Key questions:

- **On at least a preliminary basis, what insights do we have into the Trump administration's approach to conflict in space and space in conflict?**
- **What role, if any, do space military issues play in the Trump administration's National Security Strategy? In the National Defense Strategy? In the National Military Strategy?**

Colin Clark, "SecAF Wilson Touts 'Offensive' Space Weapons; McMaster Details 'Framework'", *Breaking Defense*, 6 October 2017.

- https://breakingdefense.com/2017/10/secaf-wilson-touts-offensive-space-weapons-mcmaster-details-framework/

The author provides a summary of the inaugural meeting of the Trump Administration's Space Council. He says a full-scale review of space warfare is underway, guided by four objectives: 1) strengthening the safety, stability, and sustainability of space activities; 2) deterring and, when necessary, defeating adversary space and counterspace threats; 3) partnering with the U.S. commercial sector to ensure American companies remain preeminent; and 4) maintaining and extending the U.S. human and robotic presence beyond Earth. The article says the framework will be presented to President Trump within 45 days for approval. It notes that Air Force Secretary Heather Wilson in remarks following the meeting seemed to commit the United States to more offensive weapons for space.

Elbridge Colby, *From Sanctuary to Battlefield: A Framework for a U.S. Defense and Deterrence Strategy for Space,* Center for a New American Security (January 2016).

- https://s3.amazonaws.com/files.cnas.org/documents/CNAS-Space-Report_16107.pdf?mtime=20160906081938

The author contends the existing U.S. space architecture is not designed to deal with the threats it is facing and weighs options to defend against them. He builds a case for a limited war strategy for space that he suggests could include the following five principles: 1) being the first to carry war into space is escalatory and irresponsible; 2) kinetic attacks that cause lasting damage to humanity's ability to exploit space abilities are prohibited; 3) attacks on or interruptions of strategic space assets are construed as highly escalatory and should be disfavored; 4) satellites and space assets not directly and substantially involved in a conflict are not legitimate targets for attack; and 5) attacks in space justify responses outside of space. He concludes by discussing some of the U.S. policy implications of these principles as part of a limited war strategy for space.

Jerry Hendrix and Adam Routh, *A Space Policy for the Trump Administration*, Center for a New American Security (October 2017).

- https://s3.amazonaws.com/files.cnas.org/documents/Space-Policy-for-the-Trump-Administration.pdf?mtime=20171023110127

The authors call for the Trump administration to pursue a "revolutionary leap ahead" with regard to the U.S. position in space. They suggest the administration should emphasize the commercial sector as the central pillar of future U.S. space activities, using the U.S. Government's 19th century westward exploration as an analogous historical precedent. The authors propose: significant changes to U.S. interpretation and enforcement of international laws related to space activities; a civil space policy that prioritizes development by identifying resource and settlement opportunities; enablement of the commercial space sector to fully harness the resources and wealth of space; and strengthening the national security infrastructure in space.

Panel 3: Understanding Adversary Approaches to Conflict in Space and Space in Conflict

Key questions:

- **How does Russia differentiate the roles of space combat in local, regional, and strategic conflicts?**
- **Does China make similar distinctions or does it take a different conceptual approach?**
- **Looking ahead a decade or two, are there other potential actors in space of military consequences?**
- **Looking ahead a decade or two, how much progress do they expect to have made in shifting the strategic balance in space to their advantage?**

Russia

Alexi Arbatov, "Russian Perspectives on Spacepower," in Eds, Charles D. Lutes and Peter L. Hayes with Vincent A. Manzo, Lisa M. Yambrick, and M. Elaine Bunn*, Toward a Theory of Spacepower: Selected Essays* (Institute for National Strategic Studies, National Defense University, 2011).

The author emphasizes the historical importance of Russia's space program, saying the Russian government sees space power as one of the most important attributes of a country's authority and prestige. He says the Russian program is gradually recovering from a post-Cold War decline. He observes Russia's dependence on international cooperation in space exploration and exploitation and explains cooperation on space activities as one of very few high-technology export items Russia can pursue in the near- to mid-term. The author contrasts Russia's military space requirements and programs with those of the United States, noting, for example, that Russia does not rely heavily on space systems for conventional operations. He concludes by advocating for a code of conduct for space activities designed to ban activities aimed at destroying or interfering with the functioning of space systems.

Jana Honkova: "The Russian Federation's Approach to Military Space and Its Military Space Capabilities" The Marshall Institute, Policy Outlook (November 2013).

