

BRUCE MCCLINTOCK, KRISTA LANGELAND, MICHAEL SPIRTAS

First Mover Typology for the Space Domain

Building a Foundation for Future Analysis

The defense community often uses terms that have multiple definitions, which can cause confusion and, in some cases, lead to poor decisions that can limit military effectiveness. One such term is *first mover*. Military planners and even senior leaders often use the term without first clarifying what they mean by *first mover* while explicitly or implicitly stating that there is an advantage to moving first. Clarifying the concept is especially important for military planning in the space domain. Here, the high level of technological competition, the potential for ambiguous intentions behind maneuvers in space, and the perceived offense dominance in this

domain make the discussion of when and whether to move first particularly salient. Further complicating the situation is that likely adversaries have their own lexicon and understanding of the concept. Before a meaningful discussion can be had on whether the United States or an adversary might consider exploiting a perceived first mover advantage (FMA) and how to prepare strategically for such a move, we need to first define what we mean by this phrase.

In this report, we recommend a common typology for the term *first mover* and a companion definition for the

KEY FINDING

- We propose the following typology for categorizing first moves: first to innovate and invest, first to reveal, first to maneuver, and first to employ. Each category of moves has its own objective or set of objectives; whether these objectives can be achieved by a first mover requires an understanding of the duration of a first mover advantage. A first mover advantage is measured relative to the expected outcome should the potential first mover instead wait, which, in turn, depends on expected adversary actions and responses.

RECOMMENDATIONS

- The existence of a first mover advantage should be considered relative to the circumstance; move type, duration, objectives, and adversary perceptions need to be considered in any strategic planning that seeks to procure a first mover advantage.
- More work is needed to understand the impact of being the first to employ, including building an understanding of the impact on U.S. space capabilities and U.S. ability to fight a terrestrial war.
- Adversary perceptions need to be considered to anticipate potential responses to a U.S. first move in space, and further work should focus on building an adversary-specific understanding of the concept of first mover advantage.

Abbreviations

ASAT	antisatellite
ASW	antisubmarine warfare
DARPA	Defense Advanced Research Projects Agency
DCR	deliberate capability revelation
FMA	first mover advantage
GPS	Global Positioning System
GSSAP	Global Space Situational Awareness Program
ISR	intelligence, surveillance, and reconnaissance
NSDM	National Security Decision Memorandum
RMA	Revolution in Military Affairs
RPO	rendezvous proximity operation
SATCOM	satellite communications

term *advantage* that can be used for military space planning and likely has utility across all domains.¹ Having a standardized typology will provide more-precise and more-productive discussions about the terminology and the considerations associated with the subsets of first moves. To provide clarity on the typology, we offer examples from the terrestrial domain and then examples for the space domain. We provide a specific focus on space because the military space community often uses the term *first mover*, and it may benefit more than others from the typology. We also offer a definition of *advantage* because many discussions focus on whether there is an inherent benefit to being the first mover. Although this report is intended to be an introduction to a more complex (and often classified) discussion regarding the concepts of first mover and advantage, it will not provide all the necessary analysis to fully investigate the typology and its implications for space warfare. Rather, this report is intended to provide a starting point for the more rigorous analysis and discussion that should follow.

First Mover Typology

Many in the space community who discuss first moves are discussing the actual employment of existing capabilities, usually implying that an adversary

that strikes first gains an advantage. For example, in 2020, General Jay Raymond said that the United States must “be able to meet the threat while reducing the first mover advantage” and “have the ability to punch back.”² Others use the term *first move* in a very different context—related to acquisition strategy or other factors.

To help clarify the term, we divide first moves into four categories that range from the longest term to the shortest term in terms of both objectives and time required to achieve those objectives. The four categories for first moves are as follows:

- first to innovate and invest
- first to reveal
- first to maneuver
- first to employ.

