Standoff Over the LRSO: Assessing the long-range stand-off missile's impact on strategic stability

Brandon W. Heimer[1]

While there is consensus in the executive branch and Congress regarding the need to recapitalize the U.S. nuclear weapons enterprise, the delivery system and W80–4 warhead proposed to comprise the long-range stand-off (LRSO) missile have generated considerable debate. Much of the public debate has focused on its potential to affect strategic stability. This paper seeks to elucidate both Russian and Chinese perspectives on strategic stability and apply them to a systematic analysis of how the LRSO might either enhance or diminish strategic stability for the purpose of better informing the decision-making process rather than advocate a particular position on this issue.

INTRODUCTION

The U.S. nuclear deterrent is aging. Both weapons and delivery platforms across all three legs of the triad are nearing the ends of their design life.[2] Realizing the critical role of a safe, secure, and effective nuclear deterrent in U.S. national security, the Obama administration initiated a plan to modernize U.S. nuclear forces across the 2017-2046 period at a cost of approximately $400 billion.[3] The ongoing modernization effort spans the entire U.S. nuclear triad consisting of land-based intercontinental ballistic missiles (ICBMs), submarine-launched ballistic missiles (SLBMs), and bomber aircraft armed with gravity bombs and air-launched cruise missiles (ALCMs).[4] Together, these three legs provide U.S. nuclear forces with responsiveness (ICBM), survivability (SLBM), and flexibility (gravity

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[1] Brandon W. Heimer is a senior member of the technical staff, Systems Analysis and Engineering, Sandia National Laboratories, Livermore, California. Sandia National Laboratories is a multimission laboratory managed and operated by National Technology and Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International, Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525. The author would like to express his appreciation to the Center for Strategic and International Studies for the opportunity to participate in the Nuclear Scholars Initiative and to Sandia National Laboratories for its support during the NSI experience. At SNL, thanks are due to Drs. Jarret Lafleur, Paul Nielan, and Jason Reinhardt, Mr. Mike Keifer, Mr. Anthony Juarez, and Mr. Janson Wu. Thanks are also due to Dr. Justin Anderson at National Defense University for his mentorship and feedback on this research.

[2] *U.S. Strategic Forces Posture: Testimony before the Subcommittee on Strategic Forces*, 114th Cong. (2016) (statement of Cecil Haney, Former Commander, U.S. Strategic Command).

[3] The Congressional Budget Office estimates the total cost of the plans for nuclear forces in this timeframe to be $1.2 trillion. Congressional Budget Office, *Approaches for Managing the Costs of U.S. Nuclear Forces, 2017 to 2046*, (Washington, DC: Government Printing Office, 2017), https://www.cbo.gov/system/files/115th-congress-2017-2018/reports/53211-nuclearforces.pdf.

[4] Department of Defense, *Nuclear Posture Review Report*, (Washington, DC: Government Printing Office, 2018), https://media.defense.gov/2018/Feb/02/2001872886/-1/-1/1/2018-NUCLEAR-POSTURE-REVIEW-FINAL-REPORT.PDF.

bombs & ALCM). The air delivered leg, under the 2018 Nuclear Posture Review (NPR), is comprised of the B61 and B83 gravity bombs and the AGM-86B ALCM. Gravity bombs are released from a bomber aircraft and fall to their targets. Cruise missiles fly guided, low-altitude trajectories at nominally constant speed which give them the unique ability to strike precisely from long distances rather than having to be released nearly above their targets. These attributes allow defense planners to hold distant, high-value targets at risk without putting pilots' lives at risk, particularly in denied airspace. Relative to ballistic missile systems, nuclear air-launched cruise missiles are flexible, recallable, serve as a hedge against failure in either of those two legs, and are not susceptible to anti-ballistic missile systems.

The AGM-86B ALCM equipped with the W80–1 nuclear warhead is one of several legacy systems requiring replacement.[5] The ALCM is currently twenty-six years beyond its original design life.[6, 7] As such, the United States Air Force (USAF) issued a request for proposal on 29 Jul 2016 for a nuclear air-launched cruise missile replacement, the long-range stand-off (LRSO) missile, as part of the nuclear forces modernization effort.[8] The USAF subsequently awarded contracts on 23 Aug 2017 for $900 million each to Lockheed and Raytheon for technology maturation and risk reduction (TMRR) development tasks.[9] These contracts terminate in FY2022 when the engineering and manufacturing development phase is expected to begin.[10] Little is known about the LRSO's attributes in the open literature and press; however, the USAF has announced its intent to begin fielding the missile in the late 2020s on B-52H, B-2A, and B-21 aircraft.[11, 12, 13] The current USAF

[5] "AGM-86B/C/D Missiles," U.S. Air Force, 2010, http://www.af.mil/About-Us/Fact-Sheets/Display/Article/104612/agm-86bcd-missiles/.
[6] Ibid. The ALCM became operational in December 1982 with a ten-year design life.
[7] Air Force Nuclear Weapons Center, *AF Releases Request for Proposal* (Kirtland Air Force Base, NM: U.S. Air Force, 2016), http://www.af.mil/News/Article-Display/Article/881056/af-releases-request-for-proposal-for-nuclear-air-launched-cruise-missile-replac/.
[8] Ibid.
[9] Air Force Nuclear Weapons Center, *USAF Awards Contracts for New Nuclear Missile to Lockheed, Raytheon* (Kirtland Air Force Base, NM: U.S. Air Force, 2017), http://www.af.mil/News/Article-Display/Article/1287616/usaf-awards-contracts-for-new-nuclear-missile-to-lockheed-raytheon/.
[10] "Department of Defense Fiscal Year (FY) 2018 Budget Estimates, Research, Development, Test & Evaluation, Airforce, Vol-II," Department of Defense, May 2017, http://www.saffm.hq.af.mil/Portals/84/documents/Air%20Force%20Research,%20Development,%20Test%20and%20Evaluation%20Vol-II%20FY18.pdf?ver=2017-05-23-160041-060.
[11] Air Force Nuclear Weapons Center, *USAF Awards Contracts for New Nuclear Missile to Lockheed, Raytheon* (Kirtland Air Force Base, NM: U.S. Air Force, 2017), http://www.af.mil/News/Article-Display/Article/1287616/usaf-awards-contracts-for-new-nuclear-missile-to-lockheed-raytheon/.
[12] Air Force Nuclear Weapons Center, *AF Releases Request for Proposal* (Kirtland Air Force Base, NM: U.S. Air Force, 2016), http://www.af.mil/News/Article-Display/Article/881056/af-releases-request-for-proposal-for-nuclear-air-launched-cruise-missile-replac/.
[13] The U.S. Air Force reports the B-21 Raider will begin replacing B-2 Spirit aircraft beginning in the mid-2020s at Dyess, Ellsworth, and Whiteman Air Force Bases. Secretary of the Air Force Public Affairs, *Air Force selects locations for B-21 aircraft* (Washington, D.C.: U.S. Air Force, 2018), http://www.af.mil/News/Article-Display/Article/1510408/air-force-selects-locations-for-b-21-aircraft/.