- http://marshall.org/wp-content/uploads/2013/11/Russian-Space-Nov-13.pdf

This report is divided into two main sections. In the first section, the report asserts that a gap exists between Russian military theory and practice, explaining that Russia's efforts to improve its space-related capabilities have been slow and gradual even though Russian strategists recognize the importance of space to modern warfare. The second section provides an overview of the satellites Russia uses for military purposes and highlights Russia's launch capabilities. The final section on Russian systems discusses Russia's anti-satellite (ASAT) programs, noting that its actions indicate support for airborne ASAT systems. The report encourages the reader to consider Russia's approach to outer space in the context of Russia's strategic culture and identity, suggesting that Russia's desire to achieve self-sufficiency and superiority permeate all of its military space activities.

James N. Miller Jr. and Richard Fontaine, *A New Era in U.S.-Russian Strategic Stability: How Changing Geopolitics and Emerging Technologies are Reshaping Pathways to Crisis and Conflict,* Center for a New American Security (September 2017).

- https://s3.amazonaws.com/files.cnas.org/documents/CNASReport-ProjectPathways-Finalb.pdf?mtime=20170918101504

The authors of this paper suggest renewed tension between the United States and Russia coupled with emerging new military capabilities increase uncertainties associated with strategic stability and create potential slippery slopes of escalation. The authors provide a framework for understanding the current environment, organizing the discussion into three different pathways, and highlight the implications. They suggest U.S. strategy should be guided by a principle of managed competition. They tee up a planned follow-on report

that will provide recommendations for Washington and Moscow to help prevent crises turning into conflicts, conflicts into major wars, and major wars into apocalyptic ones.

China

Dean Cheng, "China's Military Role in Space" *Strategic Studies Quarterly* (Spring 2012).

- http://www.au.af.mil/au/ssq/2012/spring/cheng.pdf

This article begins with a discussion on the evolution of Chinese military strategy, followed by a description of how this evolution informs contemporary Chinese conceptions of military space operations. According to the author, one theme present in Chinese military doctrine is the need to achieve "space dominance" in support of broader information dominance objectives during "local wars under informationalized conditions." Chinese military space strategy is organized under the guiding principal of "unified operations," which includes unified forces, unified techniques, and unified operational activities. The article discusses future Chinese space operations and concludes with a brief overview of the potential implications China's space strategy may hold for the United States.

Dean Cheng, "U.S.-China Competition in Space: Testimony before Subcommittee on Space, Committee on Science, Space, and Technology," Congressional Testimony, U.S. House of Representatives (27 September 2016).

- http://www.heritage.org/testimony/us-china-competition-space

Dean Cheng, an expert on China's military and space capabilities, discusses the evolution of Chinese views on future warfare and how the People's Liberation Army (PLA) thinks about space operations. Cheng suggests Chinese views were shaped by an analysis of past wars of other nations, particularly the United States. Chinese analysts appear to have concluded that future conflicts will most likely resemble "local wars under informationalized conditions," where information dominance will be a key factor to victory. Chinese strategists perceive that information dominance can be gained by achieving space, network, and electronic dominance. Cheng concludes with a brief overview of the newly formed PLA Strategic Support Force, along with an assessment of current and future U.S.-China space competition.

"Chapter Ten, Scorecard 8: Chinese Counterspace Capabilities Versus U.S. Space Systems," in Eric Heginbotham, Michael Nixon, Forrest E. Morgan, Jacob L. Heim, Jeff Hagen, Sheng Li, Jeffrey Engstrom, Martin C. Libicki, Paul DeLuca, David A. Shlapak, David R. Frelinger, Burgess Laird, Kyle Brady, and Lyle J. Morris, eds., *The U.S.-China Military Scorecard: Forces, Geography, and the Evolving Balance of Power 1996– 2017* (Santa Monica, CA: RAND Corporation, 2015).

- https://www.rand.org/content/dam/rand/pubs/research_reports/RR300/RR392/RAND_RR392.pdf

This book chapter discusses the development of Chinese counterspace capabilities and assesses threats those capabilities pose to U.S. space-based assets. The authors suggest the PLA has absorbed lessons from past U.S. conventional military conflicts and developed kinetic and non-kinetic weapon systems to counter the advantage provided to U.S. terrestrial forces by space systems. The chapter explores Chinese laser capabilities used to

"dazzle" and track satellites, kinetic ASAT and ballistic missile defense systems, and radio-frequency jamming capabilities. The chapter includes two useful charts: one highlighting the estimated risk posed to U.S. space systems by China's counterspace assets, and another displaying a "scorecard" that reflects the outcomes of various actions taken by both the United States and China during hypothetical conflicts over Taiwan and the Spratly Island region.