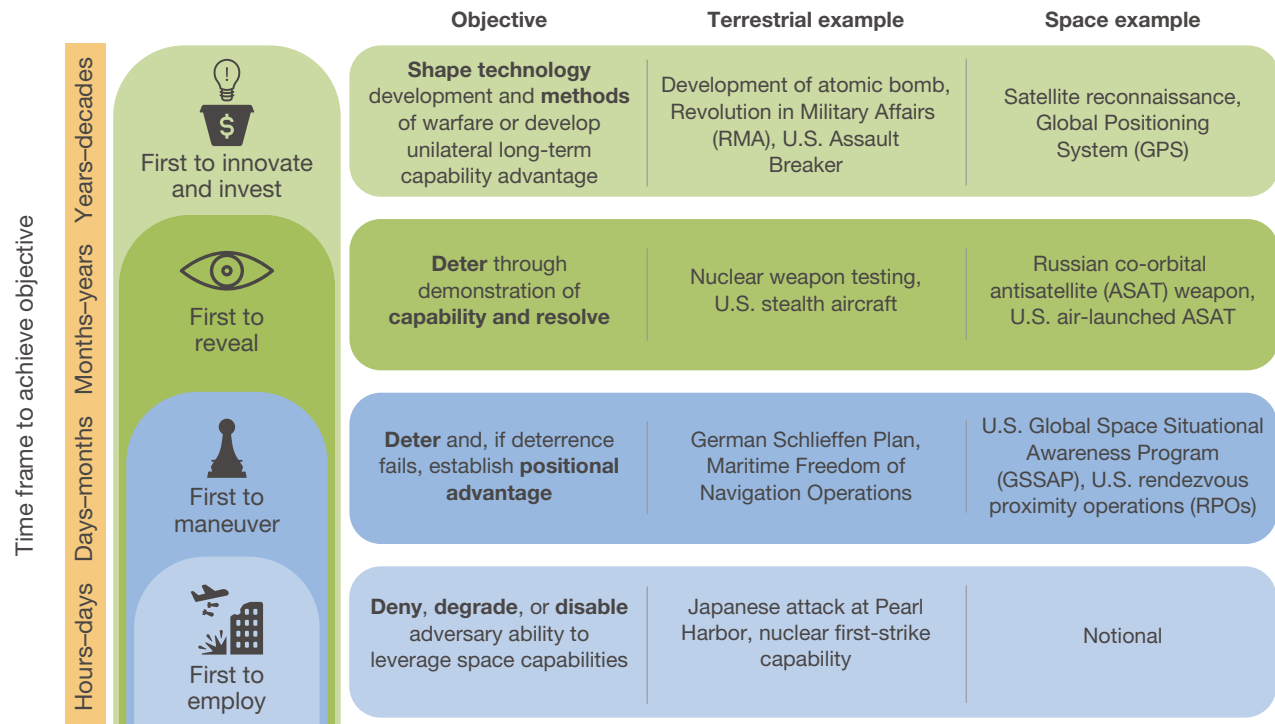
Figure 1 summarizes the four categories and examples from both terrestrial and, when available, space domains. The subsequent section provides a more-detailed description of each category and a short discussion of applications and implications for the typology.

First to Innovate and Invest

The most strategic subset of first moves applies to the actor that is first to innovate and invest in a new military capability and associated operational practices. Innovation, as discussed here, involves a shift in the way that militaries operate or plan to fight.³ This category takes the longest to implement and usually has the broadest objectives, such as transforming the methods of warfare or developing a significant military capability. For example, there is extensive academic literature on offense and defense dominance and the role of military innovation and arms races.⁴ For this move category, our emphasis is on the impact of the initial innovation and the investment in capability or *plans* to field innovative technology or capabilities. We maintain that the innovation and actual investment, regardless of whether a capability is fielded, are the heart of this category because history suggests that innovations and investments can affect adversary behavior even before a capability is operational. Two examples help justify this approach. First, Soviet Marshal Nikolai Ogarkov originally

FIGURE 1

First Mover Typology with Terrestrial and Space Examples



theorized in the 1970s and 1980s about a military technical revolution designed to transform the Soviet military into a smaller force based on advanced technology.⁵ However, it was the United States that heavily invested in a version of this concept; rebranded it RMA; and, eventually, first fielded related capabilities. RMA referred to the adoption of advanced technology and new operational concepts that led to a decisive military advantage.⁶ This example makes clear that mere innovation, such as that which Ogarkov demonstrated, is not an adequate definition of first move. On the other hand, there are examples that show that investment without actual fielding is enough to cause adversary actions. For example, the United States believed that the Soviet ASAT was operational before the Soviets considered it to be truly operational, and this belief affected U.S. planning.⁷

A related example of being the first to innovate and invest is the Defense Advanced Research Projects Agency (DARPA) Assault Breaker program from the late 1970s. DARPA integrated several technologies important for precision-guided munitions (PGMs) and established a technological foundation

for several smart-weapon systems that were fielded with high success. The program consisted of a wide variety of systems, including the Joint Surveillance Target Attack Radar System for integrating advanced intelligence, surveillance, and reconnaissance (ISR) systems with PGMs and the Brilliant Anti-Tank submunition used to detect and target tanks using acoustic sensors on its wings.⁸

