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The Center for Strategic and Budgetary Assessments is an independent, nonpartisan policy research institute established to promote innovative thinking and debate about national security strategy and investment options. CSBA's analysis focuses on key questions related to existing and emerging threats to U.S. national security, and its goal is to enable policymakers to make informed decisions on matters of strategy, security policy, and resource allocation.

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Cover: Pershing II intermediate-range ballistic missiles. U.S. Army photo.

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Executive Summary

On February 1, 2019, the United States announced the suspension of its participation in the Intermediate-Range Nuclear Forces Treaty (INF) due to Russia's long-running violations of the treaty, made apparent by its deployment of the INF-non compliant Novator 9M729 (NATO designation: SSC-8) ground-launched cruise missile. The suspension began a six-month countdown that may culminate in the full U.S. withdrawal from the treaty. As of February 2, the United States was free to test or deploy its own ground-launched ballistic and cruise missiles with INF-banned ranges between 500 and 5,500 km. China currently has thousands of ground-launched theater-range missiles that threaten U.S. and allied operations in the Indo-Pacific, and Russia likely has at least one hundred that similarly threaten operations throughout Eurasia. To date, the United States has none.

Should the United States withdraw fully from the treaty, it would be within its rights to bring into service entire classes of weaponry that have been off limits for decades. Options that were hitherto unavailable for strategists would become viable, creating new operational opportunities. This study argues that fielding conventionally armed ground-launched theater-range missiles with ballistic, cruise, and boost-glide trajectories holds substantial operational and strategic value to the United States and its allies in a post-INF world. To be clear, this study does not consider the utility of nuclear-armed missiles, which present considerations distinct from those of conventional weapons and are beyond the scope of this report.

Operationally, ground-launched theater-range missiles could hold high-value enemy targets at risk while helping U.S. air and naval forces obtain access to hotly contested battlefields, thereby contributing to military operations in challenging warfighting scenarios. Strategically, ground-launched theater-range missiles could force adversaries to invest in costly missile defense and targeting systems and increase U.S. bargaining leverage in future arms control talks, provided they are meaningful ones. They would also help to reassure U.S. allies in times of crisis or conflict by providing a survivable force that could ride out a conventional first strike and retain sufficient combat power for a protracted fight. These expected operational and strategic dividends could arrest, if not reverse, the erosion of longstanding American military advantages, enhance warfighting, shore up the U.S. competitive position, and ultimately strengthen deterrence, the cornerstone of U.S. global strategy.

Several strategists and policymakers, however, have voiced serious concerns over a U.S. decision to field ground-launched theater-range missiles that should be considered. First, some assert that the deployment of U.S. ground-based missiles would trigger a new arms race. While this could conceivably intensify the competition between the United States and its rivals, China and Russia have already fielded multiple classes of dual-capable ground-launched missiles that can strike U.S. territory. The United States has stood still in this competition, allowing China and Russia to develop an unchecked advantage. The introduction of U.S. theater-range missiles should be viewed as a reciprocal competitive response.

Second, in the event that conventional deterrence fails, some have expressed concerns that conventional strikes might trigger nuclear escalation. These dangers must be balanced against the reality that the great powers have long learned to live with the risks of nuclear escalation. Moreover, it is not self-evident that nuclear escalation is as automatic as critics presume. A missile strike designed to disarm Russia or China would be massive in both size and geographic scope. Absent the detection of such an overwhelming inbound strike, the political leadership of Russia or China may deem it worth the risk to wait for the arrival of incoming weapons, endure the few salvos of strikes, determine the nature of the attack, and decide on an appropriate response. Until they are reasonably confident about the situations they find themselves in, Russian and Chinese leaders are unlikely to reflexively retaliate with nuclear weapons, since doing so would invite a devastating, regime-ending nuclear response.

Third, critics point out that U.S. allies could deny access to and use of their territories for the deployment of ground-based missiles. Allies, however, may welcome the deployment of these missiles given that they can enhance deterrence and provide a forward-operating capability that bolsters U.S. security commitments. Additionally, even if allies would prefer not to host missiles in peacetime, missiles could be deployed to allies during a crisis, and some longer-range theater-range missiles could be based on U.S. territory.

CSBA's review of the missile options available to the United States finds that although costs vary depending on the technological maturity and sophistication of the missiles, operationally relevant numbers of different ground-launched theater-range missiles could be fielded within five to ten years.

Conventionally armed theater-range missiles are powerful tools that are currently missing from the U.S. arsenal. Theater-range missiles would yield strategic dividends, especially if the missiles were fielded in numbers and in a manner adequate to introduce uncertainty in the adversary's strategic calculus. They would contribute to a credible U.S. warfighting posture, and they would play an important role in denying the adversary's operational aims should deterrence fail. These advantages would in turn augment U.S. conventional deterrence, an essential ingredient to the stability of key regions around the world. Additionally, these weapons could contribute to a cost-imposing strategy against China and Russia by pressuring them to invest in expensive defenses and resiliency measures rather than power-projection capabilities. China and Russia have already pursued this approach with their theater-range missiles against the United States: it is now time to level the playing field.

CHAPTER 1

Introduction

On February 1, 2019, the United States suspended its participation in the Intermediate-Range Nuclear Forces (INF) Treaty.[1] The suspension began a six-month countdown to the potential full U.S. withdrawal from the treaty. Should the United States withdraw, it would be within its rights to bring into service entire classes of weaponry that had been off limits for decades. Options that were hitherto unavailable for strategists would become viable, creating new operational opportunities. Indeed, since February 2, 2019, the United States has been free to test or deploy previously prohibited ground-launched ballistic and cruise missiles with ranges between 500 and 5,500 km.[2]

Russia's long-running violations of the INF and America's increasingly untenable position as the sole treaty-abiding party were major contributing factors to the U.S. suspension. Russia reportedly tested a cruise missile prohibited under the treaty as early as 2008. By 2014, the Department of State publicly asserted that Moscow had violated the INF.[3] In every National Defense Authorization Act since 2016, Congress has called on the Department of Defense (DoD) to develop a plan to counter any advantages Russia may have gained by violating the treaty.[4] Now that Washington has moved to end this anomalous situation of unilateral restraint, the United States needs to prepare for a new and uncertain era. Understanding what

1 The INF eliminated ground-launched shorter-range missiles having a range capability equal to or in excess of 500 km, but not in excess of 1,000 km, and ground-launched intermediate-range missiles having a range capability in excess of 1,000 km, but not in excess of 5,500 km. Since it only banned ground-launched intermediate-range missiles, the INF Treaty did not apply to ship-, submarine-, or air-launched weapons. For convenience, this study refers to ground-launched missiles with INF-covered ranges as "theater-range missiles." Treaty Between the United States of America and The Union of Soviet Socialist Republics on The Elimination of Their Intermediate-Range and Shorter-Range Missiles (INF Treaty), U.S. Department of State, December 8, 1987, available at https://www.state.gov/t/avc/trty/102360.htm.

2 For the purposes of this study, theater-range missiles refer to missiles with a range of 500 to 5,500 km.

3 Michael R. Gordon, "U.S. Says Russia Tested Cruise Missile, Violating Treaty," *The New York Times,* July 28, 2014.

4 National Defense Authorization Act for Fiscal Year 2016, 114th Congress, 1st Session, H.R. 1735; National Defense Authorization Act for Fiscal Year 2017, 114th Congress, 2nd Session, S.2943, p. 30; National Defense Authorization Act for Fiscal Year 2018, 115th Congress, 1st Session, H.R. 2810, p. 131; and John S. McCain National Defense Authorization Act for Fiscal Year 2019, 115th Congress, 2nd Session, H.R.5515, Sec. 1244.

a post-INF world would look like and the strategic and operational implications of such an environment will likely become paramount to U.S. policymakers and defense planners in the months and years ahead.

Yet, with a few exceptions, recent debates have largely remained centered on the wisdom or imprudence of leaving the treaty. Strategy has been conspicuously missing in these discussions. Few studies have assessed the strategic and operational implications of the treaty's end. Only some have proposed concrete recommendations for fielding new systems, including ground-launched missile units.[5] Fewer have examined the operational concepts and the specific costs associated with the missile forces that the United States would be permitted to deploy, if it chose to do so. This study is a first step in filling that gap.

This report focuses on the operational and cost implications of a conventional missile force that the United States could deploy in the post-INF era.[6] It does not consider the possible deployment of nuclear-armed missiles, which would require a separate study. This report argues that conventionally armed land-based theater-range missiles promise operational dividends that would help shore up the U.S. position in the great power competitions with Russia and China. The missile force would help to arrest the erosion of longstanding U.S. military advantages, present new operational and strategic dilemmas to adversaries, and uphold deterrence. These benefits, however, must be carefully weighed against strategic and cost considerations.

This report first examines how Russia and China have exploited their geographical positions and missile prowess to impose costs on the United States. Second, this study demonstrates how theater-range missiles could enhance the offensive power of U.S. forces and impose costs on Chinese and Russian forces to, in turn, better assure local allies. It uses regional scenarios to illustrate these strategic and operational benefits. Third, the report considers the strategic factors that would determine the political feasibility of a land-based missile force, including the role of allies. Fourth, it estimates the costs of fielding various missile systems that would be available in the short- to medium-terms. The report concludes with some observations about how policymakers should think about the role of land-based missile forces in the larger context of strategy.

5 Thomas Callender, "The Way Forward for the United States in a Post-INF World," *The Heritage Foundation*, February 1, 2019, available at https://www.heritage.org/arms-control/report/the-way-forward-the-united-states-post-inf-world; and Sugio Takahashi and Eric Sayers, "America and Japan in a Post-INF World," *War on the Rocks,* March 8, 2019, available at https://warontherocks.com/2019/03/america-and-japan-in-a-post-inf-world/.

6 It should be noted that CSBA has led the debate on the deployment of land-based missiles since 2013. See Jim Thomas, "Why the Army Needs Missiles," *Foreign Affairs* 92, no. 3, May/June 2013; Andrew F. Krepinevich, "How to Deter China: The Case for Archipelagic Defense," *Foreign Affairs*, March/April 2015; Evan Braden Montgomery, "Time for American Land-Based Missile Forces to Counter China?" *The National Interest*, October 14, 2014, available at https://nationalinterest.org/feature/time-american-land-based-missile-forces-counter-china-11453; Evan Braden Montgomery, "Managing China's Missile Threat: Future Options to Preserve Forward Defense," testimony before the U.S.-China Economic and Security Review Commission hearing on "China's Offensive Missile Forces: Implications for the United States," Washington, DC, April 2015; and Evan Braden Montgomery, *Reinforcing the Front Line: U.S. Defense Strategy and the Rise of China* (Washington, DC: Center for Strategic and Budgetary Assessments, 2017).

CHAPTER 2

The Growing Missile Imbalance

The Intermediate-Range Nuclear Forces Treaty between the United States of America and the Union of Soviet Socialist Republics, signed December 8, 1987, committed both nations to eliminating their ground-launched ballistic and cruise missiles with ranges between 500 and 5,500 km. When the INF Treaty was negotiated, the United States and the Soviet Union were concerned about the dangers that nuclear-armed theater-range missiles posed to strategic stability. European allies questioned the reliability of the U.S. extended deterrence guarantee in the face of Soviet and Warsaw Pact intermediate-range ballistic missiles (IRBM) like the SS-20 Saber. The Soviets, in part, feared that NATO medium-range ballistic missiles (MRBM) like the Pershing II and ground-launched cruise missiles (GLCM) like the Gryphon, deployed in response to the Soviet fielding of the SS-20 intermediate-range ballistic missile (IRBM), could decapitate their leadership.[7] When the treaty entered into force, it was hailed as a great success. Indeed, it is still widely considered one of the great achievements in arms control.

Several long-term structural trends and more recent geopolitical developments have, however, increased the costs of U.S. compliance with the INF Treaty. In the 1980s, the People's Republic of China (PRC), which was not constrained by the treaty, began to field ground-launched nuclear-armed and conventionally armed missiles with ranges proscribed by the INF.[8] Over the course of three decades, China acquired the world's largest and most advanced arsenal of theater missiles that well outrange U.S. ground-based fires. According to the U.S. Defense Intelligence Ballistic Missile Analysis Committee, "China continues to have the most

7 For a brief overview of the INF Treaty and its origins, see S.J. and N.S., "What Is the INF Treaty?" *The Economist*, October 26, 2018.

8 Office of the Secretary of Defense (OSD), *Military and Security Developments Involving the People's Republic of China 2018*, annual report to Congress (Washington, DC: DoD, May 16, 2018).

active and diverse ballistic missile development program in the world."[9] A report by the U.S.-China Economic and Security Review Commission states that, "Since the mid-1990s, Beijing has built up the world's largest and most diverse arsenal of ground-launched missiles."[10] And, as Admiral Harry Harris, the former commander of Pacific Command, testified before the House Armed Services Committee, about 95 percent of China's ground-based missiles possess ranges that are prohibited under the INF.[11]

As noted above, Russia has violated the INF since the late 2000s by developing and deploying an INF non-compliant ground-launched cruise missile, the Novator 9M729, designated by NATO as SSC-8. It has also developed and tested the RS-26 Rubezh missile, a purported intercontinental ballistic missile (ICBM) that may be designed to operate at intermediate ranges. The RS-26 missile may have been developed to circumvent the INF.[12] In addition, hostile regional powers, such Iran and nuclear-armed North Korea, possess sizeable theater missile arsenals of their own, threatening U.S. allies and U.S. forces throughout their regions.[13]

Post-Cold War technological advances have substantially improved the ability of missiles to hit targets with precision at ever longer ranges. Increased accuracy has in turn broadened the types of missions that missiles can accomplish. Precision-strike missiles can target runways, buildings, vehicles, and even vessels at sea. Such flexibility has made missiles a key component of Chinese and Russian power projection and anti-access/area-denial (A2/AD) strategies. Missiles significantly increase China's and Russia's military reach in various warfighting scenarios and their ability to threaten forward staging areas essential to U.S. expeditionary operations.

Until suspending its participation on February 1, the United States was the sole great power that bound itself to the spirit and letter of the INF Treaty. Before suspending the treaty, U.S. ground-based strike was limited to short-range rocket artillery and the MGM-140 Army Tactical Missile System (ATACMS). The Army plans to develop longer-range weapons (1,600+

9 National Air and Space Intelligence Center (NASIC) and Defense Intelligence Ballistic Missile Analysis Committee (DIBMAC), *Ballistic and Cruise Missile Threat 2017* (Wright-Patterson AFB, OH: NASIC, June 2017), p. 3, available at https://www.nasic.af.mil/LinkClick.aspx?fileticket=F2VLcKSmCTE%3D&portalid=19.

10 Jacob Stokes, *China's Missile Program and U.S. Withdrawal from the Intermediate-Range Nuclear Forces (INF) Treaty* (Washington, DC: U.S.-China Economic and Security Review Commission, February 4, 2019), p. 3.