Kevin Pollpeter, "The New Domain: Space Operations and Chinese Military Reforms," *Journal of Strategic Studies,* Vol 39 (August 2016): 709-727.

- http://www.tandfonline.com/doi/full/10.1080/01402390.2016.1219946?needAccess=true

Kevin Pollpeter, an expert on Chinese national security issues, examines the role outer space plays in Chinese military operations. He argues that China's future military strategies and reforms will place high priority on the space domain. Using a framework developed by David Finkelstein, also an expert in Chinese security affairs, the author focuses on three "baskets" of likely military reform that are meant to "enhance the PLA's capacity to conduct joint operations, with special emphasis on the maritime-aerospace domains." These include an adjustment of national military strategy, development of "new type operational forces," and organizational changes. Based on his analysis, the author concludes that the PLA sees space as a new domain that must be dominated to win future wars. Thus, the goal of Chinese military space operations will be to achieve space superiority while concurrently denying adversaries use of their own space assets.

Kevin L. Pollpeter, Michael S. Chase, and Eric Heginbotham, "The Creation of the PLA Strategic Support Force and Its Implications for Chinese Military Space Operations," RAND Corporation (2017).

- https://www.rand.org/content/dam/rand/pubs/research_reports/RR2000/RR2058/RAND_RR2058.pdf

The authors of this report use available, albeit limited, open source information to assess the implications for Chinese military space operations of China's creation in 2015 of the PLA's Strategic Support Force (SSF). The authors suggest China's creation of the SSF signifies an important shift in the PLA's prioritization of space and portends an increased role for the PLA in space capabilities. They identify the main function of the SSF's space component as the launch and operation of satellites to provide the PLA with command and control, communications, computers, intelligence, surveillance, and reconnaissance capabilities (C4ISR). They highlight space's importance to the PLA and provide overviews of its space capabilities and operations. Additionally, the authors provide tables with the names, positions, and ranks of SSF leaders and evidence that the SSF is designed to augment service and theater command operations rather than operate as an independent force. They say the organization appears to be primarily staffed by Army personnel but tasked with supporting all services in its space capabilities.

Ashley Tellis, "China's Military Space Strategy," *Survival* 49, no. 3 (2007).

- http://carnegieendowment.org/files/tellis_china_space1.pdf

The author discusses China's successful 2007 ASAT test and refutes assessments that Chinese counterspace efforts are merely a response to the U.S. unwillingness to negotiate an agreement outlawing the weaponization of space. Rather, he argues that China's test represents a logical progression in the evolution of its counterspace program, one aimed at countering U.S. military dominance. He discusses the strategic logic behind Chinese counterspace efforts, its specific counterspace programs, and the implications these programs will have on future conflicts. He concludes that China's ASAT research and development efforts are grounded in a desire to counter superior U.S. conventional forces and defeat the United States during a future, regional war.

Brian Weeden, "Through a glass, darkly: Chinese, American, and Russian anti-satellite testing in space" *The Space Review*, 17 March 2014.

- http://www.thespacereview.com/article/2473/1

Brian Weeden, an expert in space operations and policy, provides an in-depth assessment of China's May 2013 ballistic missile launch. Using exclusively open source information, Weeden concludes there is strong evidence to suggest the launch was a test of the rocket component of a new direct ASAT system. Divided into three parts, this comprehensive article also presents a brief description of past U.S. and Russian ASAT testing and an examination of the parallels between hit-to-kill ASAT testing, missile defense systems, and the difficulty of politically separating the two. The author suggests the United States and China should increase transparency and confidence building measures to enhance strategic stability. Weeden aspires for the article to make available in the public domain more information about the May 2013 launch in order to spark public debate on the issue.

Panel 4: Exploring the Place of Space in U.S. Views of Future Conflict

Key questions:

- **Does the U.S. differentiate the roles of space combat in different types of conflicts? How should it?**
- **How can space be utilized militarily to achieve specific objectives in peacetime, crisis, and war, both regional and strategic?**
- **Looking ahead a decade, how might answers to these questions change? Why?**
- **What other interests should guide the development of U.S. military strategy in a way that integrates space?**

Ashton B. Carter "Satellites and Anti-Satellites: The Limits of the Possible." *International Security,* Vol. 10, No.4 (Spring 1986): 46-98.