For space, one of the most common examples of first to innovate and invest is GPS. GPS created multiple benefits for terrestrial life, including precision navigation and targeting for weapons mentioned earlier. More broadly, some authors claim that the benefits accrued from space capabilities, such as precision navigation from GPS, global satellite communications (SATCOM), and ISR “underpinned” the RMA that emerged in the decades after the Gulf War.⁹ An even earlier example is the U.S. fielding of the KH-11 satellite, launched by the National Reconnaissance Office in 1976, which provided the first instance of access to optical imagery in near real time.¹⁰

However, investing and innovating first does not necessarily result in the ultimate fielding of a

new capability, and the ability to adopt an innovation can be limited by institutional, economic, and political challenges. Furthermore, the fielding of any innovation or investment introduces the risk of being countered by adversaries through their own subsequent investments.¹¹ Some authors predicted as early as 1995 that adversaries could more cheaply offset U.S. advantages gained from innovations, such as GPS and SATCOM, through less costly jamming and interference.¹² Although not possible on a global scale, the routine use of GPS and SATCOM jamming in recent conflicts (albeit limited in time and space) demonstrates that adversaries have adapted to the first fielding of space capabilities. This latter point demonstrates the often transient nature of the advantage accrued from innovating or investing first in any domain, including space. Although a sustained advantage is possible, such sustainment may require significant effort because the information revealed supports an adversary's ability to respond.

First to Reveal

The first category of first moves consists of more strategic and sweeping advances in technology and capability that are usually more readily observable and therefore not subject to concealment designed to prevent an adversary response. In some cases, a specific capability is not readily apparent to an adversary. There are well-understood advantages of concealing a capability. If a capability is concealed, an adversary is not able to develop defenses, countermeasures, or similar systems. The second category of first moves, *first to reveal*, focuses on capabilities that can be developed in secret without an adversary's knowledge and requires a decision about whether and when to reveal a given capability. An objective for being the first to reveal could be to deter an adversary by demonstrating an asymmetric advantage.¹³ The advantage of moving first in this category is in influencing adversary military plans and investments by deterring them and shifting adversary focus to a response to the capability revealed.

Analysis of the concept of *deliberate capability revelation* (DCR) as a method to deter an adversary dates to at least the Cold War. A 1989 RAND Corporation report defined DCR as "intentional revelation

of authentic information about previously covert U.S. military capabilities with the aim of manipulating adversary military balance assessments."¹⁴ That report notes that "pre-crisis DCR would most likely be undertaken to reduce the enemy confidence in their own estimates of U.S. combat potential and thereby reduce their willingness to engage in combat." This report and others note that, for a deliberate DCR program to be successful, the United States would need to understand the enemy assessment system, have channels for revelations that are credible to the enemy, and have a well-developed process for balancing the uncertain costs and benefits of prospective revelations.¹⁵ The cited reports provide greater detail on the various advantages and disadvantages of being the first to reveal a previously concealed capability. In general, most analysts agree that there is some deterrent benefit to revealing a capability during competition. Deputy Secretary Robert Work once said: "We will reveal for deterrence, and we will conceal for war-fighting advantage."¹⁶ Revelations about U.S. advancement in antisubmarine warfare (ASW) during the Cold War is one example of a first-to-reveal approach for deterrence (or to shape adversary behavior). In this example, while shorter missile ranges pushed Soviet boats to operate relatively close to the United States toward the beginning of the Cold War, subsequent revelations of U.S. ASW technology motivated Soviet boats to modify this behavior and operate closer to their own shores rather than venture closer to the United States to hold targets at risk. Throughout the Cold War, the development of submarine technology and ASW shaped decisionmaking on what to conceal and reveal, and this example is studied in detail.¹⁷

The deterrent effect of a first-to-reveal move is very difficult to determine, however, and there are limitations to the ability of deliberate revelations to influence an adversary. Furthermore, once a capability is revealed, an adversary can develop countermeasures or its own similar capability, and either development would degrade any advantage the United States has gained through this first move to reveal.¹⁸ One example of this is the U.S. decision to be first to reveal the existence of stealth aircraft in 1980. The Russians and Chinese now possess similar capabilities in their own inventory and have found ways to reduce, but

not eliminate, the benefits of stealth technology.¹⁹ These advances might not be solely attributable to the U.S. decision to reveal stealth technology; however, it seems clear that adversaries might be motivated to accelerate their own similar capability developments or develop countermeasures based on actual reveals, illustrating the constraints on the duration of FMA for this move.²⁰ Being the first to reveal may not necessarily prompt a clear adversary response. The Russian demonstration of a co-orbital ASAT weapon was a DCR; however, the United States continued to decide against the pursuit of a new ASAT program on numerous occasions before this approach shifted in 1977 with NSDM 345. Although the United States openly developed an air-launched ASAT that was famously tested in 1985 to destroy the defunct Solwind satellite, it is not clear that this was in response to the Soviet reveal of its own ASAT capability, and, in fact, this connection has been disputed.²¹ Beyond the scope of this report but important for further analysis are the timelines between revelations and an adversary response, either with a counter to the revealed capability or with a similar capability.