plan is to acquire approximately 1,000 LRSO cruise missile bodies and field a number equivalent to the current ALCM nuclear force.[14]

STRATEGIC STABILITY FOUNDATIONS

The United States, Russian Federation, and People's Republic of China have all expressed their desire for stable strategic relations.[15] However, since the beginning of the nuclear age, the United States and Soviet Union/Russian Federation agreed only one time, articulated in the Joint Statement of [June] 1990, that "Strategic stability was understood as such a balance of strategic forces of the USSR and the U.S. (or such state of the two powers' strategic relations) where there were no incentives for a first-strike."[16] Despite this momentary agreement, perspectives on strategic stability have diverged to the point that both now disagree on its definition and requirements.[17]

Traditional American Perspective

Derived largely from the seminal work of Thomas Schelling, the traditional American conception of strategic stability is comprised of two elements: crisis and arms race stability.[18] Crisis stability is most frequently understood to mean, "[The absence of perceived or actual incentives] to use nuclear weapons first out of the fear that the other side is about to do so."[19, 20] Each leader involved in the crisis would be expected to make such decisions considering the vulnerability of his strategic forces to his opponent's.[21] In this conception, "Crisis stability differs from first-strike stability in that the former includes each leader's perception—influenced by emotional and psychological stress, miscalculation, and disinformation—of desperate alternatives in a crisis. Therefore, crisis instability includes first-strike instability, which along with many other factors might feed

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[14] Department *of Defense Nuclear Acquisition Programs and the Nuclear Doctrine: Testimony before the Subcommittee on Strategic Forces*, 115th Cong. (2017) (statement of Robin Rand, Commander, Air Force Global Strike Command).
[15] Department of Defense, *Ballistic Missile Defense Review Report*, (Washington, DC: Government Printing Office, 2010), https://www.defense.gov/Portals/1/features/defenseReviews/BMDR/BMDR_as_of_26JAN10_0630_for_web.pdf.
[16] From the U.S.-Soviet Joint Statement on the Treaty on Strategic Offensive Arms of 1990.
[17] Brad Roberts, *The Case for U.S. Nuclear Weapons in the 21st Century*, (Stanford, CA: Stanford University Press, 2016), 120-121.
[18] James M. Acton, "Reclaiming Strategic Stability," in *Strategic Stability: Contending Interpretations*, ed. Elbridge A. Colby and Michael S. Gerson (Carlisle, PA: Strategic Studies Institute and U.S. Army War College Press, 2013), 121.
[19] Thomas C. Schelling, *The Strategy of Conflict* (Cambridge, MA: Harvard University, 1960).
[20] James M. Acton, "Reclaiming Strategic Stability," in *Strategic Stability: Contending Interpretations*, ed. Elbridge A. Colby and Michael S. Gerson (Carlisle, PA: Strategic Studies Institute and U.S. Army War College Press, 2013), 121.
[21] Glenn A. Kent et al., *First-Strike Stability: A Methodology for Evaluating Strategic Forces*, R-3765-AF, (Santa Monica, CA: RAND, 1989).

crisis stability." [22, 23] For the purpose of this analysis, only first-strike stability will be considered because the human element additionally involved in crisis stability is unpredictable and subject to many variables; rigorously quantifying these is beyond the scope of the current work. The second element in the traditional conception, arms race stability, may be taken to mean, "The absence of perceived or actual incentives to augment a nuclear force—qualitatively or quantitatively—out of the fear that in a crisis an opponent would gain a meaningful advantage by using nuclear weapons first." [24, 25]

Contemporary American Perspectives

The United States has offered extended deterrence commitments to allies and partners for nearly seventy years in the form of its nuclear umbrella to advance its nuclear nonproliferation goals. Since the end of the Cold War, the world has seen the United States' conventional military superiority challenged and China rise as a great power.[26] Some have argued the American conception of strategic stability needs to be reconsidered in light of these. One such definition was articulated by Elbridge Colby, "Strategic stability should be understood to mean a situation in which no party has an incentive to use nuclear weapons *save for vindication of its vital interests in extreme circumstances*…As in the classic understanding of first-strike stability, a stabilizing force posture should both be demonstrably survivable and exhibit restraint such that an opponent does not fear excessively for the effectiveness of his retaliatory capability."[27] This conception emphasizes that nuclear use in a strategically stable relationship would necessarily need to be limited, discriminate, and restrained. Crucially, such use would communicate a leader's resolve and willingness to escalate further if necessary. Force postures under this conception would, therefore, need to provide the capability to execute discriminate and limited nuclear strikes as well as an assured, massive, retaliatory strike. Colby further emphasizes the need for an "assured ability to penetrate even sophisticated air defenses and accurately and reliably deliver a lower-yield weapon to target."[28]