In this article from 1986, former U.S. Secretary of Defense Ashton Carter argues that members of the national security community should familiarize themselves with the specialized jargon and technologies associated with ASAT weapons. To support this, Carter provides background to non-technical readers on various subjects related to satellites and ASATs. He discusses military use of space, characterizes and describes ASAT weaponry and their uses, outlines principles for U.S. military exploitation of space, and highlights the main objections to ASAT arms control initiatives. He proposes a minimal approach to ASAT arms

control, banning only those ASAT methods that are clearly verifiable. This, he suggests, would provide substantial protection for high Earth orbit (HEO) satellites. Taken together, this article provides a foundational understanding of the outer space domain as it relates to international security.

Barry D. Watts, "The Military Use of Space: A Diagnostic Assessment," Center for Strategic and Budgetary Assessments (February 2001).

- http://csbaonline.org/research/publications/the-military-use-of-space-a-diagnostic-assessment/publication

In this article from 2001, the author assesses how U.S. capabilities to exploit near-earth space for military ends are likely to stack up against those of prospective competitors from 2001 to 2025. The author's bottom-line judgment is that force enhancement is likely to be the main military use of space in the first quarter of the twenty-first century. He asserts the United States is far ahead of any other nation in its capability to use space for force enhancement, but cautions that relatively greater U.S. dependence on space systems means future opponents without a major space program may be able to offset many of the advantages the U.S. military derives from space. The author considers trigger events and more gradual paths that he suggests could prompt an earlier-than-expected transition of near-earth space from a force-enhancement to a force-application role. The assessment includes a useful history of the military use of space and commercial trends as of 2001. Appendices include—among others—a broader look at the military geography of space and listings of selected U.S. Government satellites and commercial communications projects that were either planned or existing as of 2001.

Peter L. Hays, "Spacepower Theory," in Kai-Uwe Schrogl, Peter L. Hays, Jana Robinson, Denis Moura, and Christina Giannopapa (Eds), *Handbook of Space Security* (New York: Springer, 2015), 57-79.

- https://link.springer.com/content/pdf/10.1007%2F978-1-4614-2029-3_52.pdf

The author of this chapter in an edited volume calls for spacepower theory to be more fully developed to help describe, explain, and predict how individuals, groups, and states can best derive utility, balance investments, and reduce risks in their interactions in space. He reviews existing literature on spacepower theory, noting the absence of a holistic, widely-accepted theory of spacepower comparable to seapower or airpower theories. He provides an overview of U.S. space-related policies and describes the current space environment. He goes on to identify ways in which a more developed spacepower theory could help refine U.S. policy and addresses challenges related to space security, space commercialization, and environmental sustainability and survival.

Panel 5: Exploring Space in Integrated Strategic Deterrence

Key questions:

- **What is integrated strategic deterrence?**
- **What are its potential values?**

- **What can military capabilities in space contribute to deterrence in different types of conflicts? What can space vulnerabilities detract?**
- **How do other countries answer these questions?**
- **As most U.S. military space activity is classified, how can that activity be integrated into deterrence strategies (that require openness about capabilities and credible signaling to be effective)?**

Forrest E. Morgan, "Deterrence and First-Strike Stability in Space: A Preliminary Assessment," RAND Corporation, Project Air Force (2010).

- https://www.rand.org/content/dam/rand/pubs/monographs/2010/RAND_MG916.pdf

The author of this monograph argues that first-strike stability in space as of 2010 was eroding and suggests the United States could strengthen stability by developing a strategy to deter future adversaries from attacking US space systems. He says the central pillar of such a strategy should be a national space policy that explicitly condemns the use of force in space and declares that the United States would severely punish any attacks on its space systems and those of friendly states in ways, times, and places of its choosing. He describes the concept of first-strike stability, evaluates the shifting dynamics of stability in space, applies the principles of deterrence to the space environment, and provides justification for arguing that a national space deterrence strategy is needed. The monograph includes a chart estimating notional space deterrence capabilities by system type at various levels of conflict.

David C. Compert and Phillip C. Saunders, *The Paradox of Power: Sino-American Strategic Restraint in an Age of Vulnerability*. (National Defense University Press, 2011).

- http://ndupress.ndu.edu/Portals/68/Documents/Books/paradox-of-power.pdf

This book discusses the United States, China, and their increasing vulnerabilities in the nuclear, ASAT, and cyber weapons domains. The authors advocate for a strategy of mutual strategic restraint built on a foundation of mutual deterrence in each domain, based on fear of retaliation and the limits of defense. They suggest this strategy of mutual restraint should include: pledges to refrain from attacking first; regular high-level communications about capabilities, doctrine, and plans; and steps to establish concrete confidence building measures. The book is divided into eight chapters and discusses in detail U.S. and Chinese views on: strategic power, vulnerability, and restraint; mutual restraint in the nuclear, space, and cyber domains; strategy integration and implications; and recommendations moving forward.