First to Maneuver

The next category of first moves is the *first to maneuver*. This category is much more immediate than the other two categories, but it is not instantaneous and does not yet require actual employment of weapons. The objective of being the first to maneuver is achieving a positional advantage over an adversary in a manner that either deters them or forces them to reconsider their own posture. A classic example of the first-to-maneuver concept is the German Schlieffen Plan, wherein Germany envisioned moving quickly against France before turning the German Army against Russia prior to World War I.²² A recent book about cyber conflict used this analogy and noted: “The plan’s success would be predicated on Germany’s ability to mobilize and move its armies quicker than France and much faster than Russia could.”²³ More-recent examples of first to maneuver are available in the space domain. Both Russia and the United States have conducted on-orbit maneuvers of systems designed to perform satellite surveillance missions, RPOs, or maneuvers to test or in prepara-

tion for co-orbital ASAT attacks. Russia has been conducting a series of RPO activities in low Earth orbit since at least 2013. A 2019 test of some Russian satellites also may have tested a co-orbital ASAT.²⁴ For its part, the United States has been maneuvering on-orbit surveillance satellites since at least 2014. The United States uses GSSAP to conduct surveillance and RPO with space objects of interest, and Russian, Chinese, and even independent space observers closely watch the U.S. GSSAP satellites.²⁵

First to maneuver is important in many cases because the first to maneuver may be establishing conditions for the first actual strike. Although RPO activities for the sole purpose of surveillance may not be a first to maneuver for such a purpose, these moves could be perceived as pre-positioning for an attack and, therefore, as a means to deter. Indeed, China’s People’s Liberation Army likely views counterspace operations as a means to deter the United States from intervention in a regional conflict.²⁶ One author notes that these capabilities pre-positioned in space could be a game-changing threat seeking to deter U.S. intervention in a regional crisis by “demonstrating that its space stalkers could almost simultaneously attack several critical satellites from such a close proximity that the US would not have time to save them.”²⁷

First to Employ

The final category of first moves, and often the one that speakers mean, is the *first to employ*. The objective of being the first to employ is the most immediate of the first moves categories; the first mover seeks to obviate or limit the ability of an adversary to respond. For example, first to employ could include comprehensive, multidomain attacks on a wide variety of targets, such as ones in the home territory of the adversary, and may include the use of nuclear weapons. The Russian Strategic Operations to Destroy Critically Important Targets (SODCIT) is an example of military thinking about a first employment (although the available literature does not necessarily discuss SODCIT in a first-to-employ capacity).²⁸ There is also extensive Cold War literature on *first-strike capability* in nuclear war, which refers to the ability to carry out a devastating attack

on the adversary that would leave them unable to retaliate, a circumstance that can be highly destabilizing and could tempt an adversary to “use or lose” its nuclear arsenal.²⁹

Another example of first to employ is the attack on Pearl Harbor. On December 7, 1941, Japan conducted a surprise attack on the U.S. Pacific Fleet at Pearl Harbor and two nearby naval and military airfields.³⁰ Although a successful first employment, it is worth noting that “the shock and anger that Americans felt in the wake of the attack on Pearl Harbor united the nation and was translated into a collective commitment to victory in World War II.”³¹ *First employment* can also refer to *how* forces are employed, “the art and science of employing forces on the battlefield.”³² A first tactical move can come with risks, and an example here is the United States’ use of daylight, high-altitude, unescorted precision bombing early in World War II.³³ The United States first sent in unescorted bombers, which led to a large number of combat losses, although the United States responded to these losses by correcting their tactics and sending in long-range escort fighters on later missions.³⁴

There are examples of first to employ in space depending on what we include in the overall categorization of employment. Counterspace threats are usually grouped into reversible and irreversible categories and along a continuum that the U.S. Defense Intelligence Agency describes as follows:

The counterspace continuum represents the range of threats to space-based services, arranged from reversible to nonreversible effects. Reversible effects from denial and deception and [energy weapons] are nondestructive and temporary, and the system can resume normal operations after the incident. Directed energy weapons (DEW), cyberspace threats, and orbital threats can cause temporary or permanent effects. Permanent effects from kinetic energy attacks on space systems, physical attacks against space-related ground infrastructure, and nuclear detonation in space would result in degradation or physical destruction of a space capability.³⁵