Russian Perspective

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[22] Ibid.
[23] Robert Powell, "Crisis Stability in the Nuclear Age," *American Political Science Review* 83, no. 1 (March 1989): 61, https://doi.org/10.2307/1956434.
[24] James M. Acton, "Reclaiming Strategic Stability," in *Strategic Stability: Contending Interpretations*, ed. Elbridge A. Colby and Michael S. Gerson (Carlisle, PA: Strategic Studies Institute and U.S. Army War College Press, 2013), 121.
[25] James M. Acton, *Deterrence During Disarmament: Deep Nuclear Reductions and International Security* (Abingdon, UK: Routledge, 2011).
[26] Andrew F. Krepinevich, Jr., "The Pentagon's Wasting Assets: The Eroding Foundations of American Power," *Foreign Affairs* 88, no.4 (July/August 2009): 18-33.
[27] Elbridge A. Colby, "Defining Strategic Stability: Reconciling Stability and Deterrence," in *Strategic Stability: Contending Interpretations*, ed. Elbridge A. Colby and Michael S. Gerson (Carlisle, PA: Strategic Studies Institute and U.S. Army War College Press, 2013), 55.
[28] Elbridge A. Colby, "Defining Strategic Stability: Reconciling Stability and Deterrence," in *Strategic Stability: Contending Interpretations*, ed. Elbridge A. Colby and Michael S. Gerson (Carlisle, PA: Strategic Studies Institute and U.S. Army War College Press, 2013), 67.

Strategic stability, in the narrow sense, has traditionally been viewed as a state of "rough parity" between the U.S. and Soviet/Russian military potentials.[29, 30] This conception is best represented by the definition of strategic stability articulated in the Joint Statement of 1990. Under this conception, the incentives for a first-strike are reduced. Therefore, nuclear use is less likely in a strategically stable relationship resulting in a lower risk of war. In contrast to the American view comprised solely of crisis and arms race stability, Russians subscribe to a second broader understanding of strategic stability that encompasses the collective "political, economic, military, and other measures implemented by the states."[31] This disjoint leads to differences in the perceived threat posed by advances in conventional weapons because, through the Russian lens, this affects the strategic balance even though the strategic *nuclear* balance remains unchanged.

A second Russian conception of strategic stability relies less on "rough parity" with the United States. Rather, "It instead focuses more on leveraging Russia's nuclear deterrent as a trump card to prevent what it perceives as bullying with respect to its core interests, especially in the post-Soviet space."[32] In this view, Russian nuclear forces need to maintain capabilities that ensure it remains a credible deterrent.

Numerous factors have been specifically identified as affecting strategic stability: [33, 34]

1. Survivability of strategic offensive arms,
2. Anti-ballistic missile (ABM) systems,
3. Conventional precision guided weapons including conventional prompt global strike (CPGS),
4. Nuclear weapons of third countries,
5. Tactical nuclear arms,
6. Space weapons, and
7. Anti-submarine warfare (ASW).

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[29] Matthew Rojansky, "Russia and Strategic Stability," in *Strategic Stability: Contending Interpretations*, ed. Elbridge A. Colby and Michael S. Gerson (Carlisle, PA: Strategic Studies Institute and U.S. Army War College Press, 2013), 306.
[30] Alexei Arbatov et al., *Strategic Stability after the Cold War*, (Moscow: Institute of World Economy and International Relations Russian Academy of Sciences, 2010), http://www.nuclearsecurityproject.org/uploads/publications/STRATEGICSTABILITYAFTERTHECOLDWAR_020211.pdf.
[31] Ibid.
[32] Matthew Rojansky, "Russia and Strategic Stability," in *Strategic Stability: Contending Interpretations*, ed. Elbridge A. Colby and Michael S. Gerson (Carlisle, PA: Strategic Studies Institute and U.S. Army War College Press, 2013), 306.
[33] Ibid.
[34] Alexei Arbatov et al., *Strategic Stability after the Cold War*, (Moscow: Institute of World Economy and International Relations Russian Academy of Sciences, 2010), http://www.nuclearsecurityproject.org/uploads/publications/STRATEGICSTABILITYAFTERTHECOLDWAR_020211.pdf.

Most of these factors relate directly to mutual vulnerability. Some experts assert that such mutual vulnerability provides the "basis for [U.S.-Russian] strategic stability."[35] The dynamics existing among these factors as they relate to vulnerability to strategic offensive arms are shown in Figure 1.