James P. Finch and Shawn Steene, "Finding Space in Deterrence: Toward a General Framework for Space Deterrence," *Strategic Studies Quarterly* (Winter 2011), 10-17.

- http://www.dtic.mil/dtic/tr/fulltext/u2/a569581.pdf

The authors of this commentary suggest the three traditional constituent elements of nuclear deterrence—imposing cost, denying benefit, and encouraging restraint—can enhance the space component of strategic stability. Careful to note the ways in which deterrence in space differs from nuclear deterrence, they describe how these three

elements could be applied in the space domain. They note that the three elements need not be present in equal measures for an effective space deterrence strategy. The authors press for the United States to develop a strategic posture that would not only deter counterspace operations, but that would also ensure U.S. vulnerabilities in space do not collapse the threshold for deterrence failure more broadly.

Roger Harrison, *"The Role of Space in Deterrence,"* in Kai-Uwe Schrogl, Peter L. Hays, Jana Robinson, Denis Moura, and Christina Giannopapa (Eds), *Handbook of Space Security* (New York: Springer, 2015), 113-130.

- https://link.springer.com/referenceworkentry/10.1007%2F978-1-4614-2029-3_54#page-1

This chapter in an edited volume explores possible ways in which the United States, China, other governments, and commercial space operators might help reduce the possibility of space becoming either a catalyst or theater for hostilities. Drawing attention to some of the more unique aspects of the space environment, the author explains that improved defenses in space generally come at the expense of capabilities and notes that attributing attacks in space and distinguishing between intentional and unintentional interference in the space domain can be challenging. To set the stage for his recommendations, he provides a short history of space and deterrence culminating with the current phase which he describes as "congested, competitive and contested" and constrained by budgets. Although he states that there is no imminent threat from space to be deterred, and no means in space to attack other objects in orbit, he asserts that maintaining these two conditions as a baseline is a first and necessary step in any deterrence structure. He advocates for continuing what he sees as trendlines of increased transparency, information sharing, and regulation, suggesting that greater order and predictability will enhance deterrence.

Michael Krepon and Julia Thompson, Eds, "Anti-satellite Weapons, Deterrence and Sino-American Space Relations," Stimson Center (September 2013).

- https://www.stimson.org/sites/default/files/file-attachments/Anti-satellite%20Weapons%20-The%20Stimson%20Center.pdf

This piece consists of a collection of essays that offer insights on the deterrence of destructive acts in space, drawing on lessons from the nuclear era.

- An introductory essay by Michael Krepon of the Stimson Center compares space deterrence to nuclear deterrence and suggests some of the same initiatives that proved successful in Cold War nuclear deterrence could be useful in space deterrence. These elements, among others, include: 1) secure retaliatory capabilities; 2) effective command and control mechanisms; 3) redundant safety and security mechanisms 4) situational awareness; 5) attribution capabilities; and 6) resilient space assets.
- A second essay by Karl Mueller of the RAND Corporation argues that nuclear deterrence and space deterrence are not parallel concepts, despite several similarities. He says the unique operating environment and physics of orbital mechanics create an operational and strategic world in which conventional wisdom does not apply, going as far as to suggest space deterrence may not be a useful construct at all.

- A third essay by James Lewis of the Center for Strategic and International Studies (CSIS) begins with the premise that the ability to deter attacks against networks or satellites is so limited that it raises the question of whether deterrence makes sense as an organizing principle for strategy. Arguing that nuclear weapons are uniquely destructive and that the bipolar global conflict was a unique political moment in international affairs, the author asserts that concepts of deterrence developed for nuclear weapons are not applicable to space assets.
- A fourth essay by Bruce MacDonald of the United States Institute of Peace addresses the question of how the United States and China might achieve deterrence and crisis stability in space under existing and foreseeable circumstances. He contends that offensive space capabilities do not constitute just "one more weapon in the arsenal." Among other considerations, he suggests each class of space assets has different values to both attacker and defender, with resulting "differential deterrence" and war-fighting implications.
- A fifth essay by Michael Nacht of UC Berkeley suggests any assessment of U.S.-China relations in space should begin with a broader consideration of the overall bilateral relationship. He identifies various motivations behind China's space program, outlines key elements of the space rivalry, and advocates for deeper bilateral or multilateral discussions or negotiations that could establish certain codes of conduct in space.
- A sixth essay by Brian Weeden of the Secure World Foundation asserts that differences in the current U.S.-China relationship in space far outweigh any similarities with the U.S.-Soviet relationship. He notes, in particular, incongruities between current U.S. and Chinese space capabilities, along with both countries' long-term goals. He identifies two general paths forward for U.S.-China space cooperation: a top down approach, built around high-profile initiatives such as human spaceflight, and a bottom-up approach, involving low-profile areas unlikely to generate significant opposition and controversy, such as collaborative scientific research and space science missions.