Wargames provide the most fodder for advocates of being the first to employ. Remarks such as those

from General Raymond imply, and some openly claim, that allowing an adversary to be the first to employ in space would undermine the U.S. ability to defend its own space systems and potentially have an adverse impact on U.S. ability to exploit space for terrestrial warfighting. Although recent results are not openly available, various space leaders do openly discuss the U.S. reliance on space and have done so since the so-called *first space war* over 30 years ago.³⁶ Many refer to the First Gulf War as the *first space war* because of U.S. exploitation of space capabilities. “Many of the space capabilities initially deployed at the time, such as the Global Positioning System, have become vital components to how the United States currently conducts military operations.”³⁷

Definition of Advantage

The typology presented here provides a framework for categorizing first moves. The typology does not make assumptions about whether a given move is advisable. To inform that analysis, one must be clear about how one defines the related term *advantage*. We define this term as achieving a better condition or more favorable circumstance. But we need to be explicit about what we are measuring this against. Advantage is often thought to be measured relative to position of the adversary. But an advantage procured by moving first needs to be measured relative to the expected outcome if the potential first mover instead decides *not* to move. An FMA can increase the advantage a first mover already has over their adversary, can build an advantage that is not there if they do not move first, or could lessen a disadvantage relative to an adversary. In other words, we are not trying to answer the question, “are we better off than the adversary?” but instead trying to answer the question, “are we better off going first?” More work is needed to fully define the practical military cases in which an advantage is accrued and whether it is long-lasting.

The above definition can be made more explicit using the language of game theory. In game theory, an FMA exists if, by moving first, a player achieves a better outcome than they would expect from moving simultaneously with their opponent.³⁸ An observ-

able first move informs the adversary and prompts a response from them in reaction to this move. Such a first move essentially shifts the scenario from one in which either side is waiting and guessing what the other is going to do into one in which the first move is known and the second mover reacts: sequential rather than simultaneous decisionmaking. A key feature here is the knowledge each player has of the other's move. Functionally, in a simultaneous game, neither player has a priori knowledge of the other player's move. In a sequential game, the second mover *does* have some knowledge of the first mover's choice and will decide on their own move with this extra knowledge.

The following factors should be considered when assessing a potential FMA: observability of the move, sharing of information, and shifting second-mover responses. The above scenario for a first move requires that this first move can be detected by the opponent, which necessarily gives the opponent additional information. In some cases, this additional information may motivate the opponent to take a different action in a way that favors the first mover. However, it will not always be the case that this additional information shifts the opponent's decision-making to benefit the first mover. In some circumstances, the second mover may have an advantage because of this additional information, highlighting the importance of understanding adversary perceptions and expected responses to a first move when attempting to determine whether such a first move could provide an advantage.

Implications and Recommendations for Future Analysis

As we noted, this report is intended to be an introduction to a more complex (and often classified) discussion regarding the concepts of *first mover* and *advantage*. Having an agreed-upon framework for first mover discussions that requires policymakers and analysts to clarify to which category or categories of first moves they refer will help focus the conversation and improve the quality of the analysis and discussion. There is substantially more work that needs

to be done overall and within each category that is beyond the scope of this short report. To provide a starting point for the more-rigorous analysis and discussion that should follow, we offer some suggestions on areas for further study.

First, this report offered some basic examples from terrestrial and space domains to clarify the various categories. We do not attempt to identify generalizable findings for particular categories or across terrestrial and space domains that would be useful to understand. Further research is needed to determine whether there are generalizable findings across domains or for the space domain and whether the examples provided here (and others) tell us anything useful about FMAs in future space employment. Some of this work could be done using open sources, but the more rigorous research would need to be done at higher classification levels.

Second, there is much more work to be done in the area of first to employ. In this report, we briefly touched on the distinction between reversible and irreversible employment as well as tactical versus more-operational employment of space weapons.³⁹ More analysis is needed in this area, both in terms of the impact on U.S. space capabilities and the resulting impact on terrestrial warfighting capability.