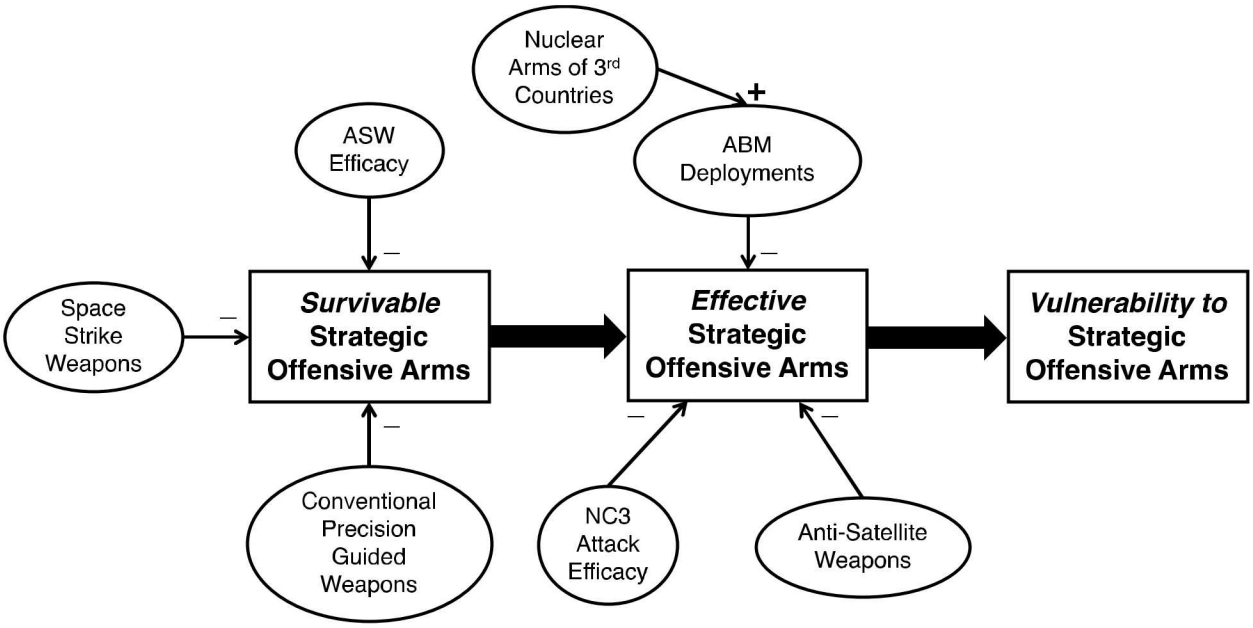

Figure 1. System diagram showing the dynamics of factors affecting the survivability and effectiveness of strategic offensive arms. Here, "survivable" means an assured, retaliatory nuclear capability and "effective" means that a weapon can produce desired effects on target when called upon by the command authority. In this diagram, an increase in a variable residing within a round node either increases (+) or decreases (–) the variable value at the end of the connecting arrow. For example, an increase in the number or quality of strategic nuclear arms of 3rd countries will likely lead to an increase in ABM system deployments which, in turn, decreases the effectiveness, or perceived effectiveness, of an adversary's incoming strategic offensive arms.

Chinese Perspective

China, like Russia, embraces both broad and narrow interpretations of strategic stability.[36] Both U.S. and Chinese experts suggest Americans tend to favor a narrow view focused on "the strategic offense/defense equation" whereas the Chinese prefer a broader view encompassing "the broader strategic environment."[37] Under the broader view, Chinese experts see nuclear weapons as only one element affecting the bilateral, strategic

[35] James N. Miller Jr. et al., *Navigating Dangerous Pathways: A Pragmatic Approach to U.S.-Russian Relations and Strategic Stability*, (Washington, DC: Center for a New American Security, 2018), https://www.cnas.org/publications/reports/navigating-dangerous-pathways.
[36] Ralph Cossa et al., *A Realistic Way Forward for the U.S.-China Strategic Nuclear Relationship*, (Beijing: Pacific Forum CSIS, 2018), https://www.csis.org/analysis/issues-insights-vol-18-cr1-realistic-way-forward-us-china-strategic-nuclear-relationship.
[37] Ibid.

relationship between great powers.[38] Consequently, they advocate for "grand strategic stability" encompassing a stable nuclear deterrence relationship as well as cooperation on nuclear nonproliferation objectives and interdependence in civilian nuclear energy.[39] Working productively toward such an objective may "gradually establish a framework for long-term cooperation, rather than confrontation."[40, 41]

A constructive U.S.-China relationship would rely more significantly on crisis-avoidance and mitigation than formal treaty processes.[42] The Chinese also call for statements of U.S. intent, a bilateral no-first-use policy, and an explicit statement by the United States accepting mutual vulnerability with China as the basis for strategic stability.[43] Chinese expert Wu Riqiang also argues that "enhancing the survivability of China's nuclear weapons would be beneficial for U.S.-China strategic stability.[44]

ARGUMENTS REGARDING LRSO'S IMPACT ON STRATEGIC IN/STABILITY

Arguments regarding LRSO's potential to either enhance or diminish strategic stability were identified from the ongoing debate within the United States, with this analysis surveying expert assessments from the military (current and retired), U.S. Department of Defense, U.S. Department of Energy, U.S. Department of State, members of Congress, and think tanks. The purpose was to ensure inclusion of diverse perspectives.

Implications for Crisis Stability

The air leg of the strategic nuclear triad was afforded special counting rules under New START because it is believed to be the least destabilizing leg of the triad: each bomber aircraft, regardless of loadout, is counted as only one accountable unit.[45] The rationale for such significant discounting was that neither the United States nor Russia maintain their bomber force (i.e., the aircraft that would potentially deliver a nuclear-capable cruise

[38] Lu Yin, "Reflections on Strategic Stability," in *Understanding Chinese Nuclear Thinking*, ed. Li Bin and Tong Zhao (Washington, DC: Carnegie Endowment for International Peace, 2016), 129.
[39] Lu Yin, "Reflections on Strategic Stability," in *Understanding Chinese Nuclear Thinking*, ed. Li Bin and Tong Zhao (Washington, DC: Carnegie Endowment for International Peace, 2016), 130.
[40] Ibid.
[41] Ralph Cossa et al., *A Realistic Way Forward for the U.S.-China Strategic Nuclear Relationship*, (Beijing: Pacific Forum CSIS, 2018), https://www.csis.org/analysis/issues-insights-vol-18-cr1-realistic-way-forward-us-china-strategic-nuclear-relationship.
[42] Ralph Cossa et al., *A Realistic Way Forward for the U.S.-China Strategic Nuclear Relationship*, (Beijing: Pacific Forum CSIS, 2018), https://www.csis.org/analysis/issues-insights-vol-18-cr1-realistic-way-forward-us-china-strategic-nuclear-relationship.
[43] Ibid.
[44] Wu Riqiang, *Issues in Sino-US Nuclear Relations: Survivability, Coercion and Escalation*, (London: Foreign & Commonwealth Office, 2013), https://www.gov.uk/government/publications/issues-in-sino-us-nuclear-relations-survivability-coercion-and-escalation.
[45] New Strategic Arms Reduction Treaty, U.S.-Rus., Apr. 8, 2010, U.S.T. 11-205.

missile) on day-to-day alert.[46] Further, the B-52H and B-2 long-range bombers fly at sub-sonic speeds requiring multiple hours for intercontinental flight, which stands in contrast to ballistic missile systems having significantly shorter flight times. Bomber aircraft range limitations additionally require either aerial refueling (from non-stealthy KC-135 Stratotanker aircraft) or basing proximate to theatre. As such, rich signature sets (e.g., aircraft generation, weapon loadout, aerial refueling, and bomber basing) and relatively long delay times associated with the air leg of the triad offer detection and signaling opportunities, as well as additional time for a crisis to be resolved without the use of force.[47, 48, 49, 50] Former Senior Director for Defense Policy and Arms Control on the National Security Council staff, Franklin Miller, a proponent of the LRSO, argues that, for these reasons, neither U.S. nor Russian doctrine regards the air-delivered leg as a first-strike weapon.[51] Therefore, the LRSO is unlikely to pose a threat of a disarming strike to either Russia or China.[52, 53, 54] They further contend that the capability of nuclear armed cruise missiles to hold "high value targets at risk in an evolving threat environment, including targets deep within an area denied environment" *maintains stable deterrence*.[55, 56] Having an updated, modern missile may be necessary to maintain a credible deterrent effect if adversaries do not believe the current ALCM is survivable against modern, or future, integrated air defense systems (IADS).