Panel 6: Strengthening the Role of U.S. Allies in Space Defense, Deterrence, and Competition

Key questions:

- **Which allies are engaged with the United States now in this domain and which might become consequential in the decade or so ahead?**
- **What perspectives do they bring to the development of strategy, policy, and capabilities?**
- **How will their interests influence the development and implementation of U.S. policy?**

Xavier Pasco, "The European "Spacepower"? A Multifaceted Concept" in Eds, Charles D. Lutes and Peter L. Hayes with Vincent A. Manzo, Lisa M. Yambrick, and M. Elaine Bunn,

Toward a Theory of Spacepower: Selected Essays (Institute for National Strategic Studies, National Defense University, 2011).

The author begins with a series of questions about European space policy, including whether the European Union's ambition to manage its own military operations is realistic without satellite networks that can operate independently of the United States and if the Europeans can fight alongside the United States in future wars without increased access to space technology. He says European governments have been slow to invest in space-based technologies for military purposes, noting that European investments in space-based military applications amount to less than 5 percent of the global total. He provides an overview of existing European space capabilities and explains that the concept of a European military space program raises the issue of how to incorporate different national and European systems and integrate decision-making procedures. He says Europeans need to decide on their future military space needs, and suggests that first priorities for European space efforts will likely be intelligence and telecommunications systems. He concludes by suggesting that the two prerequisites for the future of European military space are to make the most of new technologies and decide how to manage future security needs at the European level.

Madeleine Moon (United Kingdom), *The Space Domain and Allied Defence,* Report of the Sub-Committee on Future Security and Defence Capabilities, Defence and Security Committee, NATO Parliamentary Assembly (8 October 2017).

- https://www.nato-pa.int/download-file?filename=sites/default/files/2017-11/2017%20-%20162%20DSCFC%2017%20E%20rev%201%20fin%20-%20SPACE%20-%20MOON%20REPORT.pdf

This report calls for renewed focus by NATO members on space cooperation, explaining that the "goal of the peaceful use of outer space. . .is challenged daily" and a range of vulnerabilities exist. These vulnerabilities include: a growing volume of space debris; development and testing of ASAT capabilities by China, Russia, and the United States; India's likely development of direct-ascent ASAT capabilities in the near-term; the status of Japan, Israel, and France, as turn-key ASAT players; and various non-kinetic means of disrupting and denying access to satellite capabilities. The report suggests NATO doctrine and planning have not kept pace with developments in the space domain, noting the lack of a military strategy or policy for space operations for the alliance. The report calls on NATO members to push for a code of conduct for space and suggests the prevention, mitigation, and remediation of space debris present opportunities for allied NATO action.

"Chapter 5 Space Support to NATO Operations" in *Allied Joint Doctrine for Air and Space Operations*, NATO Standard (NATO Standardization Office, April 2016), 5-1 – 5-14.

- https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/624137/doctrine_nato_air_space_ops_ajp_3_3.pdf

This official document outlines NATO's doctrine for air and space operations. It identifies NATO space operational mission areas as: 1) space situational awareness; 2) space force enhancement; and 3) space control. A description of these three mission areas is provided, along with an overview of space support coordination (SpSC) - a function that describes the

"responsibilities and tasks for selected staff personnel who will serve as the commander's primary advisors for space support operations." The SpSC function is broken down into two levels, strategic and operational. The doctrine goes on to highlight the importance of establishing coordination relationships with relevant parties prior to space operations and the need to understand firmly the operational risks associated with the use of space capabilities. The final pages of the document contain a lexicon of acronyms and abbreviations found throughout the text.

Filling the Vacuum: A Framework for a NATO Space Policy, Joint Air Power Competence Centre (June 2012).

- http://www.japcc.org/wp-content/uploads/SPP_2012_web.pdf

The article provides an overview of NATO space capabilities, selected NATO uses of space, and examples of space systems employed by NATO members. It reviews space policies covering NATO members, noting that most NATO members have a general consensus on the key space policy positions of the European Union and United States. It proposes seven tenets to further define NATO's approach to space. It includes one annex on proposed NATO policy on the employment and coordination of space capabilities, and another that compiles E.U. and U.S. space policy guiding principles.