Finally, it is important to consider how a given adversary thinks about similar concepts and how they would perceive U.S. moves in any of the selected categories. It is likely that China and Russia would behave differently when faced with a variety of U.S. first moves in space and would also weigh making a first move, especially being the first to employ, differently. For example, it is already widely accepted that Russia is much less dependent on space and, as their 2020 destructive ASAT test showed, less concerned with international repercussions regarding the long-term sustainability of space for their own needs.⁴⁰ On the other hand, China is steadily growing more capable and, by extension, more dependent on space capabilities and therefore less likely, outside of heightened political tensions, to take an action in space (such as a first employment) that could result in unintended escalation or loss of their own space capabilities. Clearly, more work is needed in this area focused on specific adversaries and scenarios.⁴¹

Notes

¹ RAND has done extensive research on this and related topics. See especially Karl P. Mueller, Jasen J. Castillo, Forrest E. Morgan, Negeen Pegahi, and Brian Rosen, *Striking First: Pre-emptive and Preventive Attack in U.S. National Security Policy*, RAND Corporation, MG-403-AF, 2006. Also see Forrest E. Morgan, *Deterrence and First-Strike Stability in Space: A Preliminary Assessment*, RAND Corporation, MG-916-AF, 2010.

² Charles Pope, “Driven by ‘a Tectonic Shift in Warfare’ Raymond Describes Space Force’s Achievements and Future,” Secretary of the Air Force International Affairs, webpage, September 15, 2020.

³ See the discussion on military innovation in Michael C. Horowitz and Shira Pindyck, “What Is a Military Innovation and Why It Matters,” *Journal of Strategic Studies*, March 22, 2022. Mechanisms of military innovation are discussed in Moritz Weiss, “How to Become a First Mover? Mechanisms of Military Innovation and the Development of Drones,” *European Journal of International Security*, Vol. 3, No. 2, 2018.

⁴ A few prominent examples of offense and defense dominance include Robert Jervis, “Cooperation Under the Security Dilemma,” *World Politics*, Vol. 30, No. 2, 1978; Keir A. Lieber, “Grasping the Technological Peace: The Offense-Defense Balance and International Security,” *International Security*, Vol. 25, No. 1, 2000; Charles L. Glaser and Chaim Kaufmann, “What Is the Offense-Defense Balance and Can We Measure It?” *International Security*, Vol. 22, No. 4, 1998; and Stephen Van Evera, *Causes of War: Power and the Roots of Conflict*, Cornell University Press, 1999. For more information on military innovation in arms races, see, for example, Stephen Peter Rosen, *Winning the Next War: Innovation and the Modern Military*, Cornell University Press, 1991; Samuel P. Huntington, *Arms Races: Prerequisites and Results*, Federation of American Scientists Public Interest Report, February 1987; and Horowitz and Pindyck, 2022.

⁵ For further information on the military technical revolution, see Andrew F. Krepinevich, Jr., *The Military-Technical Revolution: A Preliminary Assessment*, Center for Strategic and Budgetary Assessments, 2002.

⁶ William S. Cohen, *Annual Report to the President and the Congress*, Department of Defense, 1999, p. 122. *Technology push* referred to an aspect of RMA wherein a promising new technology results in the development of a new weapon system or operational concept that enables a new mission to be performed. Also see Christopher Nelson, Andrew Krepinevich, and Barry Watts, “The Last Warrior: Andrew Marshall and the Shaping of Modern American Defense Strategy,” *Naval War College Review*, Vol. 68, No. 2, 2015.

⁷ Similarly, Moscow contemplated various asymmetric responses to American missile defense systems that were not yet operational. Thanks to Dr. Aaron Bateman for these examples.

⁸ “Assault Breaker,” webpage, Defense Advanced Research Projects Agency, undated.

⁹ Matthew Mowthorpe, “The Revolution in Military Affairs (RMA): The United States, Russian and Chinese Views,” *Journal of Social, Political, and Economic Studies*, Vol. 30, No. 2, 2005.

¹⁰ For a description of KH-11, see National Reconnaissance Office, “DEVELOP, ACQUIRE, LAUNCH, OPERATE,” brochure, 2022.

¹¹ For further discussion of RMA, see Andrew Bernard Silverstein, *Revolutions in Military Affairs: A Theory on First Mover Advantage*, thesis, University of Pennsylvania, April 1, 2013. See also Glenn Buchan, *The Impact of the Revolution in Military Affairs on Developing States’ Military Capability*, RAND Corporation, P-7926, 1995, p. 16.