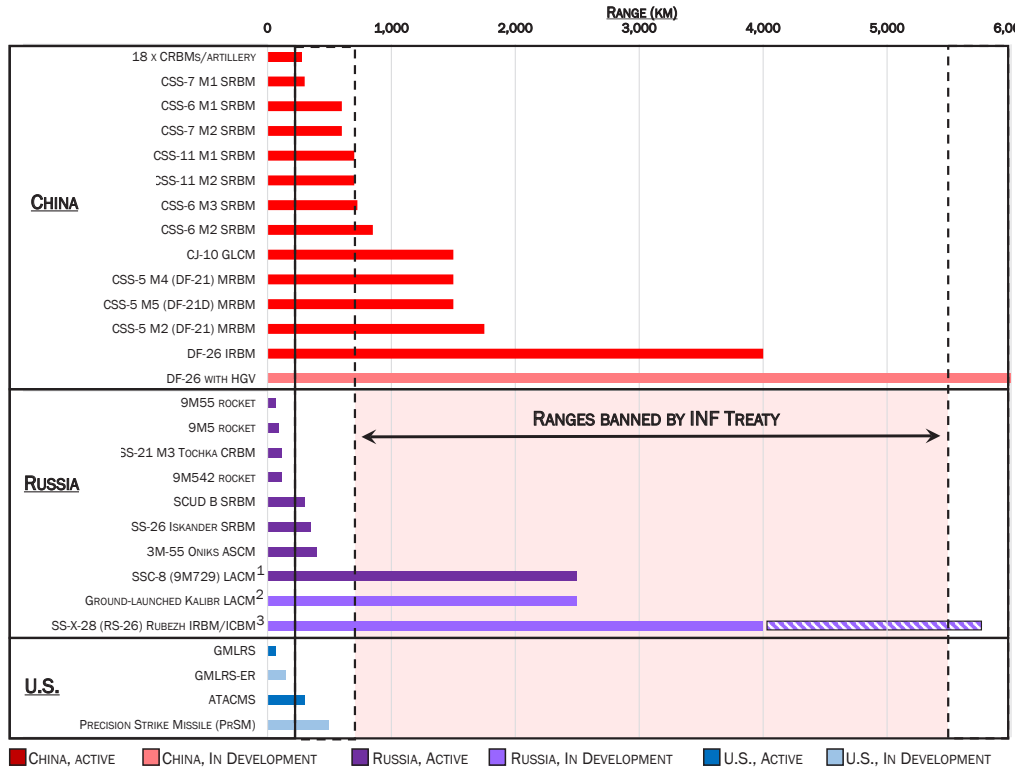
11 Harry B. Harris Jr., written testimony for the Hearing on U.S. Pacific Command Posture, House Armed Services Committee, April 26, 2017, p. 7.

12 Russia has tested the RS-26 Rubezh at intermediate ranges. Since the RS-26 has also been tested at an intercontinental range (5,800 km), it would not violate the INF unless the intermediate range test utilized a different warhead or multiple warheads that resulted in the decreased range. While the United States has not accused Russia of deploying an INF-violating ballistic missile, the potential and threat remains. For more information on this subject, see Amy Woolf, *Russian Compliance with the Intermediate Range Nuclear Forces (INF) Treaty: Background and Issues for Congress* (Washington, DC: Congressional Research Service, February 8, 2019), p. 22.

13 Iran and North Korea each possess hundreds of SRBMs and MRBMs. North Korea also possesses dozens of IRBMs. See NASIC and DIBMAC, *Ballistic and Cruise Missile Threat 2017*, pp. 21, 25; and Robert Einhorn and Vann H. Van Diepen, *Constraining Iran's Missile Capabilities* (Washington, DC: Brookings Institution, March 2019), p. 1, available at https://www.brookings.edu/wp-content/uploads/2019/03/FP_20190321_missile_program_WEB.pdf.

km), but there are no ground-launched systems currently in the U.S. inventory between the 300 km-range ATACMS and the 13,000 km-range Minuteman III ICBM.[14]

FIGURE 1: SHORT- AND THEATER-RANGE MISSILE AND RANGES BY COUNTRY



1. The Russian SSC-8 ground-launched cruise missile (also known as the 9M729) violates the now-suspended INF Treaty due to possessing a range above 500 km. Its actual range is unknown, although its suspected status as a variant of the SS-N-30 Kalibr hints at a maximum range of approximately 2,500 km.
2. The Russian government announced on February 5, 2019 that it intended to pursue a ground-launched variant of the sea-launched SS-N-30 Kalibr. Considering many reports that the SSC-8 GLCM is already a Kalibr variant, it is unclear if this Kalibr variant would be a new system or whether this is just an attempt by the Russian government to obscure the origins of the SSC-8. The Russian government also announced its intention to field a theater-range hypersonic weapon, though this weapon's exact range is unknown.
3. Russia has tested the RS-26 Rubezh at both intermediate ranges and low intercontinental ranges (5,800 km). Since the RS-26 has been tested at an intercontinental range, it would not violate the INF unless the intermediate range test utilized a different warhead or multiple warheads that resulted in the decreased range, though some reports at the time hinted this may have been the case. While the United States has not accused Russia of deploying an INF-violating ballistic missile, the potential and threat remains. If the RS-26 did utilize multiple warheads, it is possible its maximum range would be perhaps as low as 4,000 km. For more information on this subject, see Woolf, *Russian Compliance with the Intermediate Range Nuclear Forces (INF) Treaty*, p. 22.

China and Russia both have far larger arsenals of theater-range ground-based fires than the United States. China currently has thousands of ground-launched theater-range missiles, and Russia likely has at least one hundred of its INF-violating SSC-8 GLCMs.[15] They also possess larger families of missiles with different ranges. In China's case, most of its missile classes fall

14 Todd South, "Return of Fires: How the Army is Getting Back to Its Big Guns as It Prepares for the Near-Peer Fight," *Army Times*, August 27, 2018.

15 OSD, *Military and Security Developments Involving the People's Republic of China 2018*, p. 63; and Michael R. Gordon, "On Brink of Arms Treaty Exit, U.S. Finds More Offending Russian Missiles," *The Wall Street Journal,* January 31, 2019.

within ranges banned by the INF Treaty. The current ground-based missile arsenals of the United States, Russia, and China are depicted in Figure 1.

That China and Russia have more land-based missiles and have a wider range of missile classes than the United States does not in itself portend trouble. After all, the U.S. military possesses many other means, such as aircraft, ships, and submarines, to deliver precision strikes over long ranges.[16] Rather, the missile threat is an element of long-term great power competition with Russia and China. The United States has identified this competition as the most consequential challenge to its security.[17] Russian and Chinese land-based missiles exploit geographic and operational asymmetries peculiar to their respective rivalries with the United States that have in turn cut into longstanding U.S. military advantages in Asia and Europe. Renewed attention to preserving a favorable strategic balance vis-à-vis Beijing and Moscow and to the correlation of forces—of which land-based missiles are an integral part—has emerged as a national priority. Understanding why Beijing and Moscow have powerful incentives to invest in ground-launched missiles and why such missile deployments have been uniquely harmful to the U.S. competitive position are thus an essential first step to appraising Washington's options in a post-INF world.

The Geographic and Operational Sources of the Imbalance

Geography goes far to explain China's emergence as the world's leading missile power and Russia's pursuit of INF-busting missiles. Theater-range missiles play to the geospatial advantages of continental powers. Such theater weapons are ideally suited for China and Russia, whose proximity to contested terrain in their backyards allows them to base missiles deep in their home territories. Moreover, they exploit and magnify the geographical disadvantages that the United States, a distant power, labors under. By threatening the operational foundations of U.S. forward operations in Europe and Asia and by imposing costs on any U.S. and allied forces operating within range, theater-range missiles undermine the credibility of American extended deterrence, a critical pillar of Washington's global strategy for over seven decades. The missile threat is thus a strategic challenge of the highest order.

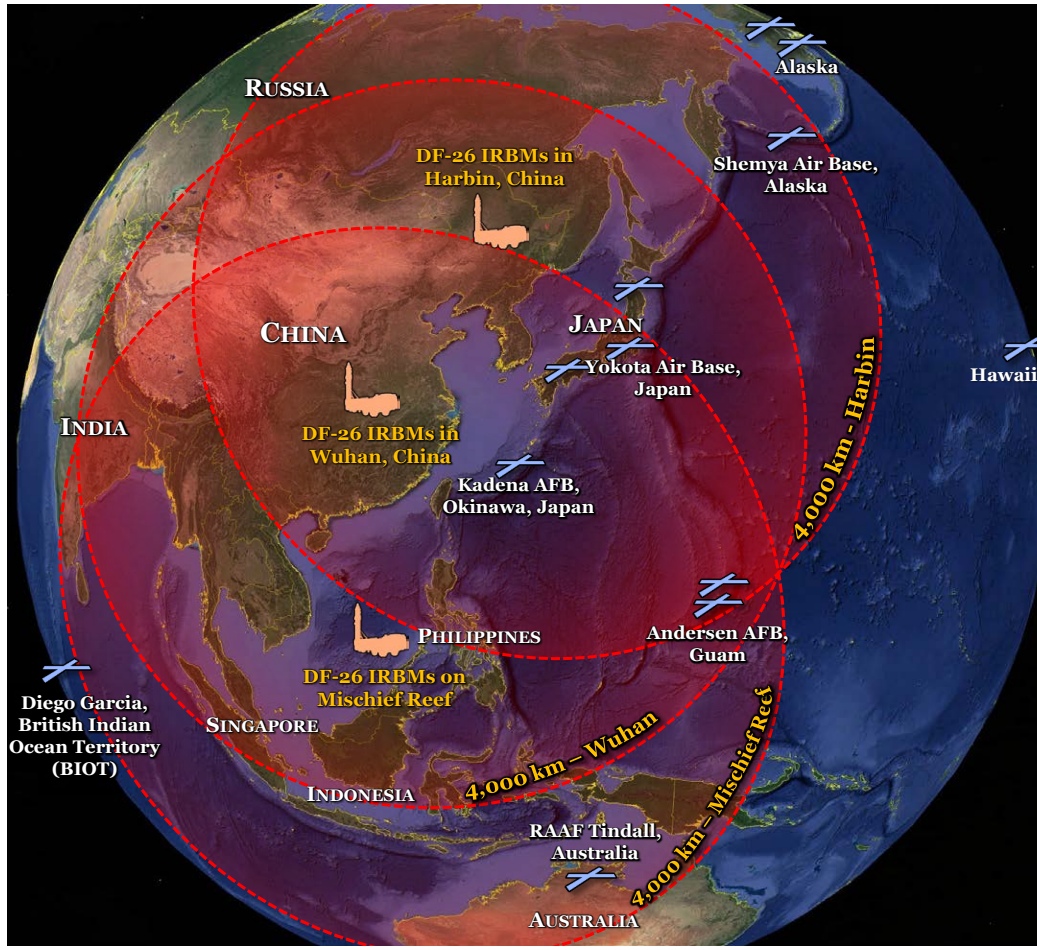
Theater-range missiles furnish China and Russia with a means to attempt to impose their will on their immediate surroundings. For Beijing and Moscow, these missiles put large swathes of Asia, Europe, and North America within striking distance. Consider China's 4,000-km range DF-26 IRBM as an illustrative case. Capable of being armed with conventional or nuclear warheads, the delivery system can strike targets located along the First and Second Island Chains, the transnational archipelagos that stretch from southern Japan through Taiwan to

16 While the United States can conduct long-range precision strikes with aircraft, ships, and submarines, these launch platforms are significantly more expensive than a ground-based missile launcher.

17 See *National Security Strategy of the United States of America* (Washington, DC: The White House, December 2017), p. 27; and DoD, *Summary of the 2018 National Defense Strategy of the United States of America: Sharpening the American Military's Competitive Edge* (Washington, DC: DoD, January 2018), p. 2.

the Philippines and from northern Japan through the Marianas and Palau to New Guinea, respectively. Depending on where the missile is launched, it can also threaten Australia, Southeast Asia, India, Russia, and even parts of Alaska, as shown in Figure 2. A hypothetical Russian missile of similar range could strike throughout Europe, Alaska, Canada, and parts of the northwest continental United States. Anti-ship versions of such a missile, which China has already developed, can also serve as maritime gatekeepers for China and Russia, enabling them to hold at risk U.S. naval combatants thousands of kilometers from their coasts.[18]

FIGURE 2: RANGE OF CHINESE DF-26 MISSILE IF BASED IN NORTHERN CHINA, CENTRAL CHINA, AND MISCHIEF REEF



18 Using such long-range missiles against a moving target requires a complex kill chain to identify and track a target, communicate that information to a missile launching unit, and transmit in-flight updates to improve the chance of striking a moving target. While the United States, Russia, and China all have the types of capabilities necessary to implement such a kill chain, this study does not assess the robustness of each country's kill chain or if one country has an advantage over another in this respect.

Theater-range missiles allow commanders to base their units far inland, effectively hiding and protecting them, while remaining well within range of regional targets. For example, a DF-26 IRBM deployed deep in the heart of Central China could not only strike Kadena Airbase in Okinawa, Japan—in the First Island Chain—but it could also attack Andersen Airbase in the U.S. territory of Guam—in the Second Island Chain. In a conflict, this strategic depth buffers the missile launchers from hostile forces seeking to destroy them, as enemy units assigned to neutralize them would have to close in on, if not cross, Chinese and Russian borders. Such operations would expose the attacking forces to a dense network of defensive weaponry, including lethal integrated air defense systems (IADS). Moreover, mobile missile units can travel along plentiful inland road and rail networks across China and Russia to elude detection and multiply the number of possible launch sites from which to fire their payloads.

Unfavorable strategic geography compounds the difficulties inherent to extending credible deterrence to faraway theaters. Such is the case of the Western Pacific. Unlike NATO Europe—a contiguous landmass that extends from Lisbon, Portugal in the west to Tallinn, Estonia in the east—maritime Asia suffers from a conspicuous absence of strategic depth. In visual terms, the United States is committed to defending a thin strip of broken terrain surrounded by sea that stretches from Japan to the Philippines. Nearly 2,500 km of empty ocean separate these frontline positions and the second line of defense, centered on the Marianas.

Solid-fueled, road-mobile ballistic and boost-glide missiles are also ideal first-strike weapons. Not only are they difficult to identify and track but they can also be launched with little warning and strike targets in as little as 10–15 minutes. Because the United States must operate well within missile range of its adversaries to fulfill its security commitments, and because the United States does not have the symmetrical capabilities to respond, it is uniquely vulnerable to a Chinese or Russian surprise attack.[19]

American forces deployed in Asia, moreover, are at the end of long, tenuous lines of communications, operating and drawing logistical support from a relatively small, concentrated number of bases and facilities on allied territories that are fragile and lightly defended. Should deterrence fail, Chinese missiles could land devastating blows against these soft targets, which U.S. and allied forces depend upon for sustaining combat operations. An effective Chinese strike against critical air and naval bases like Kadena Airbase or Yokosuka Naval Base may deprive the United States of its most effective and efficient means of staging reinforcements, resupplying units, repairing equipment, and launching sorties.