"Air & Space Power in NATO: Future Vector - Part II," Joint Air Power Competence Centre, Germany (October 2014).

- http://www.japcc.org/wp-content/uploads/JAPCC_FV_III_web.pdf

This compendium of essays focuses on military- and operational-strategic aspects of NATO's "air and space power paradox," a term the authors use to characterize the contradiction inherent in what they say is NATO members' unwillingness or inability to act collectively to maintain and evolve the organization's air and space power capabilities at a time when the importance of these capabilities as the military tools of choice for NATO is growing. The authors call on NATO members to develop a comprehensive space policy and outline issues they say the policy ought to address. Among other recommendations, they welcome duplication of space systems among NATO member states, call for close dialogue with the European Union and European Space Agency, suggest NATO should consider acquiring a commonly-funded NATO "responsive space capability" with space satellites, and call for the establishment of a NATO space situational awareness capability.

Gregory Schulte, "Protecting NATO's Advantage in Space", *Transatlantic Current* No. 5 (National Defense University, May 2012).

- http://www.dtic.mil/dtic/tr/fulltext/u2/a577645.pdf

The author observes NATO's dependence on space while asserting that its doctrine and planning have not kept up. He notes that several countries outside the alliance are developing and fielding jammers, lasers, direct ascent ASAT missiles, and cyber attack capabilities that could be turned toward space, and calls on NATO to prepare for future operations when its use of space is actively challenged. He says NATO should: continue to build the expertise and capacity to conduct operations enabled by space; ensure that doctrine, requirements, and planning account for the operational advantages provided by space; and adapt exercises and training to ensure forces can effectively exploit space-based capabilities. He contends that, at a strategic level, NATO is uniquely positioned to bolster

deterrence in space because—with the alliance increasingly reliant on space for its collective defense and economic prosperity—an attack on the space assets of any one ally impacts the security of all allies.

Tae-Hyung Kim, "South Korea's space policy and its national security implications," *Korean Journal of Defense Analysis,* Vol 22, Issue 4 (2010), p515-529.

- http://www.tandfonline.com/doi/abs/10.1080/10163271.2010.519935?journalCode=rkjd20

This article discusses the evolution of South Korea's space policy as it relates to national security. The author notes that South Korea recognizes how crucial space is for national security in today's informationalized world. The article briefly discusses the historical evolution of South Korea's space program, South Korean efforts to balance the development of military space assets while maintaining and building relationships with its neighbors, and current efforts to enhance the country's space capabilities. The author finds that progress toward developing a domestic military space capability has been limited due to a lack of coordination with civilian authority, bureaucratic issues with prioritizing projects, budgetary limitations, and lack of public awareness and support. To address these issues, the author recommends that South Korea establish a coordinating mechanism between civil and military planners, prioritize space within national security policies, and encourage public debate about the direction of Seoul's space policy.

Malcolm Davis, *Getting starry-eyed about space,* Australian Strategic Policy Institute, 28 September 2017.

- https://www.aspistrategist.org.au/getting-starry-eyed-about-space/

The author comments on the then-recent announcement that Australia would stand up a national space agency, characterizing the decision as a "positive step forward for a country that's done very little in the way of flying satellites and launching rockets since the 1960s." He opines that the primary role of the new space agency should be to create a vibrant Australian sovereign space industry that can engage with and compete in the international market. In so doing, the new space agency would play a supporting role, assisting the private sector in space, and helping Australian space-related start-ups take the lead. He suggests a first task for the agency should be to update the country's national space policy from the 2013 Satellite Utilization Policy that forms the basis of Australian space policy today. He asserts that the new policy should recognize that continued dependency on outside providers for Australian space capability generates the unacceptable risk of Australia losing access to space in a crisis, and stifles Australian space industry development.

Steve Buchta, "Space Weaponization and Canada-U.S. Relations: Lessons from Australia", *Journal of Public and International Affairs* Vol. 19 (Spring 2008), 177-192.

- https://jpia.princeton.edu/sites/jpia/files/2008-10.pdf

This article sheds light on the possible future of space weaponization by examining past, present, and future approaches taken by the United States, Canada, and Australia to weaponize space. The author suggests Canada needs to move beyond broad international policy statements and modernize its security doctrines by developing a defense strategy

specific to outer space. Additionally, the article discusses Canadian military space security initiatives, highlights lessons Canada can learn from U.S.-Australian relations, outlines the role of space weapons in Canadian politics, and concludes with policy recommendations for decision makers.