¹² This aligns with the *second-mover advantage* discussed in Alexander Gerschenkron, *Economic Backwardness in Historical Perspective: A Book of Essays*, Belknap Press, 1962. This concept is also discussed in business development literature. One such example notes that “creating a product is costly, both in terms of the money invested and the mistakes made on the path to success. While the pioneer pays a steep price in creating the product category, the later entrant can learn from the experience of the pioneer, enjoying lower costs and making fewer mistakes as a result” (Venkatesh Shankar and Gregory Carpenter, “The Second Mover Advantage: A Primer on How Late-Entering Companies Can Compete with Pioneers,” Kellogg School of Management at Northwestern University, November 4, 2013). Related research discusses the potential benefits of a fast second mover as providing a strategic advantage over moving first because this approach can leverage the dominant product design emerging from the first mover and still be part of shaping the dominant design (see Constantinos C. Markides and Paul A. Geroski, “Fast Second,” Harvard Management Update, *Harvard Business Review*, February 26, 2008).

¹³ The revelation of U.S. stealth aircraft is used as an example for terrestrial “first to reveal,” but it is important to note that there may be objectives other than deterrence for this move, including domestic political ones.

¹⁴ Kevin Lewis, *Getting More Deterrence Out of Deliberate Capability Revelation*, RAND Corporation, N-2873-AF, 1989.

¹⁵ In addition to Buchan, 1995, see Thomas G. Mahnken, *Selective Disclosure: A Strategic Approach to Long Term Competition*, Center for Strategic and Budgetary Assessments, 2020; and Brendan Rittenhouse Green and Austin Long, “Conceal or Reveal? Managing Clandestine Military Capabilities in Peacetime Competition,” *International Security*, Vol. 44, No. 3, 2020.

¹⁶ Dan Lamothe, “The Killer Robot Threat: Pentagon Examining How Enemy Nations Could Empower Machines,” *Washington Post*, March 30, 2016.

¹⁷ Green and Long, 2020, pp. 63–82.

¹⁸ The development of adversary countermeasures is noted, for example, in the now-declassified National Security Decision Memorandum (NSDM) 345 from 1977 directing the development of a U.S. ASAT capability, dictating that “to avoid stimulating Soviet actions to counter electronically U.S. high altitude COMINT [communications intelligence] and ELINT [electronic intelligence] collectors, the ‘fact of’ a U.S. electronic anti-satellite capability should be classified” (“U.S. Anti-Satellite Capabilities,” National Security Decision Memorandum 345, National Security Council, January 18, 1977).

¹⁹ See description of China stealth aircraft capabilities in Office of the Secretary of Defense, *Military and Security Developments*

Involving the People's Republic of China, Annual Report to Congress, 2021. Russia has developed its Su-57 aircraft, but this aircraft appears to be more in line with fourth-generation fighters rather than fifth-generation stealth aircraft. See description of both China's J-20 and Russia's Su-57 in "Top 10 Fighter Aircraft," Military Today, website, undated.

²⁰ Dmitry Adamsky, "The Art of Net Assessment and Uncovering Foreign Military Innovations: Learning from Andrew W. Marshall's Legacy," *Journal of Strategic Studies*, Vol. 43, No. 5, 2020. See also John T. Correll, "History of Stealth: From Out of the Shadows," *Air & Space Forces Magazine*, September 1, 2019.

²¹ The panel ordered by President Gerald Ford in 1975 to reexamine U.S. ASAT weapons policy, overseen by American physicist Solomon Buchsbaum, produced recommendations that led to the miniature homing vehicle test and specifically stated that the weapons policy was not in response to the Soviet ASAT program. Further discussion of these ASAT capabilities can be found in Brian Weeden and Victoria Samson, eds., *Global Counterspace Capabilities: An Open Source Assessment*, Secure World Foundation, April 2020, p. 01-12.

²² It is important to note that the Schlieffen Plan was constructed such that launching the plan also meant starting the war. There was not an option for mobilization without employment built into the plan. For this reason, while the example is one often cited as a first to maneuver, it also reflects a decision to initiate the conflict rather than explicitly maneuvering to deter.

²³ Francis J. Gavin, "Crisis Instability and Preemption: The 1914 Railroad Analogy," in George Perkovich and Ariel Levite, eds., *Understanding Cyber Conflict: 14 Analogies*, Carnegie Endowment for International Peace, October 16, 2017.

²⁴ Weeden and Samson, 2020, pp. 02-06–02-07.

²⁵ Weeden and Samson, 2020, pp. 01-06–01-08.

²⁶ Defense Intelligence Agency, *Challenges to Security in Space: Space Reliance in an Era of Competition and Expansion*, 2022.

²⁷ Brian Chow, "China's New Space Threat and the Justification of US Pre-Emptive Self-Defense," *Space Review*, January 18, 2016.

²⁸ Timothy L. Thomas, *Russian Military Thought: Concepts and Elements*, MITRE, product MP190451V1, August 2019, p. 8-6.