If forward bases on the First and Second Island Chains were rendered either unusable or inaccessible, the United States would be compelled to fall back on Hawaii or Australia, thousands of kilometers from the frontlines. The farther forward that Chinese missile forces can interdict

19 Deploying such weapons would allow the United States to pose a similar military challenge to Chinese and Russian forces. Additionally, by presenting a similar capability and forcing China and Russia to confront the same vulnerability, it may also deter their use.

the flow of American forces into theater, the more difficult it will be for U.S. and allied militaries to maximize their combat power. Such is the stark reality for a distant expeditionary power like the United States.

In times of crisis, the vulnerability of high-value forward-deployed forces—including aircraft on the ground and ships in port—to a devastating first strike could compel the United States to relocate certain military units to areas beyond the reach of Chinese missiles. Such a move could, however, undermine the credibility of U.S. security commitments to allies and friends, accustomed as they are to perceiving American presence as the most concrete symbol of U.S. resolve. Imagine how Japan would interpret American reliability if the first action the United States took in a crisis or conflict was to pull its aircraft out of Kadena and ships out of Yokosuka. Tokyo could lose confidence in Washington, and mutual recriminations could ensue over the wisdom of a U.S. pullback, even if such a move was operationally sensible. The potential fallout between the allies after the crisis had passed—or, worse, in the middle of the crisis—would benefit China, determined as it is to weaken or split the security partnership. The missile threat, therefore, is not merely a tactical danger. It imposes diplomatic and political costs that are central to China's aim of undermining U.S. extended deterrence and eroding allied confidence in America's security commitments to them.

To the extent that conventional theater-range missiles can deny access to or significantly disrupt the ability of the U.S. military to project power into a region, they also provide cover for Chinese and Russian aggression in their near-abroad while raising the cost of U.S. reaction. For instance, the Chinese leadership may act more aggressively throughout the First Island Chain if it believes that the United States would be loath to risk the consequences of a Chinese first strike against forces ashore and afloat throughout the region. Similarly, the Russian leadership may prove opportunistic and willing to use force in Eastern Europe if it believes its strike capabilities could disrupt and delay U.S. forces in Europe enough that Russia could achieve a *fait accompli* before the United States could stage its forces and mount operations in the region.

Finally, the ability of theater-range weapons to target high-value assets, such as carrier strike groups or key bases, pressures the United States to invest considerable sums on missile defense systems. Current-generation missile defense systems are optimized to defeat a small number of incoming weapons, not the larger salvos China and Russia could launch, and are often more expensive than the incoming weapons. The unit cost for a ground-based Terminal High Altitude Area Air Defense (THAAD) interceptor is $9.4 million. SM-3s for sea-based ballistic missile defense (BMD) are even more expensive at $12.8 million.[20] Assuming a shot doctrine in which each incoming ballistic missile is targeted by at least two interceptors, two THAAD interceptors targeting a Chinese DF-16 SRBM (at an estimated $6 million per missile)

20 Missile Defense Agency (MDA), *Department of Defense Fiscal Year (FY) 2020 Budget Estimates: Missile Defense Agency, Procurement, Defense-Wide Justification Book*, Volume 2b of 2 (Washington, DC: DoD, March 2019), pp. 87, 127, available at https://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2020/budget_justification/pdfs/02_Procurement/PROC_Vol2_MDA_PROC_OM_MILCON_PB20_Justification_Book_Final.pdf.

results in a cost-exchange ratio of 3:1.[21] This imbalance will continue to impose significant costs on the United States if it does not adopt different defensive concepts and technologies. Alternatively, if the threat posed by such missiles is deemed too great, it may force the United States to operate at greater and greater ranges from an adversary, decreasing the U.S. ability to project power.

In the realm of nuclear strategy, Chinese or Russian nuclear theater-range missiles could prove particularly nettlesome for U.S. extended deterrence. The moves and countermoves that culminated in the 1987 INF Treaty are instructive. Moscow's introduction of SS-20 IRBMs in the late 1970s stoked NATO's fears about the erosion of U.S. extended deterrence, as the 4,000-km range missiles held most of Western Europe at risk from launchers stationed well within Soviet territories. At the time, European NATO allies were alarmed that such theater weapons threatened to decouple NATO security from American security. In other words, a nuclear danger confined exclusively to Europe might disincline the United States—whose territory would be spared from the SS-20s—to intervene and retaliate on behalf of its allies across the Atlantic. America's distance from the geographic epicenter of superpower rivalry proved to be a politico-psychological liability that was only mitigated by the deployment of its own theater capabilities to Europe. As China's arsenal of conventional and nuclear-capable theater-range missiles continues to expand, Beijing may soon be able to introduce similar doubts about U.S. security commitments in Asia. Russia, too, may be able to test American credibility in Europe, just as it did in the late 1970s.[22]

In sum, distance matters. China's and Russia's home-court advantage drives them to build up missiles. The logic of geography, technology, and strategy make long-range missiles an appealing choice for Beijing and Moscow.[23] For its part, Washington's unilateral constraint, prior to the suspension of U.S. participation in the INF, denied the benefits that conventional land-based theater missiles would have conferred to American statesmen and commanders, whereas it permitted its rivals to compete in a resistance-free environment. If the United States had continued to adhere strictly to the INF, it might have risked falling further behind in the competition as China's rocket force expanded apace and Russian INF violations continued. Now that Washington has edged closer to abrogating the treaty, it is time to begin examining the concrete operational and cost implications of a U.S. land-based missile force, should policymakers choose to deploy such an arsenal.

21 The cost exchange ratio is based on the price of a Chinese DF-16 SRBM, as estimated by CSBA's ballistic missile cost estimate tool. China and Russia both have more recent and extensive experience producing ballistic missiles, so their costs may end up being lower than U.S. costs. It does not account for the costs of the THAAD launcher or radar or the costs of Russian or Chinese missile launchers and targeting infrastructure.

22 Russian military operations against Georgia in 2008 and Ukraine in 2014 and Chinese maritime expansion in the South China Sea since 2012 demonstrate a familiar pattern of behavior aimed at undercutting U.S. credibility.

23 The same logic appeals to such hostile regional actors as Iran and North Korea.

CHAPTER 3

A Primer on Ground-Launched Theater-Range Missiles

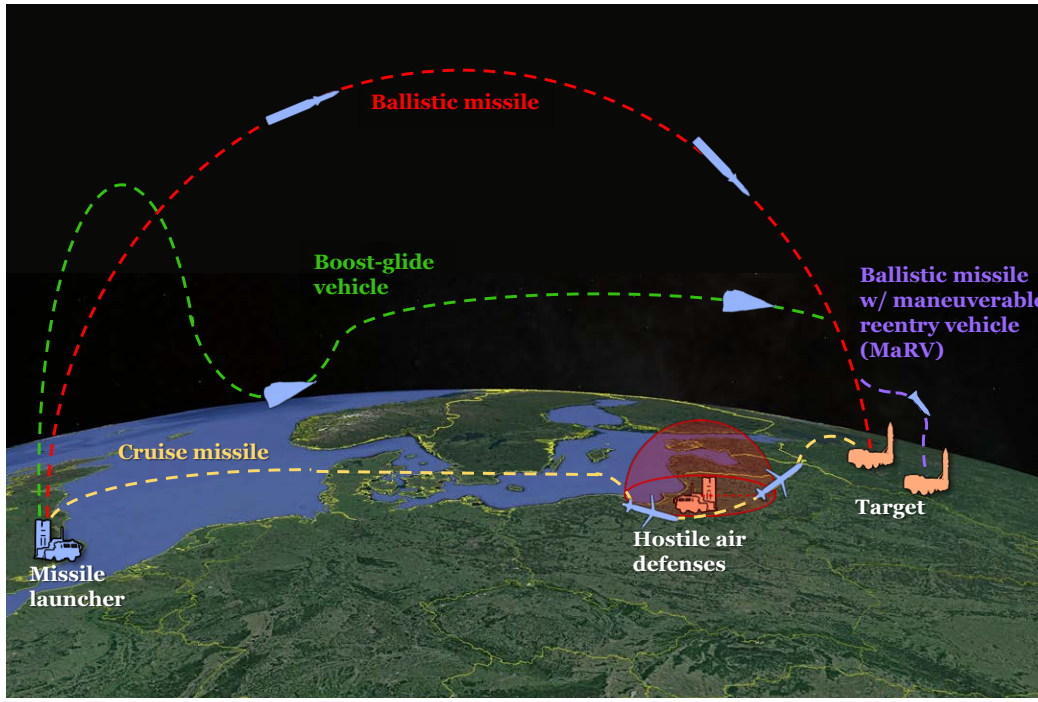
Knowledge of the functions, capabilities, and requirements of ground-based theater-range missiles is a prerequisite to understanding the operational choices available to policymakers should the United States opt to deploy such systems. Simply put, there are different types of theater-range missiles that can be fired from various kinds of ground launchers. Many combinations of missiles and launchers are thus conceivable. This section introduces missiles, launchers, and realistic modes of operating them.

Missile design is subject to complex trade-offs among parameters such as the size and weight of the missile's warhead, range, and speed, all of which affect missile cost, the anticipated tactical effects on targets struck by the missile, and the missile's ability to survive the defender's various countermeasures. Accordingly, different types of ground-launched missiles should be tailored to the specific missions that the missiles are designed to perform.

Classes of missiles include ballistic missiles, which are initially powered and predominantly fly along a parabolic trajectory; hypersonic boost-glide missiles, which are initially powered but largely glide on a non-parabolic trajectory; and cruise missiles, which remain powered throughout the course of their flight.[24] As depicted in Figure 3 below, ballistic, hypersonic boost-glide, and cruise missiles reach their targets along very different flight paths.

24 Other classes of missiles include powered hypersonic gliders, which are initially boosted and then use a motor or rocket to provide further impulse. An example of a U.S. ballistic missile is the previously mentioned Pershing II that was eliminated due to the INF Treaty. An example of a U.S. cruise missile is the Tomahawk. DoD has reported it already has an Army, Navy, Air Force, and Missile Defense Agency cooperative effort underway to field boost-glide hypersonic missiles. Steve Trimble, "MDA Joins Tri-Service Hypersonic Weapon Program," *Aviation Week*, October 22, 2018.

FIGURE 3: REPRESENTATIVE FLIGHT PROFILES OF THEATER-RANGE MISSILES



Each type of missile possesses unique attributes for which an adversary needs to prepare. In general, cruise missiles are slower, less expensive, and easier to intercept than ballistic missiles and hypersonic weapons.[25] By contrast, ballistic missiles and hypersonic weapons are generally faster, more expensive, and harder to intercept than cruise missiles. These different qualities would help campaign planners develop and tailor effective strike packages. For example, a smaller proportion of hypersonic and ballistic missiles, which are faster and harder to intercept but more expensive, could be used to punch holes in the enemy's defenses during the initial stage of a campaign. This first salvo could provide an opening, which a larger number of cheaper cruise missiles could exploit in follow-on strikes and in turn create more opportunities for other forces.

Ground-launched missiles can be fired from different types of launchers. The simplest type of launcher is a stationary launcher, such as one built into a building, on an outdoor launch platform, or in a silo. Given the relative ease with which an adversary can target this type of launcher if it is positioned forward, this report largely discounts the utility of this class of launcher and instead focuses on mobile launchers. Ground-launched missiles can be fired

25 Cruise missiles can fly at low altitudes that makes their detection very challenging. Therefore, while they may be slower and in turn kinematically easier to intercept than ballistic or hypersonic weapons, they may be more challenging to detect and in turn cue defenses to intercept. Hypersonic glide weapons are also capable of flying at higher altitudes than cruise missiles but lower than ballistic missiles, which makes their detection similarly challenging.

from tracked and wheeled vehicles of various kinds.[26] They can also be fired from relocatable launchers, such as ones inside containers that can be mounted on trailers. Figure 4 below depicts different types of ground launchers. In general, missiles with longer ranges (and in turn larger sizes and greater weights) must be transported on larger and heavier launchers. In the case of large missiles, such as IRBMs, a single very large launcher can transport only one to two missiles.

FIGURE 4: CLASSES OF GROUND MISSILE LAUNCHERS

Details and images of these systems also appear in NASIC and DIBMAC, *Ballistic and Cruise Missile Threat 2017*. These photos are used for illustrative purposes and no claim of copyright is made.

To survive against enemy units seeking to destroy or neutralize them, mobile ground launchers can adopt multiple passive and active defense measures, such as dispersal, movement, camouflage, concealment, and deception. These measures can be enhanced by dedicated efforts to deny, degrade, or deceive enemy sensors, as well as by area and point air and missile defense systems that can protect launchers from enemy aircraft and munitions. If effectively operated, mobile ground launchers can be very difficult for an enemy to keep track of, much

26 Classes of launcher vehicles include Transporter Erector Launchers (TEL), an integrated vehicle that transports, erects, and launches missiles; Mobile Erector Launchers (MEL), a tractor that hauls a trailer in which the trailer erects and launches missiles; and a Transporter Erector (TE), "either a tractor-trailer combination or single vehicle that transports and erects missile, but leaves the missile on a firing table and departs prior to launch." Launcher vehicle classes and definitions drawn from Scott LaFoy, "TELs and MELs and TEs!" *Arms Control Wonk*, June 1, 2017, available at https://www.armscontrolwonk.com/archive/1203304/tels-and-mels-and-tes-oh-my/.

less hit. The disappointing results that U.S. forces achieved in their resource-intensive hunt for mobile launchers during Operation Desert Storm and Operation Allied Force demonstrate just how elusive moving targets can be.[27] These experiences did not go unnoticed by China and Russia. Both powers now field hundreds of mobile ground launchers that train and exercise to maximize survivability.

As with any other weapon system, ground launchers rely on supporting systems to facilitate their operations. These include threat- and target-detecting sensors organic to a ground-launcher battery (such as coastal defense radars or unmanned aerial systems), external to the battery (such as satellites or aircraft), or to command, control, and communications systems. The missile launchers also rely on infrastructure, such as roads that can support the weight of launchers; launch sites, camps, or bases where launchers can operate from or be deployed to; maintenance facilities; and, in some cases, munitions magazines.