Panel 7: Identifying the Interests of the Private Sector in Space Defense, Deterrence, and Competition

Key questions:

- **How will the emerging role of the private sector in space influence strategies for space security?**
- **How should it?**

Jeff Foust, "Commercial space's policy wish list", The Space Review, 1 May 2017.

- http://www.thespacereview.com/article/3230/1

The article summarizes a hearing on commercial space regulatory issues held by the Space Subcommittee of the Senate Commerce Committee in April 2017. The hearing's witnesses, which included the heads of four commercial space companies, called for increased funding for the Federal Aviation Administration's (FAA's) Office of Commercial Space Transportation to avert an "impending licensing traffic jam" because of a growing number of launches. One participant additionally called for the designation of the FAA as the sole lead agency for licensing commercial space launches independent of the location of the range. Although participants lacked consensus on some regulatory issues, other issues raised during the session included: streamlining the regulatory environment for hybrid vehicles; consideration of a permanent indemnification regime for the U.S. launch industry; protection of intellectual property developed in space; and embracement of commercial pathfinding and profit-making on the International Space Station.

Joshua Hampson, *The Future of Space Commercialization,* Niskanen Center Research Paper (25 January 2017).

- https://science.house.gov/sites/republicans.science.house.gov/files/documents/TheFutureofSpaceCommercializationFinal.pdf

This paper highlights the importance of space commercialization in supporting the U.S. economy and national security architecture. The author argues that commercial outer space can promote economic growth, innovation, and strengthen national security. However, he cautions that changes in U.S. space policy would be required to realize space's potential in each of these domains. Divided into four parts, the paper discusses the importance of space to the United States, provides a brief history on the commercial uses of outer space, highlights future challenges, and offers policy recommendations. The author finds that with a "few smart decisions" and loose regulatory control over the space industry, the government can promote innovation, growth, and national security.

Global Space Industry Dynamics, Research Paper for Australian Government, Department of Industry, Innovation and Science by Bryce Space and Technology, LLC, (2017).

- https://brycetech.com/downloads/Global_Space_Industry_Dynamics_2017.pdf

This report gives an in-depth description of the global space economy as of 2016 in an effort identify lucrative space markets for Australian investment. The authors identify five trends in today's space economy and also highlight elements and attributes of the global space industry. Commercial space activities are dominated by services and products that satellites provide, but new commercial activities attracting investment include satellite servicing, space mining, space situational awareness, and in-space research and manufacturing. The report includes two helpful tables: one providing a snapshot of mature space markets, and the other a description of emerging space markets. The authors provide two appendices that outline core space technologies and define useful space terms and acronyms.

Sean Cate and Jesse Sloman, "Operating Under Constant Surveillance**,**" *Proceedings Magazine* Vol. 142/5/1, 359 (May 2016); published on *U.S. Naval Institute*.

- https://www.usni.org/magazines/proceedings/2016-05/operating-under-constant-surveillance

The authors suggest the enormous expansion of space-based communications and remote-sensing capabilities in the previous three years will force the military to rethink assumptions about detectability. They advise that U.S. military forces should prepare for a future of "constant surveillance." Additionally, the authors attribute the change primarily to what they characterize as an "extraordinary increase in miniature satellite capability," noting that these satellites offer capabilities comparable to traditional large satellites at a fraction of the size and cost. They predict that if current trends continue, within a decade it will be possible to employ commercial technology to image the entire Pacific Ocean several times a day with high levels of detail. One implication is that surface forces will need to shift their focus from making themselves difficult to detect to making themselves difficult to engage. To capitalize on the miniature satellite revolution, the authors call on DoD to heavily fund commercial miniature satellite companies while retaining an inventory of its own miniature satellites for space reconstitution.

Other General, Historical, or Technical Readings

David Wright, Laura Grego, and Lisbeth Gronlund, "The Physics of Space Security: A Reference Manual," (American Academy of Arts and Sciences, 2005).

- https://www.amacad.org/multimedia/pdfs/publications/researchpapersmonographs/Physics_of_Space_Security.pdf

This piece is a comprehensive reference manual on physical laws and technical facts related to space that is designed for a general audience. The authors describe the mechanics of satellite orbits and explain why certain operations are suited to particular orbits; they discuss the requirements for launching satellites into space and maneuvering them once in space; they consider the consequences of the space environment for basing certain military missions there; and they describe the elements of a satellite system and assess its vulnerabilities. They also include an analysis of technical measures for reducing satellite vulnerability. It incorporates several useful diagrams, tables, and graphs on topics such as: the inclination angle of orbits; the speed and altitude of satellites in circular orbits; and orbital speed versus altitude.

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