²⁹ For discussion of first- and second-strike capability in the nuclear realm, see, for example, Thomas C. Schelling, *Arms and Influence*, Yale University Press, 1966; and Richard K. Betts, *Nuclear Blackmail and Nuclear Balance*, Brookings Institution Press, 1987. There is debate in the nuclear field about the wisdom of having a *no first use* policy to promote stability. For example, see Michael S. Gerson, "The Future of U.S. Nuclear Policy: The Case for No First Use," *International Security*, policy brief, February 2011.

³⁰ "Pearl Harbor Attack, 7 December 1941," Naval History and Heritage Command, webpage, undated.

³¹ "Pearl Harbor Attack, 7 December 1941," undated. A further discussion of the availability of surprise and the impact of this on an FMA can be found in Richard K. Betts, *Surprise Attack: Lessons for Defense Planning*, Brookings Institution Press, 1982.

³² Dennis M. Drew and Donald M. Snow, *Making Strategy: An Introduction to National Security Processes and Problems*, Air University Press, 1988, p. 20.

³³ Williamson Murray, "Strategic Bombing, the British, American and German Experiences," in Williamson Murray and Allan R. Millett, eds., *Military Innovation in the Interwar Period*, Cambridge University Press, 1996, pp. 122–127.

³⁴ Drew and Snow, 1988, p. 20.

³⁵ Defense Intelligence Agency, 2022, p. 3.

³⁶ The United States has recognized this dependence on space since the 1960s; it was the subject of interagency deliberations in the 1970s via the Buchsbaum study.

³⁷ "Remembering the First 'Space War': A Discussion with Lt. Gen. B. Chance Saltzman," Brookings Institution, March 19, 2021.

³⁸ In this case, moving simultaneously does not necessarily mean moving at the same time; instead, it means moving without prior knowledge of the opponent's move. Thus, it is defined by the information a player has and is not necessarily distinguished by time. For a description of the construct of sequential games, see Heinrich von Stackelberg, *Marktform und Gleichgewicht*, J. Springer, 1934. In these so-called *Stackelberg games*, a firm makes decisions sequentially rather than simultaneously, with the second mover observing the choice of the first mover and choosing their best action accordingly. See further discussion on sequential games in Lucía Martínez Ordóñez, *Military Operational Planning and Strategic Moves*, Springer, 2017.

³⁹ Recognizing that the concept of a space weapon is not always clear, we define *space weapons* here as "things intended to cause harm that are based in space or that have an essential element based in space." This definition is based on Bob Preston, Dana J. Johnson, Sean J. A. Edwards, Michael Miller, and Calvin Shipbaugh, "Kinds and Capabilities of Space Weapons," in *Space Weapons, Earth Wars*, RAND Corporation, MR-1209-AF, 2002, pp. 23–50.

⁴⁰ Russia's destruction of Cosmos 1408 created a field of at least 1,500 pieces of trackable debris. See Shannon Bugos, "Russian ASAT Test Creates Massive Debris," *Arms Control Today*, December 2021. Pavel Luzin notes that "Russia's economy is less dependent on space infrastructure than that of America or China." See Pavel Luzin, "Russia Is Behind in Military Space Capabilities, but That Only Drives Its Appetite," *Defense News*, April 2, 2020.

⁴¹ China has been increasing investments in space infrastructure and sees space as playing a key role in its growth. State Council Information Office of the People's Republic of China, *China's Space Program: A 2021 Perspective*, January 28, 2022.

⁴² See comments from Chief of Space Operations Gen. Jay Raymond in Pope, 2020. See also comments from Lt. Gen. Saltzman in Sandra Erwin, "Space Force Official: Satellites in Orbit Have Become Pawns in Geopolitical Chess Games," *SpaceNews*, November 29, 2021.

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About This Report

The concept of *first mover advantage* is used often by military planners without clarification about what it means to move first or what sort of advantage such a first move is expected to provide to the mover. In space, there is often a perceived offense dominance that provides a first mover advantage to an adversary, and senior policymakers have highlighted reducing this advantage as an explicit goal.⁴² To help build an understanding of when and whether exploitation of this concept should be considered in a broader military strategy, as well as when an adversary may consider such exploitation, the authors of this report seek to provide more-explicit definitions of what these first moves are and what objectives are sought with each. Furthermore, they seek to provide an explicit definition of *advantage* that distinguishes between the expected outcome should a mover wait versus the expected outcome should they move first. This foundational typology is intended to be a base for further analysis, and their recommendations reflect the nuanced view required to determine whether engaging in a first move indeed provides an advantage.

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