A well-conceived support infrastructure would increase the likelihood that a missile campaign could be sustained for a protracted period. Operations that targeted an adversary's fixed sites and mobile units would rapidly consume large quantities of firepower. A network of depots, some of which could be hidden or heavily fortified, could be constructed to ensure that the launchers have multiple places to obtain munitions, fuel, and materiel. Ideally, the launchers would not have to travel long distances to replenish themselves. Access to air and sea ports could ensure that launchers receive additional munitions, supplies, and forces. Redundant and well-protected storage and distribution infrastructure would go far to sustain a missile campaign. Launch units would not only survive, they would also remain armed and lethal.

For the United States, basing, access, and overflight rights on and over allied territory would be critical to increase the number of locations from which theater-range missile launchers could fire. While longer-range missiles could be based in U.S. territory in Alaska, Guam, and the Northern Marianas, most ground-launched theater-range missiles will require foreign basing access to strike most relevant targets in conflicts involving China or Russia. Similarly, the degree of basing access and the ability to operate throughout an ally's territory will also impact the survivability of forward-based U.S. ground launchers. If the host nation were to permit the United States to build numerous firing sites and fortifications on a base and to operate over a wider area outside bases during exercises, crises, or war, then the survivability of ground launchers and their weapons stockpiles would be higher than if U.S. forces were confined to a small, unprepared portion of a base. While basing options and access on U.S. territory will be greater than those abroad, exclusive U.S. basing may force the United States to rely solely on longer-range, more expensive missiles that may be difficult to acquire in sufficient numbers. Figures 5 and 6 below depict coverage areas of missiles with different ranges

27 See William Rosenau, *Special Operations Forces and Elusive Enemy Ground Targets: Lessons from Vietnam and the Persian Gulf War* (Santa Monica, CA: RAND Corporation, 2001), Chapter 3, pp. 33–34; DoD, *Conduct of the Persian Gulf War: Final Report to Congress* (Washington, DC: DoD, April 1992), Chapter IV, p. 118; and Paul McLeary, "DoD Wants Help to Spot—& Kill—Mobile Missiles," *Breaking Defense*, February 22, 2019.

from different bases possibly available to U.S. forces in scenarios involving China and Russia, respectively.

FIGURE 5: IMPACT OF BASING ACCESS ON THEATER-RANGE MISSILE COVERAGE IN CHINA SCENARIO

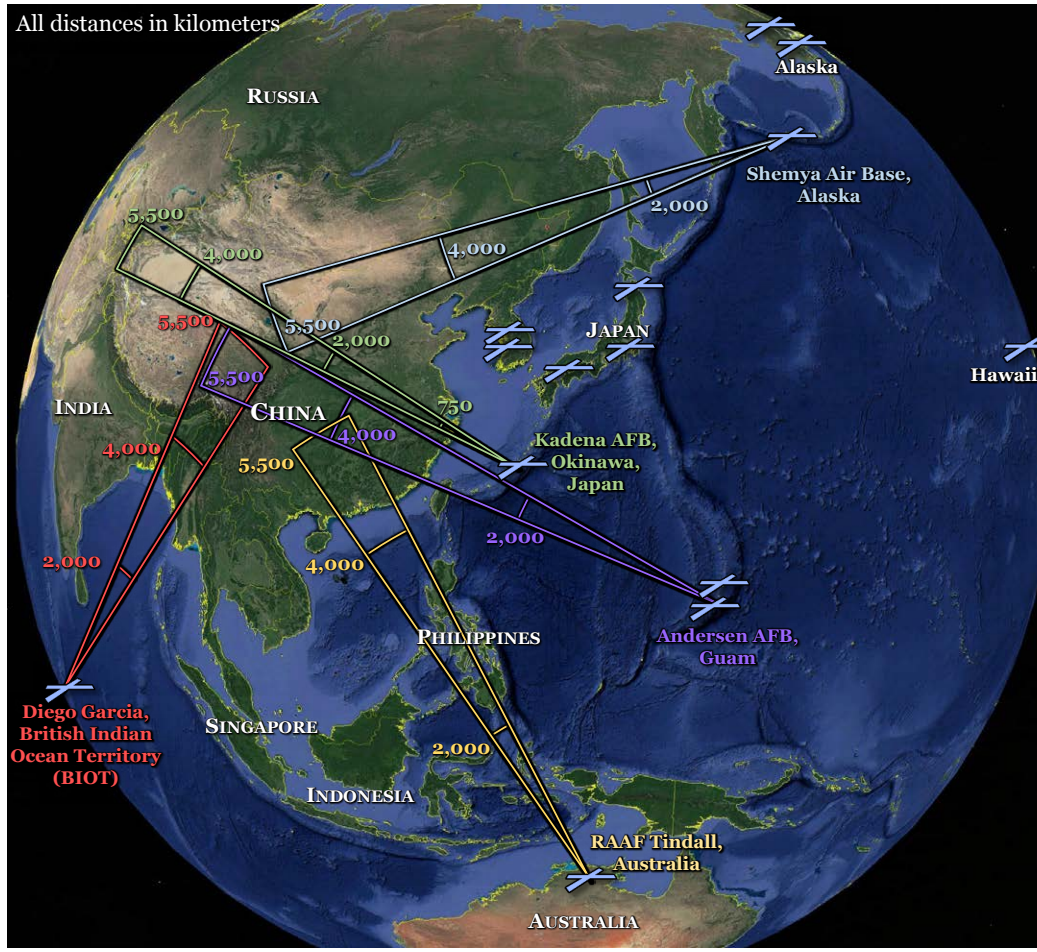
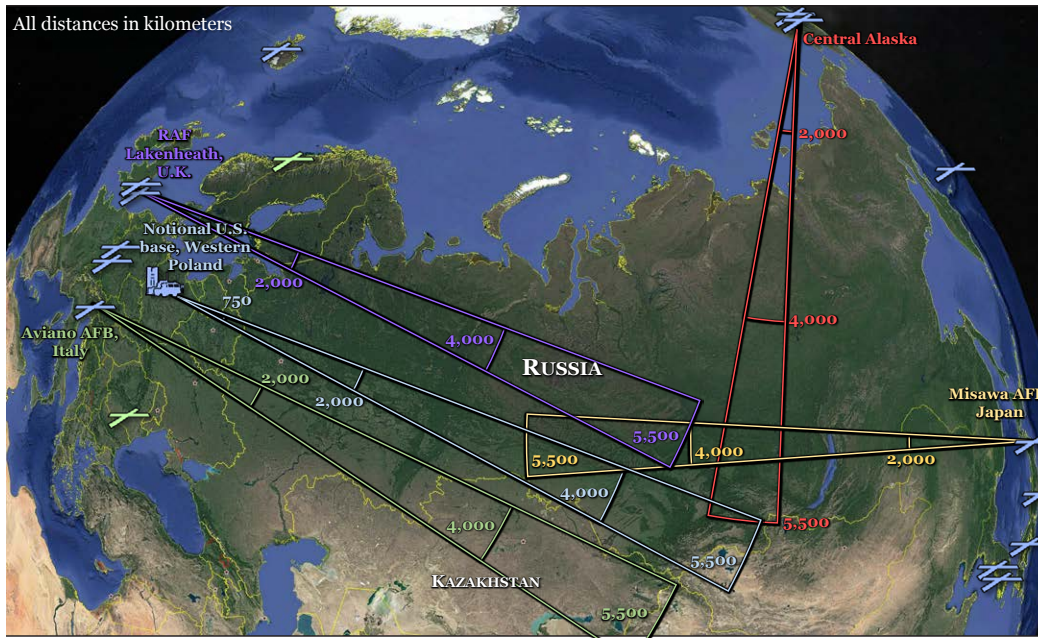


FIGURE 6: IMPACT OF BASING ACCESS ON THEATER-RANGE MISSILE COVERAGE IN RUSSIA SCENARIO



A mix of missiles with different ranges would allow the United States to deploy some longer-range missiles on U.S. territory and large numbers of shorter-range missiles on allied territory. Careful analysis of and close consultation with allies regarding potential peacetime and conflict access to operating locations should inform U.S. decisions regarding what types and how many missiles to acquire and where to operate them. The following section examines the operational benefits of theater-range missiles.

CHAPTER 4

Operational Value of Theater-Range Missiles

Theater-range missiles promise considerable operational benefits to the United States. They possess unique attributes, especially when compared with their air and naval counterparts, that can make them particularly responsive to crises if prepositioned appropriately. They can also help other U.S. forces obtain access to the battlefield that might otherwise be very challenging to reach. And, they could impose operational and budgetary costs on adversaries. A series of warfighting scenarios across different regions will illustrate these advantages.

Responsiveness

Theater-range missiles are highly responsive, a quality that would be at a premium in a conflict against a capable foe. Elements of Chinese and Russian military forces are mobile or can strike fast, affording U.S. forces only brief windows of opportunity to attack them. They include ships, aircraft on the ground, and missile launchers that can move out of harm's way; relocatable sensors; and potent anti-satellite (ASAT) weapons that could quickly destroy U.S. or allied space systems.[28] Theater-range missiles provide a means to promptly strike these forces. Three principal factors explain their responsiveness: they can be forward positioned, their launchers can better survive enemy ripostes, and the missiles are well equipped to get through the adversary's defenses, increasing the likelihood of reaching the intended targets.

First, forward-deployed missiles could hold enemy targets at risk from where they are stationed. In other words, the latent U.S. ability to do harm to the enemy would become a constant rather than a transient factor. Very short missile flight times, owing to proximity to the opponent and possibly combined with high speeds, mean that enemy mobile

28 While theater-range missiles can strike many relocatable targets, the movement time of some systems may be so rapid that they can only be targeted by short-range air-delivered weapons.

or relocatable units have much less time to escape danger, shrinking the margin of error to survive a missile strike. They would also allow U.S. forces to promptly engage high-priority threats. For example, the time that it would take a hypersonic missile to launch and strike a target would be measured in minutes, provided that the firing unit received timely and accurate information.

Second, ground-launched theater missiles can employ measures to make their launchers survivable. As such, enemy forces are less likely to disrupt or suppress U.S. missile operations, thereby shoring up responsiveness. As noted above, mobile ground-based missiles are notoriously difficult to find and to attack. Truck-mounted missiles can move quickly from location to location on roads. More rugged vehicles can even travel on rough terrain. Trucks and trailers can blend into complex urban and rural terrains. Warehouses and highway underpasses in cities and foliage in the countryside are just a few of the many places where vehicles can hide. Low cost and readily available camouflage techniques and decoys could fool sensors in the air and in space. Air and missile defense systems could hoist a protective umbrella over the mobile missile launchers.

In contrast to many classes of ships and aircraft that may need to stay out of contested areas during the initial phases of a campaign, ground launchers would be designed to stay and fight inside the effective striking ranges of enemy forces.[29] Because of their high chances of surviving an adversary's attack, theater-range missiles could be permanently deployed or surged into contested zones to keep within range of enemy units and hold those units at risk.[30] Additionally, longer-range missile systems can deploy outside of the densest and most lethal parts of an adversary's contested zones and still be effective. Collectively, such survivability would likely frustrate enemy attempts to undermine the responsiveness of U.S. missile forces.

Third, ground-launched missiles can be designed to defeat enemy defenses, thus increasing the likelihood that they reach the intended targets. Some missiles can use low radar signatures, high speeds, or their high maneuverability to decrease the likelihood of being shot down by enemy IADS.[31] Using these features, land-based missile forces could circumvent IADS to directly destroy targets or key elements of the IADS, enabling other forces to reach and operate over or near the battlefield. The combination of survivability and the high probability of hitting the mark would further boost responsiveness.

29 This is particularly important in assuring allies that the United States will share the same risks and fight alongside allies instead of pulling vulnerable forces back to a safe location and then gradually fighting back into theater as the threat is degraded.

30 The ability to remain forward would allow ground launchers to engage enemy forces with a greater volume of smaller, shorter-range missiles (rather than relying on larger, longer-range missiles fired from standoff distances), use longer-range missiles to strike a larger set of targets deep inside enemy territory, or fire their missiles at ranges shorter than their maximum kinematic range (allowing kinematic energy to be converted to maneuvering potential to avoid enemy missile defense threats).

31 These features are not unique to land-based forces. Air and naval platforms could also deliver many of the same kinds of missiles.

Given the existence of adversary air and missile defenses that can defeat sizeable salvos of U.S. missiles, American planners will need to develop a range of approaches to increase the ability of missiles to strike their targets.[32] This is just as much a concern for ground-launched missile batteries as any other strike platform for three reasons: 1) launchers may be limited in the number of missiles they can carry and, in turn, fire at a target to overwhelm defenses; 2) it may be difficult in the friction of war to coordinate the launch of numerous missiles from multiple groups of launchers to maximize the simultaneous arrival of missiles on targets; and 3) reloading munitions may pose considerable logistical challenges.

In any event, responsiveness allows theater-range missiles to act rapidly on verified target information. Tactical commanders would not have to wait for ships or aircraft to arrive in position or for a slow weapon fired from significant distances to arrive, at which point the target may have moved or launched an attack. In contrast, threats to air and naval platforms may significantly reduce their responsiveness. Theater-range missiles thus compensate for the vulnerabilities of U.S. air and naval forces in potential conflicts involving capable opponents such as China and Russia. Understanding some of the inherent limitations of aircraft and ships in high-end conflict further illustrates the operational value that land-based missiles could add to the fight.

In the air, the United States may find it difficult to conduct a prolonged campaign against the kinds of stiff resistance that would be expected from China and Russia. For one thing, American forward airbases that put tactical aircraft in range of enemy targets are themselves well within the reach of Chinese and Russian missile and air raids. Enemy bombardment against U.S. bases, like Kadena Airbase in Okinawa or Andersen Air Force Base in Guam, could cut runways, destroy aircraft caught on the ground, and cripple the logistical infrastructure that would be essential to support air operations. For another, tactical aircraft, especially older-generation airframes that lack stealth features, would have difficulties penetrating modern air defense systems to deliver munitions. Even if stealth aircraft were able to elude the enemy's sensors, they might not be able to stay aloft long enough to loiter, detect, track, and attack large numbers of fixed sites and moving targets. Long-range bombers operating from airbases farther from threats would take time to reach the theater. They, too—especially non-stealth bombers—would be exposed to enemy air defenses. And, there are not enough of them to generate the around-the-clock sorties necessary to engage the array of targets that would need to be struck—especially when they are operating from bases far from the contested area. At sea, many classes of warships—especially large surface combatants—may need to operate at a distance from threats, at least during the initial stages of a conflict. The reality is that the United States can no longer assume that it can command the air and seas in areas contested by Chinese and Russian forces.

32 This could include more sophisticated weapons that are difficult to intercept, larger numbers of shorter-range weapons that can overwhelm defenses, and integration with other capabilities such as electronic warfare to improve the ability of missiles to penetrate defenses. For more information on this subject, see Mark Gunzinger and Bryan Clark, *Sustaining America's Precision Strike Advantage* (Washington, DC: Center for Strategic and Budgetary Assessments, 2015).