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[46] Eric Schmitt, "Bush's Arm Plan; Cheney Orders Bombers Off Alert, Starting Sharp Nuclear Pullback," *New York Times*, September 29, 1991, http://www.nytimes.com/1991/09/29/world/bush-s-arm-plan-cheney-orders-bombers-off-alert-starting-sharp-nuclear-pullback.html.
[47] Ibid.
[48] *Hearing to Review Budget Requirements & Justification for the Nuclear Cruise Missile: Testimony before the Subcommittee on Energy and Water Development*, 114th Cong. (2016) (statement of John Hamre, Former Deputy Secretary of Defense).
[49] *Hearing to Review Budget Requirements & Justification for the Nuclear Cruise Missile: Testimony before the Subcommittee on Energy and Water Development*, 114th Cong. (2016) (statement of Rose Gottemoeller, Former Undersecretary of State for Arms Control and International Security, U.S. Department of State).
[50] *Hearing to Review Budget Requirements & Justification for the Nuclear Cruise Missile: Testimony before the Subcommittee on Energy and Water Development*, 114th Cong. (2016) (statement of Robert Scher, Former Assistant Secretary of Defense for Strategy, Plans and Capabilities, U.S. Department of Defense).
[51] *Hearing to Review Budget Requirements & Justification for the Nuclear Cruise Missile: Testimony before the Subcommittee on Energy and Water Development*, 114th Cong. (2016) (statement of Franklin Miller, Former Special Assistant to President George W. Bush and Senior Director for Defense Policy and Arms Control on the National Security Council).
[52] *Hearing to Review Budget Requirements & Justification for the Nuclear Cruise Missile: Testimony before the Subcommittee on Energy and Water Development*, 114th Cong. (2016) (statement of John Hamre, Former Deputy Secretary of Defense).
[53] *Hearing to Review Budget Requirements & Justification for the Nuclear Cruise Missile: Testimony before the Subcommittee on Energy and Water Development*, 114th Cong. (2016) (statement of Rose Gottemoeller, Former Undersecretary of State for Arms Control and International Security, U.S. Department of State).
[54] *Hearing to Review Budget Requirements & Justification for the Nuclear Cruise Missile: Testimony before the Subcommittee on Energy and Water Development*, 114th Cong. (2016) (statement of Robert Scher, Former Assistant Secretary of Defense for Strategy, Plans and Capabilities, U.S. Department of Defense).
[55] *Department of Defense Nuclear Acquisition Programs and the Nuclear Doctrine: Testimony before the Subcommittee on Strategic Forces*, 115th Cong. (2017) (statement of Robin Rand, Commander, Air Force Global Strike Command).
[56] "Debate: Modernization of Nuclear Missiles," Center for Strategic & International Studies, video, 1:28:45, May 23, 2017 (statement of C. Robert Kehler, former Commander, U.S. Strategic Command), https://www.csis.org/events/debate-modernization-nuclear-missiles.

Critics argue that, in a crisis or conflict, the LRSO could be used in a role "beyond deterrence" to initiate a "tactical" nuclear war which may escalate to a major, nuclear exchange.[57, 58, 59] While little is known about the LRSO's attributes, some have speculated it may utilize stealth technology.[60, 61] When paired with a stealthy, penetrating bomber such as the B-2 or B-21 in development, the LRSO may create the possibility of a no-warning nuclear strike. Faced with this possibility, the capability of a delivery platform to carry both conventional and nuclear forces may create warhead ambiguity for adversaries leading to unintended nuclear war.[62, 63, 64] A related argument is that it is redundant and unnecessary to deploy both a stealthy, penetrating bomber and a stealthy stand-off missile together.[65] This argument, however, is predicated on the assumption that such bomber aircraft will be able to indefinitely penetrate denied airspace and drop gravity bombs on target despite adversaries' sustained investments in anti-access/area denial (A2/AD) technologies and strategies.[66]

Implications for Arms Race Stability

The LRSO is being proposed as a replacement for the nuclear capable AGM-86B the United States has had for three decades. No new military capability is being created within the

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[57] William J. Perry and Andy Weber, "Mr. President, Kill the New Cruise Missile," *Washington Post*, October 15, 2015, https://www.washingtonpost.com/opinions/mr-president-kill-the-new-cruise-missile/2015/10/15/e3e2807c-6ecd-11e5-9bfe-e59f5e244f92_story.html?utm_term=.b802f34f2f08.
[58] Dianne Feinstein and Adam Smith, *Cancel the New Nuclear Cruise Missile*, (San Francisco, CA: Ploughshares Fund, 2016), https://www.ploughshares.org/issues-analysis/article/cancel-new-nuclear-cruise-missile.
[59] Ed Markey, "Markey, Senators Introduce Legislation to Limit Spending on Nuclear War-Fighting Missiles," las modified March 8, 2017, https://www.markey.senate.gov/news/press-releases/markey-senators-introduce-legislation-to-limit-spending-on-nuclear-war-fighting-missiles.
[60] "USAF to Launch LRSO and B-52 Integration in 2019," Jane's by IHS Markit, April 10, 2018, http://www.janes.com/article/79170/usaf-to-launch-lrso-and-b-52-integration-in-2019.
[61] "Just How New is the New, Nuclear-armed Cruise Missile?" Union of Concerned Scientists, January 13, 2016, https://allthingsnuclear.org/syoung/the-new-cruise-missile.
[62] Ed Markey, "Markey, Senators Introduce Legislation to Limit Spending on Nuclear War-Fighting Missiles," las modified March 8, 2017, https://www.markey.senate.gov/news/press-releases/markey-senators-introduce-legislation-to-limit-spending-on-nuclear-war-fighting-missiles.
[63] William J. Perry and Andy Weber, "Mr. President, Kill the New Cruise Missile," *Washington Post*, October 15, 2015, https://www.washingtonpost.com/opinions/mr-president-kill-the-new-cruise-missile/2015/10/15/e3e2807c-6ecd-11e5-9bfe-e59f5e244f92_story.html?utm_term=.b802f34f2f08.
[64] "Debate: Modernization of Nuclear Missiles," Center for Strategic & International Studies, video, 1:28:45, May 23, 2017 (statement of Christine Parthemore, CEO and Founder, CLP Global), https://www.csis.org/events/debate-modernization-nuclear-missiles.
[65] "Debate: Modernization of Nuclear Missiles," Center for Strategic & International Studies, video, 1:28:45, May 23, 2017 (statement of Jon Wolfsthal, Associate, Project on Managing the Atom, Harvard University), https://www.csis.org/events/debate-modernization-nuclear-missiles.
[66] Frank Rose, "Five Myths About a Controversial Nuclear Weapon," War on the Rocks, last modified June 20, 2017, https://warontherocks.com/2017/06/five-myths-about-a-controversial-nuclear-weapon/.

nuclear explosive package as defined by the U.S. Department of Defense.[67] The program of record only calls for refurbishing the existing W80 warhead.[68]
The LRSO complies with all U.S. commitments under the New START and Intermediate-Range Nuclear Forces (INF) Treaties.[69, 70] It may also be used as a bargaining chip in future arms reductions negotiations.[71] In the shorter term, the LRSO advances U.S. non-proliferation objectives by enabling the United States to carry out its extended deterrence commitments particularly if bomber aircraft are unable to penetrate denied airspace to drop gravity bombs.[72, 73] The flexible options afforded by the LRSO allow the United States to deter limited nuclear attacks on its allies and partners.[74] The LRSO will be the single weapon system maintaining the nuclear cruise missile capability following the U.S. Navy's retirement of the nuclear Tomahawk Land Attack Missile (TLAM-N) until the sea-launched cruise missile (SLCM) proposed as a supplementary capability in the 2018 NPR is fielded.[75] Assuring allies that the United States has a credible nuclear option to respond to an attack on their territory provides for their security without having to develop their own nuclear arsenals and, therefore, promotes stability.

Will Saetren argues that what really matters in this debate is "how America's nuclear posture is perceived by potential adversaries."[76] If Russia and China perceive the LRSO as a threat capable of evading their air defenses, each may choose to invest in new capabilities

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[67] Office of the Deputy Assistant Secretary of Defense for Nuclear Matters, "Chapter 5: Stockpile Management, Processes, and Organizations," in *Nuclear Matters Handbook 2016* (Washington, DC: US Department of Defense, 2016), 62. OSD Nuclear Matters defines a capability as "new" if "the design of one or more of the nuclear components (within the nuclear explosive package—the pit or the secondary, either individually or together) was neither previously produced or tested nor based on previously tested designs. The use of newly manufactured non-nuclear components does not cause a nuclear weapon to be considered new."
[68] "W80-4 Life Extension Program," National Nuclear Security Administration, 2018, https://www.energy.gov/sites/prod/files/2018/05/f51/W80-4%20LEP%20factsheet%202018.pdf.
[69] *Hearing to Review Budget Requirements & Justification for the Nuclear Cruise Missile: Testimony before the Subcommittee on Energy and Water Development*, 114th Cong. (2016) (statement of Rose Gottemoeller, Former Undersecretary of State for Arms Control and International Security, U.S. Department of State).
[70] *Hearing to Review Budget Requirements & Justification for the Nuclear Cruise Missile: Testimony before the Subcommittee on Energy and Water Development*, 114th Cong. (2016) (statement of John Hamre, Former Deputy Secretary of Defense).
[71] Ibid.
[72] *Hearing to Review Budget Requirements & Justification for the Nuclear Cruise Missile: Testimony before the Subcommittee on Energy and Water Development*, 114th Cong. (2016) (statement of Franklin Miller, Former Special Assistant to President George W. Bush and Senior Director for Defense Policy and Arms Control on the National Security Council).
[73] *Hearing to Review Budget Requirements & Justification for the Nuclear Cruise Missile: Testimony before the Subcommittee on Energy and Water Development*, 114th Cong. (2016) (statement of Robert Scher, Former Assistant Secretary of Defense for Strategy, Plans and Capabilities, U.S. Department of Defense).
[74] Ibid.
[75] Department of Defense, *Nuclear Posture Review Report*, (Washington, DC: Government Printing Office, 2010), https://www.defense.gov/Portals/1/features/defenseReviews/NPR/2010_Nuclear_Posture_Review_Report.pdf.
[76] Will Saetren, "Five Facts About a Controversial Nuclear Weapon," War on the Rocks, last modified August 10, 2017, https://warontherocks.com/2017/08/five-facts-about-a-controversial-nuclear-weapon/.

to counter it.[77] Further, each may develop its own nuclear, offensive capability to "offset the perceived advantage that the LRSO has given the United States."[78] The successive development of offensive and defensive capabilities initiated by the deployment of LRSO would, therefore, constitute arms race instability.

ANALYSIS OF STRATEGIC STABILITY IMPACTS

The plurality of Russian and Chinese perspectives on strategic stability most consistently articulate mutual vulnerability to nuclear forces as the basis for strategic stability. The United States formally accepts mutual vulnerability between itself and Russia. While the U.S. government does not formally recognize mutual vulnerability with China, a 2009 Council on Foreign Relations task force on U.S. nuclear weapons policy concluded that "mutual vulnerability with China—like mutual vulnerability with Russia—is not a policy choice to be embraced or rejected, but rather a strategic fact to be managed with priority on strategic stability."[79] If that statement is accurate, the question becomes, "Does the LRSO threaten mutual vulnerability by enabling the United States to successfully execute a disarming first-strike?" Given the delay and rich signature sets associated with the air delivered leg of the triad, it seems highly unlikely the LRSO would provide a capability that makes a disarming first-strike more possible or attractive.