At some point in the campaign, ships and aircraft that have exhausted their ordnance must return to base to refuel and rearm. But, for those forward deployed, their home bases may be heavily damaged by enemy air and missile raids. For example, fuel and ammunition depots and maintenance facilities could be destroyed or rendered inaccessible and unusable in the opening phases of hostilities. Moreover, ships suffer from a limited ability to reload their magazines while underway or at forward anchorages. Ships and aircraft may thus have to fall back to rear-area bases. Those in transit to and from faraway bases would not be available to fight on the frontlines.[33] And, the larger the number of ships and aircraft en route to or from resupply points, the greater difficulty U.S. forces would have generating the combat power required to conduct military operations in contested areas. The tyranny of distance would eat away U.S. warfighting prowess, particularly in a protracted conflict.

The serious threats to air and naval platforms and the difficulties of sustaining operations at distance may reduce the responsiveness of many aircraft and warships. By contrast, ground-launched missiles may be more responsive, especially during the opening phases of a campaign when enemy defenses have not yet been affected by U.S. counterstrikes and are thus able to offer their stiffest resistance. Land-based missile forces could in turn reduce the fighting power of defending forces, opening the way for follow-on attacks by air and naval forces.

Enabling Operations for Other Forces

Theater-range missiles enable other forces to fulfill their missions in a high-threat environment. By defeating or suppressing key adversary systems, theater-range missiles can create more favorable conditions for other forces to enter the operating area and conduct operations at lower levels of risk. For example, at the beginning of a campaign, ground-launched hypersonic missiles could be fired to destroy key nodes in enemy air and missile defenses. Then, a follow-on salvo of cruise missiles could inflict further damage while air forces could exploit the breakthrough. In other words, a modestly sized land-based missile force could bring down portions of enemy defenses, thereby opening the way for bombers to bring to bear far more numerous and cheaper short-range weapons.[34] Such a burden-sharing arrangement would free up air and naval forces to conduct operations that played to their strengths while sparing these same forces from risky missions.[35] As another example, ground-launched missiles could

33 Ground-based missile batteries have similar logistical demands but do not require the kinds of specialized facilities that aircraft and naval vessels need to rearm and refuel. Fuel and additional missiles can be located closer to the front, thus decreasing the transit time between refueling/rearming points and the front lines, which would decrease the time missile batteries are unavailable for combat operations.

34 The People's Liberation Army (PLA) envisions exploiting this very synergy. By using ballistic missiles with submunitions to destroy air defense batteries and crater runways, they could paralyze U.S. air bases. This paralysis would, in turn, enable the launch and arrival of large numbers of cruise missiles and bombs dropped from PLA Air Force (PLAAF) aircraft to "annihilate" enemy forces.

35 See also Eric Sayers, "The Intermediate-Range Nuclear Forces Treaty and the Future of the Indo-Pacific Military Balance," *War on the Rocks*, February 13, 2018.

destroy enemy counter-space sensors, allowing satellites to more freely sense enemy forces, provide communications, or conduct other missions.

Imposing Costs on Adversaries

The fielding of theater-range missiles could impose operational and budgetary costs on adversaries. These costs could help shape competitions and conflicts in favor of the United States and, as a result, possibly deter adversary aggression.

Theater-range missiles can shape the battlefield by forcing an adversary to honor the threat posed by them. For example, at sea, enemy surface combatants would be forced to stay out of the range of shore-based anti-ship missile batteries or otherwise accept more risk by operating inside the engagement zone of those missile units. In the latter case, they may have to devote tactical energy to defending against inbound missiles or neutralizing the threat with counter-battery fires, either of which would draw attention away from other warfare missions.

A defender may also find it necessary to go on the offense to suppress U.S. land-based missiles. To neutralize the threat, the onus would be on the opponent to search, find, and attack the launchers. In such a case, the adversary would have to devote its sensors—a scarce resource that could be in extreme demand in wartime—to scan, search, detect, and keep track of mobile units. Each sensor diverted and dedicated to finding elusive trucks and trailers would be one less sensor available to search for other targets and maintain awareness of the larger operational environment. Similarly, each aircraft or missile launched to destroy the ground launchers would be one less offensive tool to fulfill other missions. The opponent would also be risking its aircraft and pilots if the airspace over the U.S. launchers were protected by friendly air defenses. The adversary's opportunity costs of pursuing such an offensive could mount rapidly, especially if the search-and-destroy missions proved fruitless—a likely outcome given the advantages of mobile launchers cited above—and if the conflict protracted. Overall, theater-range missiles could impose significant operational costs on adversaries.

Theater-range missiles could also impose budgetary costs on an opponent by compelling the adversary to develop defenses that it may otherwise prefer not to spend scarce resources on. Provided that the United States acquires sufficient numbers and types of theater-range missiles, U.S. forces could multiply the means by which to defeat and complicate enemy defenses. As previously depicted in Figure 3, ballistic, hypersonic boost-glide, and cruise missiles reach their targets along very different flight paths. There is no economical one-size-fits-all solution to defeat these missile threats. Furthermore, as noted above, U.S. defense planners can design campaigns around varying combinations of missile salvos and tactics to overwhelm the opponent or drive up the costs of defense.

To cope with these multiple dangers, a defender could choose to acquire more active defenses, including sensors to detect and track incoming missiles and weapons to shoot them down. A defender could also adopt more passive defenses, such as aircraft hangars reinforced to

withstand missile strikes. It could also pull back or disperse forces in peacetime, crisis, or conflict to keep them safe from the reach of U.S. missiles. The cumulative costs and inefficiencies of these measures could prove substantial. The cost of each countermeasure could come at the expense of other preferred capabilities, like offensive strike systems. The defender could find itself in the horns of a dilemma: it has to either defend everywhere, which would be prohibitively expensive, or accept higher levels of risk and leave gaps in its defenses.

These costs could compound in peacetime. An American land-based missile force could induce China and Russia to invest in expensive and technologically complicated systems to track and intercept new types of missile threats as well as passive defenses to minimize the damage done by missiles that get through. It could also prod China and Russia to devote scarce resources to developing persistent surveillance and strike systems designed to suppress a U.S. offensive missile campaign. As noted above, defense and offense against missiles are inherently expensive and challenging missions with uncertain prospects for success. The United States has labored under such a burden for years. Deploying theater-range missiles would impose similar costs on China and Russia.

The operational dilemmas and the sharpening budgetary trade-offs illustrated above mirror those that China and Russia have imposed on the United States in recent years. In other words, a well-conceived plan to deploy U.S. ground-based theater-range missiles could turn the tables on China and Russia. They may force Chinese and Russian planners to reevaluate campaign designs in light of new U.S. theater-range missile capabilities, possibly enhancing deterrence. They may also force Chinese and Russian planners to consider expensive alternatives to their existing force posture and force structure, resulting in a costly reallocations of resources. Ultimately, theater-range missiles would help level the operational playing field, shoring up the U.S. competitive position for the longer term.

Role of Theater-Range Missiles in Potential Conflicts

China

The potential utility of different classes of theater-range missiles is best assessed using operational scenarios. In potential conflicts, the United States faces many operational problems that would be difficult to address with its current military force, such as when targets need to be struck quickly, are well defended, or are located deep within a country's borders. Ground-based missiles can make key contributions in these cases. A few tactical vignettes from scenarios involving conflict with China, Russia, and North Korea serve to illustrate ways in which these missiles would be useful.

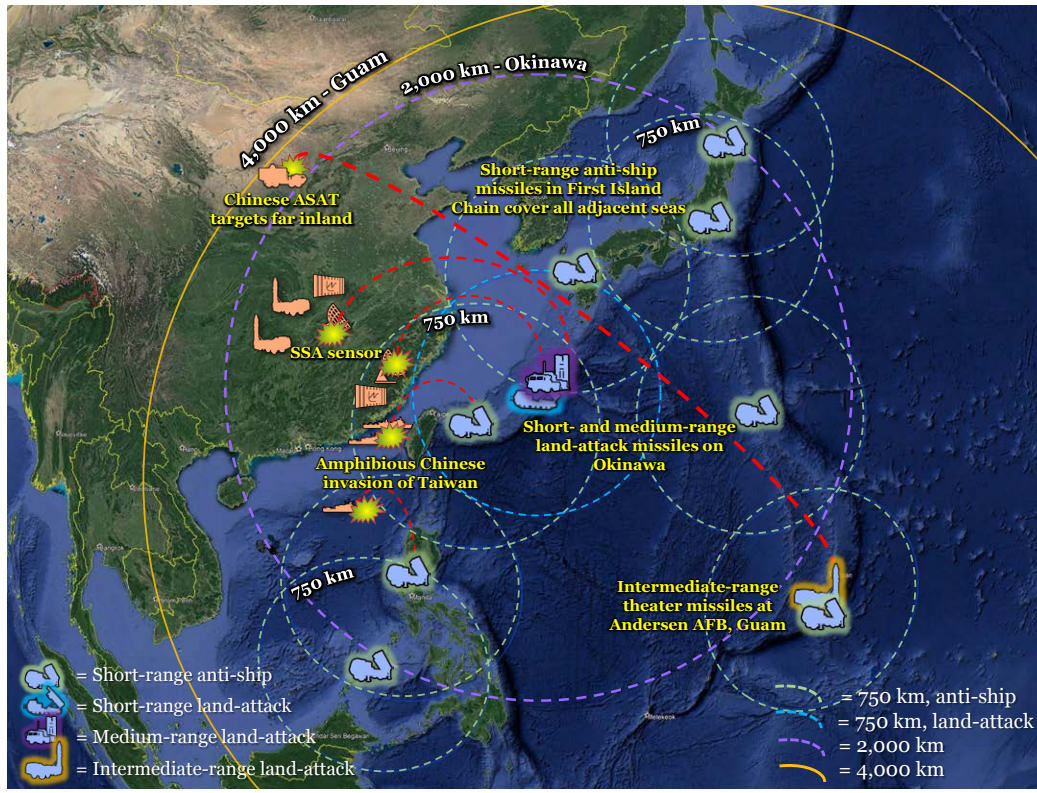
Theater-range missiles could have considerable utility in a conflict with China.[36] For example, in the case of an invasion of Taiwan, Chinese military forces could mount powerful anti-ship

36 It is worth noting the PRC would also likely bring to bear its arsenal of ground-launched missiles, the largest in the world.

defenses within the First Island Chain, especially within the Taiwan Strait, to protect its invasion force. These defenses could either slow the U.S. Navy's ability to move in to reinforce Taiwan or force U.S. naval forces—including submarines—to stand off at a distance. Additionally, Chinese air defenses both ashore and afloat could render air and missile attacks against a Chinese invasion force both unlikely to succeed and risky to the attacking platforms. In this time-sensitive period in which the invasion force would need to be sunk before it offloaded forces on Taiwan, theater-range missiles could target key Chinese IADS on ships and ashore, generating operational access that would allow U.S. aircraft and their missiles to target key transport ships.

As another example, China could use Space Situational Awareness (SSA) sensors, satellite downlink and control stations, and ASAT weapons—many of which could be heavily defended and located deep in the Chinese interior—to attack U.S. and allied satellites. This could rapidly degrade any coalition's ability to conduct effective Command and Control (C2) or Intelligence, Surveillance, and Reconnaissance (ISR) operations. Theater-range missiles could be used to avoid defenses and attack these systems promptly, thus preserving U.S. and allied space capabilities. These vignettes are depicted in Figure 7 below.

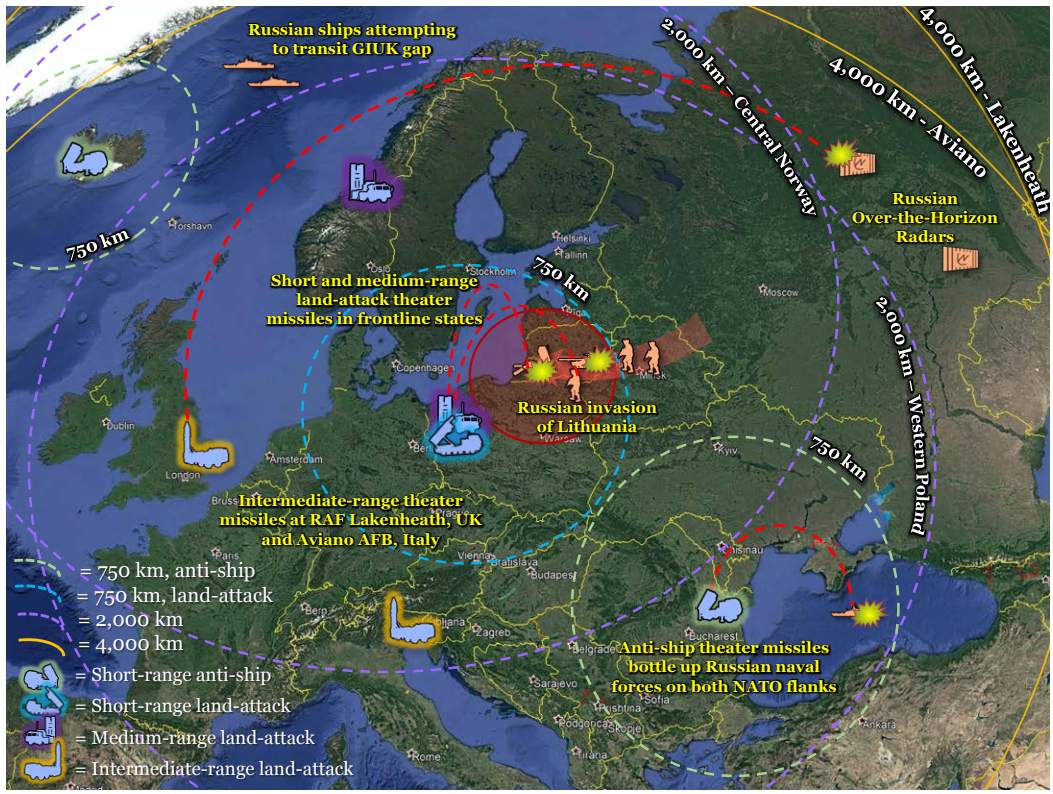
FIGURE 7: THEATER-RANGE MISSILES IN A POTENTIAL CONFLICT WITH CHINA



Russia

In the case of a conflict with Russia, conceivably caused by a Russian invasion of a North Atlantic Treaty Organization (NATO) ally like Lithuania, Russia could use its powerful IADS in the area to contest airspace throughout Eastern Europe and protect its invading forces. This could grant them enough time to secure territory and entrench themselves in strong defensive positions. These IADS would challenge the ability of NATO aircraft to attrite Russian forces invading Lithuania, since Russian IADS could shoot down planes that are only armed with short-range munitions. Also, Russian IADS themselves are defended with point defenses and other measures that make traditional Suppression of Enemy Air Defenses (SEAD) or Destruction of Enemy Air Defenses (DEAD) operations challenging. Russian missile attacks against NATO airbases could also decrease the number of aircraft sorties generated. During this critical period, theater-range missiles could promptly target key nodes in Russian IADS, creating the operational access that other U.S. military forces need to destroy other parts of the IADS and strike Russian ground maneuver forces. Additionally, if equipped with appropriate munitions (such as anti-armor or area effect submunitions) ground-launched missiles could directly attack Russian maneuver forces early in the conflict and provide responsive fires throughout the course of the campaign.