Modern American perspectives on strategic stability provide reasoning for the use of nuclear weapons to "[defend vital U.S.] interests in extreme circumstances."[80] Under this conception, nuclear weapons are intended to be instruments of "violent signaling" that may be used discriminately and demonstrating restraint in response to an adversary's limited strikes. The LRSO would likely be one weapon considered to provide flexible options in such employment. This issue of "limited" nuclear use and its ramifications are the subjects of another, ongoing debate and will not be addressed here beyond stating there is no guarantee that escalation to a major nuclear exchange could be avoided beyond first use. Engaging with both Russia and China to establish reliable communication channels as well as to develop shared understanding of each other's policy and intent may alleviate potential instability in such a crisis.

The prospect of a completely unexpected strike without warning seems possible when a stealthy bomber aircraft may be used to deliver a stealthy weapon. However, as stated above, bomber range limitations require aerial refueling from non-stealthy tanker aircraft or deployment to bases within range of theatre which itself may be observable. Context

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[77] "Debate: Modernization of Nuclear Missiles," Center for Strategic & International Studies, video, 1:28:45, May 23, 2017 (statement of Christine Parthemore, CEO and Founder, CLP Global), https://www.csis.org/events/debate-modernization-nuclear-missiles.
[78] Will Saetren, "Five Facts About a Controversial Nuclear Weapon," War on the Rocks, last modified August 10, 2017, https://warontherocks.com/2017/08/five-facts-about-a-controversial-nuclear-weapon/.
[79] Charles Ferguson et al., *U.S. Nuclear Weapons Policy*, (New York, NY: Council of Foreign Relations, 2009), https://cfrd8-files.cfr.org/sites/default/files/report_pdf/Nuclear_Weapons_TFR62.pdf.
[80] Elbridge A. Colby, "Defining Strategic Stability: Reconciling Stability and Deterrence," in *Strategic Stability: Contending Interpretations*, ed. Elbridge A. Colby and Michael S. Gerson (Carlisle, PA: Strategic Studies Institute and U.S. Army War College Press, 2013), 55.

also matters for plausibility. U.S. nuclear use would only be considered in "extreme circumstances" such as following a significant strategic attack; at which point, the parties in conflict would undoubtedly be expending significant resources to ascertain the readiness condition of each other's strategic forces. Further, one side may deliberately choose to mobilize strategic forces to signal resolve. Therefore, it begins to seem less plausible that a peer or near-peer nation state would be surprised by a nuclear attack or would misinterpret a conventional air-launched cruise missile as a nuclear one. The historical record may support this conclusion. There has been no reported instance where a U.S. launched conventional air-launched cruise missile (CALCM) was misinterpreted to be nuclear despite over 100 CALCMs being employed across no fewer than five military operations from 1991 through 2003.[81] However, it is important to note these CALCMs were not used in a conflict with Russia, China, or another nuclear State.

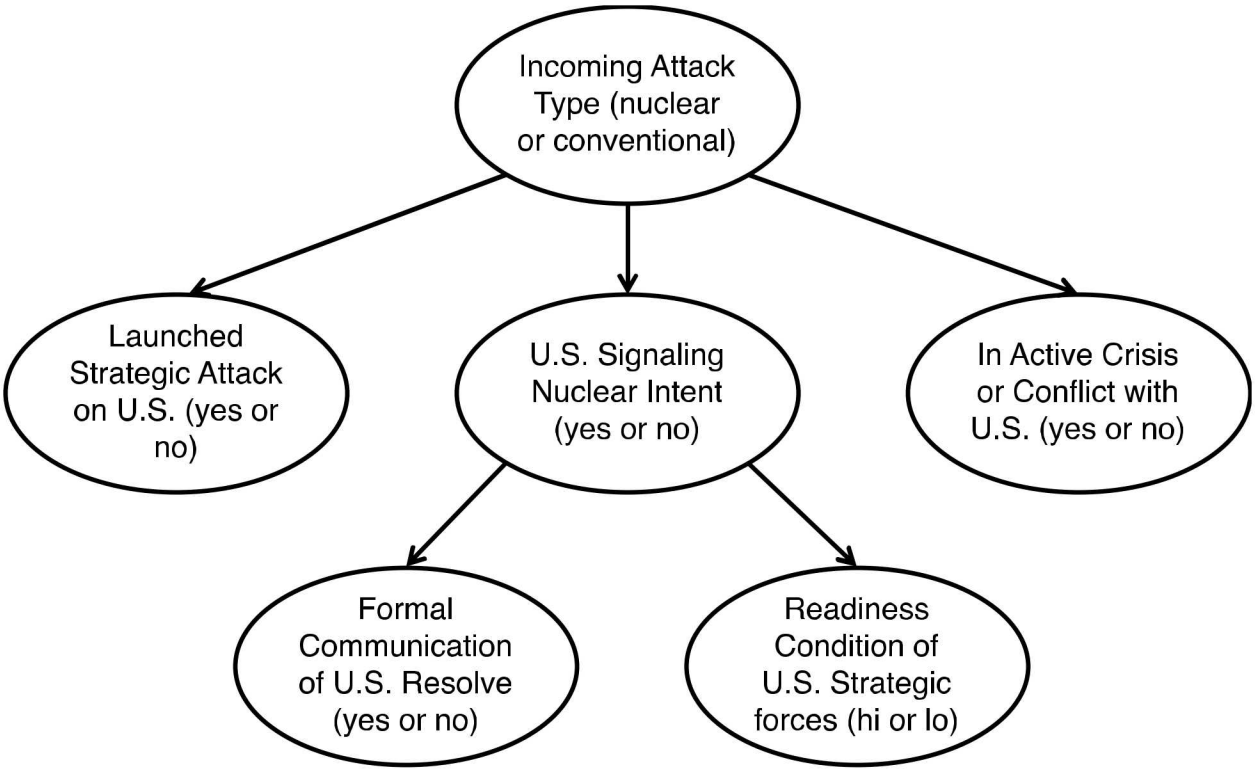

Figure 2. Notional Bayesian network to assess the probability than an incoming U.S. bomber or missile is nuclear. The diagram is presented from the perspective of an adversary that "sees" inbound U.S. forces. Realizations for each variable are shown in parentheses following the variable name.