FIGURE 8: THEATER-RANGE MISSILES IN A POTENTIAL CONFLICT WITH RUSSIA

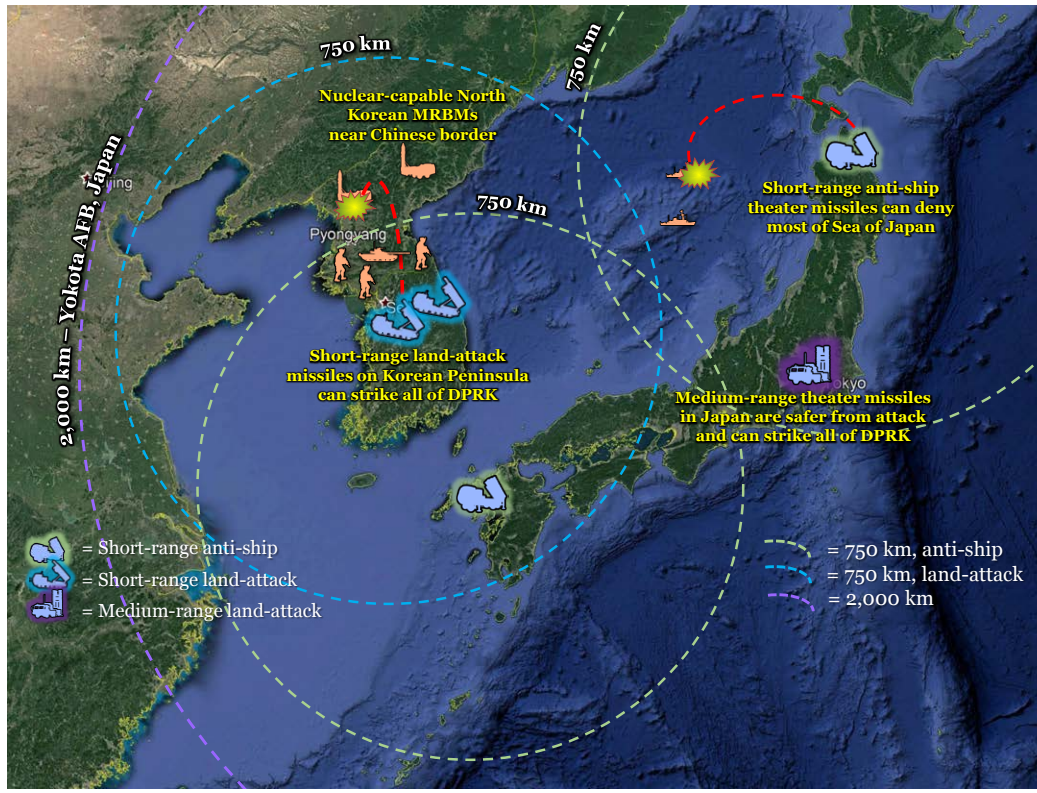


As another example in the same potential conflict, Russia could use long-range sensors located deep within Russia (such as Over-the-Horizon Backscatter radars) to detect NATO forces within Central and Western Europe and provide its forces with advance notice of inbound NATO units and, in some cases, even target cueing. Because these sensors would be located deep within Russia's borders and heavily defended by IADS, it would be challenging for NATO aircraft to safely ingress and egress these target areas early in a campaign. Consequently, these sensors could constrain NATO's ability to rapidly respond to Russian aggression. Theater-range missiles could directly target these sensors (circumventing IADS) and degrade Russia's ability to target NATO forces. These vignettes are depicted in Figure 8.

North Korea

In another potential conflict, North Korea could plan to use nuclear-armed ballistic missiles against U.S. allies (such as Japan or the Republic of Korea) or the United States. Given the consequences of potential nuclear strikes, the United States needs the ability to rapidly strike mobile ballistic missile launchers once they are detected, and high-speed ground-launched missiles could be one means of rapidly targeting these threats. This vignette is depicted in Figure 9.

FIGURE 9: THEATER-RANGE MISSILES IN A POTENTIAL CONFLICT WITH NORTH KOREA



Conclusion

Overall, at the operational level, theater-range missiles could provide valuable capabilities that would be relevant in potential conflicts. They would provide significant value on their own, but they would provide even greater value as part of the U.S. military's family of strike systems. Although not a panacea, theater-range missiles are powerful tools that are currently missing from the U.S. arsenal.

Determining what types and how many theater-range missiles to field should be evaluated in light of other new and existing weapons that can be employed from platforms in other domains (such as ships, submarines, and aircraft).[37] Ground-launched theater-range missiles, however, provide a set of capabilities not found in many other platforms based in other domains. To maximize their effectiveness, these missiles should be acquired in operationally relevant numbers that can generate sustained effects over time at the campaign level; achieving this would justify the likely significant resource investment and opportunity costs required to modify or develop and field these forces.[38]

The operational benefits of theater-range missiles could also generate strategic dividends. They would contribute to a credible U.S. warfighting ability to deny adversary aims in potential conflicts, contributing to U.S. conventional deterrence and regional stability—especially if the missiles were fielded in large numbers and in a manner that introduces uncertainty to an adversary's strategic calculus. Additionally, these weapons may contribute to a cost-imposing strategy against China and Russia by pressuring them to invest in expensive defenses and resiliency measures rather than devote those same resources to power-projection capabilities. China and Russia have been pursuing this approach with their theater-range missiles against the United States, and this would be an opportunity to return the favor.

37 In some cases, there may be opportunities to field common missiles across platforms in different domains.

38 There are other capabilities that would support the operation of theater-range missiles, including effective ISR and rapid battle management capabilities. These would also support numerous other systems across domains.

CHAPTER 5

The Strategic Benefits and Liabilities of Missile Deployment

The operational benefits detailed above must be assessed within the context of broader strategic considerations. Operations and tactics must be consistent with and nested within national objectives and strategy. Operational concepts, however efficacious, are unlikely to be translated into reality if they do not meet the standards of political feasibility. Indeed, political nonstarters are doomed to fail. It is thus important to acknowledge the liabilities, risks, and controversies as compared to potential benefits that are likely to accompany a policy decision to deploy theater-range missiles. While the objections to a U.S. ground-based missile force should be taken seriously, they are not as dispositive as critics have depicted them. The following summarizes three anticipated strategic liabilities, the counterarguments to them, and the strategic advantages to assist policymakers in weighing the political costs and benefits of deploying theater-range missiles.

First, some claim that the deployment of U.S. ground-based missiles would trigger an arms race.[39] They contend that the United States would activate a tit-for-tat cycle in which China

39 While theoretically plausible, arms races may not bear out in reality. For a Cold War example, consider Harold Brown's assessment of Soviet defense spending: "When we build, they build, and when we don't build, they build." Sven F. Kraemer, *Inside the Cold War from Marx to Reagan: An Unprecedented Guide to the Roots, History, Strategies, and Key Documents of the Cold War* (Lanham, MD: University Press of America, 2015). On arms races in general, see Thomas G. Mahnken, Joseph A. Maiolo, and David Stevenson, eds., *Arms Races in International Politics from the Nineteenth to the Twenty-First Century* (Oxford: Oxford University Press, 2016).

and Russia would respond with an accelerated buildup of their own missile arsenals.[40] A multi-sided sprint for qualitative and quantitative superiority would ensue. Such a vicious action-reaction spiral would not only deepen mutual hostilities, it would also encourage higher-risk strategies and postures on all sides. According to this view, the dangers of miscalculations and crises would rise.

Yet, the United States has been locked in "one-sided arms races" with Russia for years and with China for decades. China's rocket force has developed and deployed treaty-busting missiles since at least the 1980s, even as the United States faithfully committed itself to arms treaty limitations. As a result of its sustained investment, China's rocket force, according to the Defense Intelligence Agency, has emerged as the "the world's largest and most comprehensive missile force."[41] Both China and Russia have already fielded multiple classes of dual-capable ground-launched missiles that can strike U.S. territory—especially Guam, the Northern Marianas, Hawaii, and Alaska. As Matthew Kroenig argues, "What would be truly destabilizing would be to allow Russia and China, autocratic powers with revisionist aims, to exploit a one-side treaty on their way to a decisive military advantage."[42]

Strategy is, or ought to be, reciprocal. Continued American self-restraint in the missile competition would cede a critical strategic advantage to China and Russia. The introduction of theater-range missiles would begin to restore the military balance and shift the terms of competition in ways that favor the United States.

Moreover, rather than stimulate an arms race, it is plausible that the introduction of U.S. land-based missiles could give China and Russia an incentive to revisit their calculus about arms control regimes. Just as the deployment of the Pershing II and Gryphon helped bring the Soviet Union to negotiate the INF Treaty, the fielding of similar weapons could provide leverage in future arms control negotiations with Russia or China.[43] Specifically, the diplomatic goals would be to bring Russia back into compliance with the INF and to draw China into a multilateral version of the INF Treaty. Although neither country appears willing to agree to an arms control treaty in the short term, the United States should hold open the possibility that Russian and Chinese positions could change if both countries faced a credible threat from U.S. missile systems.

40 On concerns about arms races, see Alexandra Bell, "We Don't Have a Missile Gap in Asia. We Have a Diplomacy Gap," *The Bulletin of the Atomic Scientists,* November 2, 2018; Daryl G. Kimball, "Two Ideas That Might Stop a Post-INF Arms Race and One That Won't," *Defense One*, February 11, 2019; Rachael Bronson, "Welcome to the New Age of Nuclear Instability," *The New York Times,* February 1, 2019; and Daryl G. Kimball and Kingston Reif, "Trump's Counterproductive Decision to 'Terminate' the INF Treaty," *Issue Brief* 10, no. 9, Arms Control Association, October 21, 2018, available at https://www.armscontrol.org/issue-briefs/2018-10/trumps-counterproductive-decision-terminate-inf-treaty.

41 Lieutenant General Vincent R. Stewart, Director of the Defense Intelligence Agency, written testimony for the hearing on "Worldwide Threat Assessment," Senate Armed Services Committee, February 9, 2016.

42 Matthew Kroenig, "Withdrawal from Russia Nuclear Treaty if Right Move for America," *The Hill*, October 24, 2018.

43 Timothy A. Walton, "Why We Need the Advanced Hypersonic Weapon," *War on the Rocks*, June 9, 2014.

Second, some have expressed concerns about the risks of nuclear escalation dynamics should deterrence fail.[44] A long-range missile carrying a conventional warhead is indistinguishable from that carrying a nuclear payload. A defender, especially under the duress of war, could mistake an incoming missile salvo for a nuclear attack and respond accordingly with its own nuclear arsenal. A conventional missile campaign could also inadvertently threaten the adversary's nuclear forces, command and control, and other infrastructure, tripping the conflict over the nuclear brink. It is thus imaginable that a limited conventional missile strike could spiral into a nuclear exchange.

That having been said, the risk of nuclear escalation dynamics must be balanced against the reality that the great powers have long learned to live with the risks of nuclear escalation. As noted above, China and Russia possess a panoply of dual-use delivery systems that could threaten the United States with conventional and nuclear strikes. China's DF-26 IRBM can deliver precision-guided conventional munitions to Guam or obliterate the island with a nuclear blast. China's Rocket Force is responsible for conventional and nuclear strike missions, while its doctrine calls for the integrated use of conventional and nuclear weapons during a military campaign. The missile service embraces the idea that it would fight future wars in which the line dividing nuclear and non-nuclear operations would be blurred.

The United States, too, has long had the means to launch dual-use weaponry. American warships and submarines have fired conventionally armed Tomahawk cruise missiles against targets deep within enemy territory for decades. The United States is considering resurrecting the nuclear version of the Tomahawk after retiring it less than a decade ago. Similarly, U.S. bombers are designed to conduct strikes on the enemy's interior with conventional and nuclear-armed cruise missiles and bombs. New types of air- and sea-launched long-range strike systems, including hypersonic weapons, that can carry conventional or nuclear payloads will likely be fielded in the future.

The point is that China, Russia, and the United States all deploy dual-use long-range strike systems. They are no strangers to the potential danger of a conventional attack being misconstrued as a disarming nuclear strike, bringing with it all the attendant escalatory risks. There is insufficient empirical evidence to suggest that ground-launched weapons are inherently more escalatory than those fired from the sea or in the air.

It is not self-evident that nuclear escalation is as automatic as critics presume. Consider the calculations of a country on the receiving end of an incoming missile salvo launched by the United States. Leaders of that country would not likely reflexively conclude that they were coming under nuclear attack and thus immediately order a counter nuclear strike, a response that would guarantee a devastating, if not regime-ending, nuclear riposte. The stakes would simply be too high for decision makers to succumb to such knee-jerk reactions. Instead, it is

44 See Mary A. Kuo, "US Withdrawal from INF Treaty: Impact on Asia; Insights from Gregory Kulacki," *The Diplomat*, March 1, 2019.

plausible, and perhaps even likely, that the country under attack would absorb the first wave of attacks to determine whether it was indeed a nuclear assault rather than lash out unthinkingly out of fear and thus invite a nuclear counterattack. Such a wait-and-see response would be especially likely if the incoming strikes were limited in numbers and in geographic scope, giving the defender more confidence that it was not coming under a disarming first strike and giving it more time to rule out the worst-case scenario.

Thus, the introduction of U.S. land-based theater-range missiles would not represent a discontinuous shift in the ways that great powers have competed in the past. Rather, the extra risks, however real, would be measured by degree rather than by kind. It is up to policymakers to judge whether the added increment of escalatory risk arising from land-based missiles outweighs the strategic and operational benefits.

Third, U.S. allies could deny access to and use of their territories for the deployment of ground-based missiles.[45] Allied capitals in Europe and Asia may be deeply ambivalent about hosting American long-range strike systems, owing to the arms race and escalatory risks previously described. Moreover, they would likely fear entrapment. After all, a missile war would be waged on their soil. The Euromissile Crisis of the late 1970s and early 1980s suggests that domestic opposition to becoming embroiled in a great power war would weigh heavily on allies. At the same time, adversary coercion, such as China's strong-arm tactics against South Korea following Seoul's decision to permit the deployment of THAAD missile defense batteries, could disincline allies to cooperate. The refusal of allies to play host would deal a heavy blow to any U.S. plan, given that allied proximity to China and Russia maximizes the operational advantages of a land-based missile force.