Both of these issues, (1) interpreting the mission of an inbound stealth bomber and (2) discriminating cruise missile warhead type, are inference problems. Figure *2* presents a notional Bayesian network that shows how these variables may affect an adversary's belief that the attack will be nuclear. Arrows show conditional dependence between variables residing within the ovals. For example, the first link is read as "what is the probability an

[81] Operation Desert Storm (1991); Operation Desert Strike (1996); Operation Desert Fox (1998); Operation Allied force (1999); and Operation Iraqi Freedom (2003).

incoming U.S. bomber or missile is nuclear given that 'I' recently launched a strategic attack against the United States." This framework shows how numerous factors may be interpreted collectively. If the United States has not been attacked by a strategic weapon, has not alerted its strategic forces to a high readiness condition, is currently prosecuting an unrelated, conventional conflict (e.g., a campaign against Al-Qaeda or ISIS) and is not involved in a crisis or conflict with a peer nation, it seems highly unlikely a flying stealth bomber is executing a nuclear first-strike mission. The converse may be also be true. If the United States is engaged in a conflict with a peer nation, has sustained a strategic attack from that nation, generated strategic bomber aircraft, and communicated intent, it may be reasonable to believe the incoming strike is nuclear. The extremes these scenarios represent are inherently the most certain. Cooperation between nations to prevent miscommunication and misperception will be most important to address the range in between where uncertainty is the greatest.

USSTRATCOM Commander Gen. John Hyten said, in reference to the analogous high-yield versus low-yield discrimination problem for SLBMs, he would not immediately recommend a massive nuclear response if he detected a limited number (one or two) of inbound missiles realizing they do not pose an existential threat to the United States.[82] With this public statement, he may be implicitly suggesting that other nations follow a similar course of action when confronted with a warhead discrimination problem. Establishing a "wait and see" norm for some situations could promote stability by reducing the danger of misinterpretation and unintended escalation resulting from a potentially ambiguous missile employment.

It is unclear whether the proposed LRSO has or will inspire either Russia or China to develop similar systems or countermeasures. It has been reported that, as of late 2017, Russia is upgrading its heavy bomber aircraft to be able to carry the Kh-102 air-launched cruise missile.[83] Due to the more advanced state of the Russian nuclear modernization effort, it is doubtful this missile is a direct response to LRSO. However, if the LRSO is similar enough to the Kh-102, Russia may believe these two missiles maintain the strategic balance thereby promoting stability and choose not develop additional arms in response. The extent of China's recent developments makes it difficult, if not impossible, to determine whether any particular system is a response to LRSO or not. Given the value China places on mutual vulnerability, it may feel compelled to develop new systems (defensive or offensive) if it believes the survivability of its strategic forces are threatened by the LRSO. The Russians may follow a similar course of action and augment air defense capabilities if they believe the LRSO could similarly threaten the credibility of their nuclear deterrent.

CONCLUSION

[82] *Hearing to Receive Testimony on United States Strategic Command in Review of the Defense Authorization Request for Fiscal Year 2019 and the Future Years Defense Program*, 115th Cong. (2018), https://www.armed-services.senate.gov/imo/media/doc/18-28_03-20-18.pdf.
[83] Hans M. Kristensen, "Russian Nuclear Forces: Buildup or Modernization?" Russia Matters, last modified September 14, 2017, https://www.russiamatters.org/analysis/russian-nuclear-forces-buildup-or-modernization.

Mutual vulnerability to strategic forces seems to remain the *de facto* foundation for strategic stability across the U.S.-Russia and U.S.-China dyadic relationships.

- This work has suggested the bomber force tasked with delivering the LRSO is characterized by relatively long flight times and rich signature sets which make its use inconsistent with the requirements for a disarming first-strike. Therefore, the LRSO would not be expected to disrupt mutual vulnerability by making a disarming strike more possible or attractive.
- Even if a stealthy air-launched cruise missile is paired with a stealth bomber aircraft, the signatures associated with bomber generation and aerial refueling from non-stealth tanker aircraft make it unlikely the LRSO could be launched against a peer or near-peer nation-state without advance warning.
- To the extent a nuclear armed air-launched cruise missile deters would-be U.S. adversaries from nuclear use, maintaining a *survivable* weapon system is crucial for maintaining that stable deterrent effect. A modern stand-off weapon and stealth delivery platform increase the probability this capability will be maintained in the future against other nations' increasingly capable A2/AD systems.
- The LRSO has been touted as a flexible option to deter, or conduct should deterrence fail, limited nuclear strikes pursuant to Russia's reported "escalate-to-deescalate" doctrine. The concept of limited nuclear use is still intensely debated, and there is no guarantee that escalation could be controlled even with tailored LRSO employment.
- The challenge of warhead discrimination has not historically led to a nuclear response to a cruise missile launch, but there is no guarantee that cannot change. Having accurate military intelligence coupled with discerning analysis of the context in which cruise missiles are employed (e.g., how escalated is the conflict, how many missiles have been launched, have there been signatures of strategic force mobilization, or has the nuclear threshold been crossed?) will likely be essential for reducing the danger of misperception. Developing norms and/or communication channels in the aforementioned dyadic relationships may also further these ends.

In sum, this work has identified and analyzed many of the major arguments in the debate regarding the LRSO's impact on strategic stability. During this study and survey of other nation's conceptions of strategic stability, it became clear that the LRSO is neither inherently stabilizing or destabilizing; rather, it is one instrument in addition to unambiguous U.S. policy, clear messaging, and signaling of intent that may promote stability by reducing the risk of miscalculation and unintended escalation.