Allied dissent, however, is not a foregone conclusion.[46] Theater-range weapons would increase U.S. warfighting options, complicate adversary war plans, and contribute to strategic deterrence. They would enhance U.S. security commitments to its allies at a time when ascendant Chinese and Russian power has eroded allied confidence. They reassure allies at the front line of intensifying great power competitions at a moment when traditional tools of American power projection are increasingly hard-pressed to inspire confidence. China and Russia can already contest U.S. air and naval supremacy near their territories, including allied territories on which American forward-deployed forces are based. During the initial phases of conflict, many types of U.S. ships and aircraft may have to withdraw from the most heavily contested areas near allied territories and operate from greater range. By contrast, forward stationed or rapidly deployable mobile missile units could withstand and survive the first waves of enemy assaults on allied territory. They would represent the most visible and potent symbol of U.S.

45 For a summary of the challenges the United States could face with Asian allies, see Pranay Vaddi, "Leaving the INF Treaty Won't Help Trump," article, Carnegie Endowment for International Peace, January 31, 2019.

46 While it is too soon to tell how receptive Tokyo would be to an American offer to deploy ground-based theater-range missiles, there is evidence that the Japanese government has begun to consider the potential merits and liabilities of U.S. missile presence on Japanese soil. See Koji Sonoda, Takashi Funakoshi, Ryo Kiyomiya, Kenji Minemura, and Taketsugu Sato, "In Post-INF Treaty World, China, U.S. Risk Arms Escalation," *The Asahi Shimbun*, April 12, 2019.

steadfastness while incurring tangible costs on adversary operations. The presence of such missile forces and their continuing resistance would demonstrate allied resolve and solidarity.

By introducing theater-range missiles, the U.S. military could rebalance its portfolio of forward-deployed forces in ways that relied less on certain types of vulnerable air and naval assets. Such a change in the composition of forward presence could do more to assure allies in times of crisis and conflict. Given its current posture, the United States may be compelled to pull back high-value air and naval forces during a crisis to avoid suffering substantial losses in a surprise attack, keep them temporarily out of harm's way, and bring them back into the fight under more favorable circumstances. Such a prudent act of self-preservation, however, could send the wrong message to U.S. allies at the precise juncture when they would need reassurances the most. The prospect of fighting for some time, perhaps over an extended period, without substantial U.S. forces on the ground or nearby would be unappealing, if not alarming, to allied capitals. Allies would have to further trust that such an air and naval withdrawal, even if partial, would be temporary. In some cases, they would have to count on the United States to fight its way back to defeat an adversary and, if necessary, liberate captured territory. Even if allies were confident that they would ultimately prevail under such a sequence of events, the idea that they may have to resist alone or fight without the full force of American power, at least initially, would prove to be a heavy burden.

It is in this urgent and politically sensitive context that forward-based theater-range missiles would pay strategic dividends. Ground-based missiles are both far more survivable than aircraft on the ground and ships in port and far harder to move out of theater. These missiles—akin to boots on the ground—could be deployed in peacetime in place of or in conjunction with more vulnerable air and naval platforms. They would stay through times of crisis, even as air and naval units fell back to safer areas, and the missiles' presence would be communicated unequivocally to friend and foe alike. Or, they could be surged onto allied territories during crisis or war. Additionally, if these missile forces were dispersed to well defended or well-hidden sites and firing positions amply stocked with prepositioned fuel, ammunition, and materiel, they could provide a combat-credible force for an extended period. The presence of such missiles, involving as it does American blood and treasure, could allay allied fears following the pullback of other U.S. forces in an emergency. A forward-deployed force that featured an appropriate mix of air, naval, and missile units could thus more effectively telegraph U.S. resolve. If such a force adopted a peacetime posture that routinely demonstrated the resilience and lethality of land-based missiles through regular exercises and training, it could go far to reassure regional partners and reshape allied expectations about how the United States would signal its firmness of purpose in times of duress.

By no means should policymakers dismiss the three risks illustrated above, but they are far more ambiguous than their proponents presume. Provided that policymakers are clear-eyed about these risks and take prudent measures to mitigate them, including close consultations with allies, the strategic barriers to a land-based missile force are not insurmountable.

CHAPTER 6

The Costs of Catching Up

Despite the overall benefits ground-launched theater-range missiles can provide to U.S. forces, those merits must be examined in light of their costs. CSBA has estimated the acquisition costs (research, development, testing, and evaluation [RDT&E] and procurement) for over a dozen capabilities the United States could pursue as it departs the INF Treaty, as well as two other options that are not expressly prohibited under the INF Treaty. These cost estimates, all in constant 2018 U.S. dollars, were generated through two primary methods. First, for systems that have already been procured or are in development, costs were based on the best public data for the most recent year available—usually sources such as the DoD budget submission or DoD Selected Acquisition Reports. Second, for systems that do not currently exist or for systems in-development whose characteristics are still largely unknown, costs were estimated based on relevant current and past DoD programs. For instance, CSBA used the ATACMS and Pershing II procurement costs and weapon system characteristics to estimate procurement costs for the Army's new Precision Strike Missile (PrSM) and an illustrative Pershing III MRBM, respectively. Using these historical programs as a baseline, CSBA developed a missile cost estimate tool to predict the costs of a new missile based on its capabilities (range and payload weight) relative to the capabilities of that relevant older system.

The estimated costs presented here are the costs of pursuing each system individually. If multiple variants of the same missile are developed (e.g., developing an anti-ship variant of an already-developed land-attack missile), multiple missiles use the same launcher vehicle, or a missile with similar specifications is pursued as a follow-on program to an already-developed missile, then it is likely that acquisition costs could be sizably lower. Cost estimates can also vary based on factors such as historic program cost growth and the degree to which a technology has matured and, subsequently, reduced cost since the time of the relevant baseline program.

These capability options vary by range (short, medium, and intermediate); missile type (ballistic, cruise, and boost-glide); and missile purpose (land-attack or anti-ship).[47] None of these options include fielding nuclear-armed missiles, though nuclear-capable variants of many of these systems could be developed. All options use ground-based road-mobile launchers. Several of these systems could feasibly be fielded in large numbers within five years, but most options will likely require more than five years of development and production to field in large quantities, even with a high and consistent level of funding and attention. Each capability option examined here is given an estimated procurement cost per missile, an estimated procurement cost per battery, and an estimated cost of acquiring 400 missiles and sufficient launchers to carry 200 missiles simultaneously.[48]

When examining the estimated costs of ground-launched missiles, two major trends come to the forefront. First, longer-range systems are more expensive than equivalent shorter-range systems due to the need for more fuel and more propulsive motors to achieve longer ranges. Second, anti-ship weapons tend to be more expensive than their land-attack counterparts, as more sophisticated and costly sensor equipment is required onboard each missile to hit a moving target rather than a stationary one.

Near-Term Options

Of the capabilities the United States could pursue in the short-term, all are shorter-range systems currently in development or active systems that could be adapted to become ground-launched. All these systems could be fielded in significant numbers for lower costs than many of the longer-range and longer-term capabilities discussed later in this section. The options listed in this section are representative of the full range of near-term options available to U.S. forces.

The Precision Strike Missile is the planned successor to the ATACMS missile. Scheduled to achieve Initial Operational Capability (IOC) between 2023–2025, not only is the PrSM

47 Many types of anti-ship missiles could also have a land-attack capability, making them multi-mission weapons. For purposes of clarity, this report categorizes missiles as either land-attack or anti-ship. Another option CSBA does not examine in this report are long-range missiles with ranges greater than 5,500 km. If it were a ground-launched ballistic missile with a range greater than 5,500 km, it would fall under the auspices of the New START Treaty. However, if the missile did not have a ballistic trajectory over most of its flight path (as could be the case with some boost-glide missiles), then it would not fall under New START. Protocol to the Treaty Between the United States of America and the Russian Federation on Measures for the Further Reduction and Limitation of Strategic Offensive Arms, U.S. Department of State, April 8, 2010, pp. 2, 7, available at https://www.state.gov/documents/organization/140047.pdf.

48 Missile batteries, as a unit of force structure, are assumed to include the deployed missiles, an additional set of missiles to allow each launcher to fire a second salvo, launcher vehicles, and the necessary support vehicles. For ease of comparison, CSBA assumed a consistent battery size for all missile systems. Each battery deploys with 16 missiles ready for launch and an additional 16 available for a second salvo. As an example, a future Precision Strike Missile (PrSM)-armed HIMARS battery would consist of 16 PrSM SRBMs deployed on eight launchers and an additional 16 missiles available for a second salvo. Many of these missile systems would likely not be fielded in batteries of 16 missiles (the Pershing II was fielded in batteries of nine, for example). The number of launcher vehicles per battery will vary depending on how many of each missile can fit on the launcher, with the number of missiles per launcher estimated based on missile dimensions, launcher size, and weight capacity.

expected to be "less than half the cost" of the ATACMS, but also a HIMARS launcher should fit two PrSMs, as opposed to one ATACMS.[49] Since the planned maximum range of the PrSM (over 400 km but less than 499 km) is more of a political limit imposed on its design by the INF Treaty than a technical one, it may be relatively practical and inexpensive to increase this range by a few hundred kilometers.[50] If the planned PrSM is indeed half the cost of the ATACMs or less, a 750-km extended-ranged PrSM may cost between $500,000 and $800,000 per missile.[51] This would likely provide the PrSM with the lowest per battery cost (about $25 million) of any missile examined; this is due in part to the Army and Marine Corps extant possession of the HIMARS launchers they would fire from, as well as to the PrSM having the lowest procurement cost of any missile considered. If PrSM units required new HIMARS launchers, however, the average battery cost could nearly triple. If the United States wanted to acquire 400 PrSM missiles for its HIMARS launchers, the total cost may be about $1.1 billion, including $780 million of further development costs for the ongoing program.[52]

The Long-Range Anti-Ship Missile (LRASM) is another plausible, near-term post-INF option. The LRASM is currently only an air-launched missile, though a surface-launched variant has been tested multiple times, potentially reducing the development costs necessary to adapt LRASM to become a ground-launched missile.[53] Developing a ground-launched variant could cost between $250–500 million.[54] LRASM could be integrated on a HIMARS; however, fitting four missiles, as on the Gryphon launcher during the Cold War, would likely require a different, larger launch vehicle. This larger launcher could be based on the HEMTT variant of the FHTV and used for other weapons systems in this section. This HEMMT-based launcher (hereafter referred to as the HEMMT-M), could cost roughly $300–400 million to develop,

49 "Double the Combat Power with Raytheon's DeepStrike Missile System," video, The Raytheon Company, October 24, 2018, available at https://www.raytheon.com/capabilities/products/deepstrike_long_range_precision_fires; and Jen Judson, "Army Pushes to Get Precision Strike Munition to the Force by 2023," *Defense News,* October 9, 2018.

50 Sydney J. Freedberg Jr., "Army Building 1,000 Mile Supergun," *Breaking Defense,* October 11, 2018; and Jason Sherman, "Army Rachets Up Range Requirement for PrSM to 400 Kilometers," *Inside Defense,* May 10, 2019.

51 The ATACMS per-unit cost is sourced and inflated to 2018 USD from Office of the Secretary of Defense (Comptroller) (OUSD[C]), Procurement Programs (P-1): Department of Defense Budget for Fiscal Years 1998/1999 (Washington, DC: DoD, February 1997), available at https://comptroller.defense.gov/Portals/45/Documents/defbudget/fy1998/fy1998_p1.pdf.

52 Development costs of the PrSM were based off the Army's FY 2020 budget proposal for "Long Range Precision Fires," deflated to 2018 dollars, as noted in U.S. Army, *Department of Defense Fiscal Year (FY) 2020 Budget Estimates: Army Justification Book of Research, Development, Test & Evaluation*, Volume III, *Budget Activity 7* (Washington, DC: DoD, March 2019), p. 69, available at https://www.asafm.army.mil/documents/BudgetMaterial/fy2020/rdte_ba7.pdf.

53 Sam LaGrone, "LRASM Scores in Navy Test Ship Launch," *USNI News,* July 20, 2016.

54 Adaptation costs to develop a ground-launched LRASM were based on a 2017 RAND estimates that it would cost $200–300 million to develop a ground-launched LRASM variant from a fully developed surface-launched variant. Since the surface-launched LRASM was only ever tested, CSBA estimates this cost would be higher, perhaps $250–500 million. See Timothy Bonds et al., *What Role Can Land-Based, Multi-Domain Anti-Access/Area Denial Forces Play in Deterring or Defeating Aggression?* (Santa Monica, CA: RAND Corporation, 2017), p. 140, available at https://www.rand.org/content/dam/rand/pubs/research_reports/RR1800/RR1820/RAND_RR1820.pdf.

about $7 million per launcher to procure, and carry four LRASMs.[55] If the U.S. were to acquire 400 LRASM missiles and 50 launchers, it may cost about $2.0–2.5 billion (at about $3 million per missile and $130 million per battery).

Perhaps the easiest short-term means of fielding a theater-range missile is a ground-launched Tomahawk Land-Attack Missile (TLAM). The United States already has many medium-range TLAM Block IVs in its inventory, with its most recent bulk Tomahawk purchase in FY 2018 costing $1.4 million per missile.[56] The Tomahawk and its in-development anti-ship variant, the Maritime Strike Tomahawk (MST), are surface-launched systems and may require only minimal adaptations to become ground-launched, perhaps less than $100 million in development costs. With four missiles per HEMMT-M launcher, the total cost of acquiring 400 TLAMs and 50 launchers may be $1.4 billion (about $80 million per battery). Alternatively, the same number of MSTs may cost between $1.6–2.0 billion, depending on whether the MSTs are modified Block IV Tomahawks or new-build missiles.

Medium-Term Options

This section includes theater-range missiles that the United States could pursue in the medium-term (more than five years) to field a robust theater missile capability. Some of these systems could build off existing designs or test programs and be fielded in limited numbers in slightly less than five years, while others would involve significant, years-long development programs. Also, since these are all longer-ranged systems and many require longer development periods, they tend to come with a higher price tag.

One of the most widely cited options available to the United States in a post-INF world is to bring back a next-generation conventional variant of the missile that the INF Treaty was famous for banning in the first place—the Pershing II MRBM. If the United States pursued a "Pershing III" MRBM with a 2,000-km range (slightly greater than the 1,700-km Pershing

55 Development cost estimates for this notional HEMMT-M launcher were based on the inflated base year 2003 costs of developing the FMTV into the HIMARS ($323 million 2018 constant USD) found in "HIMARS: Selected Acquisition Report (SAR)," Defense Acquisition Management Information Retrieval (DAMIR), December 31, 2011, accessed at https://www.globalsecurity.org/military/library/budget/fy2011/sar/himars_sar_31-dec-2011.pdf. Per-unit procurement cost of the notional HEMMT-M launcher was calculated based on the deflated FY 2020 gross weapon system unit cost of the HEMTT-Load Handling System (LHS) multiplied by the per-unit cost ratio between the FMTV and HIMARs (HIMARS per-unit cost source noted in footnote above). HEMMT unit cost is noted in U.S. Army, *Department of Defense Fiscal Year (FY) 2020 Budget Estimates: Army Justification Book of Other Procurement, Army Tactical and Support Vehicles, Budget Activity 1* (Washington, DC: DoD, March 2019), p. 61, available at https://www.asafm.army.mil/documents/BudgetMaterial/fy2020/opa_ba1.pdf. FMTV unit cost was inflated from data found in ""FMTV: Selected Acquisition Report (SAR)," Defense Acquisition Management Information Retrieval (DAMIR), December 31, 2011, accessed at https://www.globalsecurity.org/military/library/budget/fy2011/sar/fmtv_sar_31-dec-2011.pdf.

56 Richard Scott, "Raytheon Receives Last Tomahawk Production Contract from USN," *IHS Janes,* May 1, 2018, available at https://web.archive.org/web/20180706055900/http://www.janes.com/article/79689/raytheon-receives-last-tomahawk-production-contract-from-usn.

II), CSBA estimates it may cost about $16 million per missile and $820 million to develop.[57] However, larger missiles like a Pershing III likely require a heavier launcher vehicle than the HEMTT-M. One Pershing III may fit on the HEMMT-M launcher, though two Pershing IIIs almost certainly could not. A new heavier launcher, based on the FHTV's Palletized Load System (PLS), would cost perhaps $12–14 million apiece.[58] With this PLS-M launcher carrying two Pershing IIIs each, one Pershing III battery may cost about $625 million. If the United States were to acquire 400 Pershing IIIs and 100 launchers, it may cost $9 billion. If the United States elected to modify this Pershing III to create an American answer to the Chinese DF-21D anti-ship ballistic missile (ASBM), a Pershing III ASBM would be slightly more expensive, costing roughly $18 million per missile and $700 million per battery.

Another option would be to field a notional Small MRBM, designed to deliver a 250-lb warhead 1,500 km rather than the Pershing III's 1,000-lb warhead 2,000 km. These lower requirements could make this Small MRBM comparatively cheaper at $6–8 million per missile.[59] The smaller size would allow for more Small MRBMs to fit on the smaller HEMTT-M launcher, lowering the average battery cost to about $275 million. Acquiring 400 of these Small MRBMs and 50 launchers may cost an estimated $4 billion. An anti-ship variant could cost $8–10 million per missile and about $325 million per battery.

If the United States wanted to develop an IRBM with a 4,000-km range equivalent to China's DF-26, such a missile may cost $21 million apiece and $1.1 billion to develop.[60] With only one missile fitting on the heavy PLS-M launcher, the average battery cost would be a good deal higher than the Pershing III MRBM at $900 million. If the United States instead decided to pursue a boost-glide missile of the same range, which would technically be an INF-compliant system, it may have a similar unit cost to its ballistic missile counterpart, assuming both

57 Estimated per-unit cost of the longer-range "Pershing III MRBM" was generated using CSBA's missile cost estimate tool, taking into account the range, payload, and per-unit cost inflated to 2018 dollars ($13.6 million) of the Pershing II, sourced from Stephen Schwartz, *Atomic Audit: The Costs and Consequences of U.S. Nuclear Weapons Since 1940* (Washington, DC: Brookings Institution, June 1, 1998). Since the Pershing II acquisition cost data in *Atomic Audit* is not broken down into subcomponents like procurement, procurement costs were estimated using the ratio of Pershing II procurement cost to the total program cost (68 percent) found in U.S. General Accounting Office (GAO), *INF Treaty: Cost of Weapon Systems to be Destroyed and Possible Savings* (Washington, DC: GAO, March 1988), p. 3, available at https://www.gao.gov/assets/90/87960.pdf. Development costs of the notional Pershing III MRBM were based off the Army's FY2020 proposal for a "Mobile Medium-Range Missile," deflated to 2018 dollars, as noted in Jason Sherman, "Army Proposing New Mobile Medium-Range Missile, a $900M Development Project," Inside Defense, March 18, 2019.

58 Per-unit procurement cost of the notional PLS-M launcher was calculated based on the deflated FY 2020 gross weapon system unit cost of the Palletized Load System multiplied by the per-unit cost ratio between the FMTV and HIMARS. The PLS unit cost is noted in U.S. Army, *Army Justification Book of Other Procurement, Army Tactical and Support Vehicles, Budget Activity 1* (March 2019).

59 The Small MRBM per-unit cost was generated using CSBA's missile cost estimate tool, taking into account the Small MRBM's range and payload relative to the Pershing II.

60 The IRBM per-unit cost was generated using CSBA's missile cost estimate tool, taking into account the IRBM's range and payload relative to the Pershing II. Development costs of the notional IRBM and intermediate-range boost-glide missile were based off of the Army's FY 2020 proposal for a "Long-Range Hypersonic Weapon," deflated to 2018 dollars, as noted in Jason Sherman, "Army Earmarks $1.1B in FYDP for Long-Range Hypersonic Weapon," *Inside Defense,* March 15, 2019.

systems use similar rocket boosters. Deploying 400 of either an IRBM or a boost-glide intermediate-range missile on 200 launchers may cost about $12–13 billion.

Figure 10 summarizes the estimated procurement cost of each real or notional missile, the costs if each type of missile was fielded in a 12-missile battery, and the estimated development/adaptation costs required before the missile could be procured.

FIGURE 10: ESTIMATED MISSILE AND BATTERY PROCUREMENT AND SYSTEM DEVELOPMENT COSTS OF DIFFERENT THEATER-RANGE MISSILE OPTIONS

	Short-Range (500–999 km)	Medium-Range (1,000–2,999 km)		Intermediate-Range (3,000–5,500 km)
Ballistic, Land-Attack	**PrSM** Missile: $500–800k Battery: $25M Dev: $780M	**Pershing III MRBM** Missile: $16M Battery: $625M Dev: $820M	**Small MRBM** Missile: $6–8M Battery: $275M Dev: $600M	**IRBM** Missile: $21M Battery: $900M Dev: $1.1B
Ballistic, Anti-Ship	**PrSM Anti-Ship** Missile: $1.5–2M Battery: $60M Dev: $900M	**Pershing III ASBM** Missile: $18M Battery: $700M Dev: $1B	**Small MR-ASBM** Missile: $8–10M Battery: $325M Dev: $700M	**IR-ASBM** Missile: $23M Battery: $950M Dev: $1.3B
Cruise, Land-Attack	**Ground-Launched JASSM-ER** Missile: $1.1M Battery: $65M Dev: $250–500M	**Ground-Launched Tomahawk** Missile: $1.4M Battery: $80M Dev: <$100M		**Ground-Launched Tomahawk—Extended Range** Missile: $3–4M Battery: $160M Dev: $600M
Cruise, Anti-Ship	**Ground-Launched LRASM** Missile: $3M Battery: $130M Dev: $250–500M	**Ground-Launched Maritime Strike Tomahawk (MST)** Missile: $2–2.5M Battery: $110M Dev: <$100M		**Ground-Launched Maritime Strike Tomahawk—Extended Range** Missile: $4–5M Battery: $200M Dev: $700M
Boost-Glide, Land-Attack				**IR-Boost-Glide** Missile: $21M Battery: $900M Dev: $1.1B
Boost-Glide, Anti-Ship				**IR-Boost-Glide Anti-Ship** Missile: $23M Battery: $950M Dev: $1.3B

The costs offered in this table include the estimated procurement cost of the missile, the estimated cost of a battery of 12 of these missiles, and the cost to develop this missile as a standalone system. Each system's listed development costs would likely be lower if the system was pursued as a follow-on program or variant of a similar capability elsewhere in this table. Real and notional missile systems are categorized by general range classes (Short-Range, Medium-Range, and Intermediate-Range). The missiles listed in the table may not necessarily reach the upper bounds of each range class. For example, a Ground-Launched Tomahawk is listed within the Medium-Range class (1,000–2,999 km) but has an estimated maximum range of roughly 1,500 km. Short-range is considered by NASIC to be ranges between 300 km and 999 km, split by the INF Treaty's ban on ground-launched systems between 500 and 5,500 km.
ORANGE: Near-term option
PURPLE: Medium-term option

A comparison with other platforms that could play similar operational and strategic roles as those of ground-launched missiles puts the estimated costs summarized above in perspective. For example, a new *Arleigh Burke*-class guided-missile destroyer (DDG) costs about $1.8 billion to procure and carries 96 Vertical Launch System (VLS) cells for missiles, each of which could hold one Tomahawk land-attack cruise missile (LACM).[61] However, on most DDGs, an estimated 75 percent of VLS cells are assigned to missions other than strikes ashore, including ballistic missile defense, anti-submarine warfare, anti-surface warfare, and anti-air warfare. These other missions are essential to fleet defense as well as to shielding the homeland and allies from ballistic missile attack. As such, there may be a significant opportunity cost to using DDGs, or other naval strike platforms, for land-attack missions. In contrast, a battery and a half of ground-launched Tomahawks (24 missiles on six launchers) could fire the equivalent number of missiles typically loaded onboard a destroyer at the cost of about $120 million. To be sure, comparing the cost of a single-mission system like a ground-launched LACM with that of a highly mobile and versatile platform like a modern warship is imperfect at best. Nevertheless, land-based missiles may be cheaper instruments for delivering long-range strikes. More importantly, ground-launched missiles would free up multi-role platforms, like ships and aircraft, for other tasks, including to conduct strikes in areas not reachable by ground-launched missiles.

The foregoing assessment represents a first-order costing of ground-launched missiles. As defense planners and policymakers study strike options available to U.S. forces, they should examine the operational utility of different ground-launched missiles in relevant scenarios—taking into account their expected level of survivability under different conditions—and the costs required to field operationally relevant numbers of weapons. They should also compare the costs required to field these systems with alternate capabilities, such as bombers, ships, or submarines. When evaluating capabilities from other domains, defense planners and policymakers should further consider the cost implications for end-strength as well as the costs of any additional sensors or datalinks necessary to enable the effective use of ground-launched theater-range missiles.

61 OUSD(C)/Chief Financial Officer (CFO), *Program Acquisition Cost by Weapon System*, United States Department of Defense Fiscal Year 2020 Budget Request (Washington, DC: DoD, March 2019), p. 6-5, available at https://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2020/fy2020_Weapons.pdf.

CHAPTER 7

Conclusion

This report concludes with several parting thoughts for policymakers who must anticipate the difficult and pressing decisions that will almost certainly accompany the end of the INF Treaty. First, policymakers should hold realistic expectations about the potential contributions of land-based missiles forces in competition, crisis, and conflict. Theater-range missiles should not be viewed as a silver bullet to the operational challenges that U.S. forces face in Europe and Asia. They could help claw back some of the military advantages that the United States had ceded to its opponents in past years. They are one among many military instruments that will need to be sharpened to uphold deterrence. Should deterrence fail, they offer more options, mitigate some risks, and impose certain costs on Russia and China. While they are not a panacea, they may be the difference that denies the adversary its operational objectives and averts defeat.

Second, policymakers should view the introduction of land-based missile forces as one of many moves and countermoves in a long-term competition with China and Russia. Competition is an inherently dynamic, interactive process involving two or more resourceful and determined competitors. Each side in such a competition will do its very best to obtain or preserve its strategic advantage while denying gains to its opponent. Policymakers should thus expect Beijing and Moscow to respond to this U.S. initiative with the kinds of ingenuity and verve that they have consistently exhibited in the past. The deployment of theater-range missiles is not a checkmate. Rather it is one step that will likely trigger Chinese and Russian counteractions intended to blunt the worst effects of U.S. missile forces and hold valuable U.S. targets at risk. To ensure that its advantages are not short lived, Washington must creatively think ahead. Such is the nature of competitions.

Third, policymakers should anticipate that the strategic and the financial considerations documented above will influence the shape, size, and configuration of a future land-based missile force. Moreover, they should recognize early the potential interplay and tensions between politics and resources. The scarce political capital spent to obtain access to allied territory, which would open the door to the deployment of shorter-range and thus cheaper missiles, could ease

the overall financial burden of fielding a missile force. But, missiles on allied soil are likely to be subjected to a range of host nation restrictions that would constrain the use of forward-deployed units. In contrast, long-range missiles based on U.S. territory are likely to enjoy more operational latitude; yet, the high costs of such missiles could limit the force size and thus reduce the kinds and numbers of missions that these delivery systems could perform. Striking a meaningful balance between close-in and more distant missile forces that maximizes U.S. deterrence will demand rigorous operational analysis and political dexterity of the first order.

What this report has sketched out should be the start of a conversation about the strategic and operational implications of fielding a land-based theater-range missile force. Should Washington exercise the freedom to deploy missiles following the treaty's abrogation, many specific and difficult tasks—ranging from high politics to the mundane—would await policy-makers. Such issues as force design, doctrine, tactics, allied consultations, and Congressional support will need to be tackled. It behooves policymakers to think through these challenges now as the post-INF era draws near.

LIST OF ACRONYMS

A2/AD	anti-access/area denial
AFB	Air Force Base
ASAT	anti-satellite
ASBM	anti-ship ballistic missile
ASCM	anti-ship cruise missile
ATACMS	Army Tactical Missile System
BMD	ballistic missile defense
C2	command and control
CRBM	close-range ballistic missile
DDG	guided missile destroyer
DEAD	Destruction of Enemy Air Defenses
DPRK	Democratic People's Republic of Korea
FHTV	Family of Heavy Tactical Vehicles
FMTV	Family of Medium Tactical Vehicles
GIUK	Greenland-Iceland-United Kingdom
GLCM	ground-launched cruise missile
HEMTT	Heavy Expanded Mobility Tactical Truck
HGV	hypersonic glide vehicle
HIMARS	High Mobility Artillery Rocket System
IADS	integrated air defense system
ICBM	intercontinental ballistic missile
INF	Intermediate-Range Nuclear Forces Treaty
IOC	Initial Operational Capability
IR-ASBM	intermediate-range anti-ship ballisic missile
IRBM	intermediate-range ballistic missile
ISR	intelligence, surveillance, and reconaissance
JASSM-ER	Joint Air-to-Surface Standoff Missile - Extended Range
LACM	land-attack cruise missile
LHS	Load Handling System
LRASM	Long-Range Anti-Ship Missile
MEL	mobile erector launcher
MRBM	medium-range ballistic missile
MST	Maritime Strike Tomahawk
NATO	North Atlantic Treaty Organization
PLA	People's Liberation Army
PLAAF	People's Liberation Army Air Force
PLS	Palletized Load System
PRC	People's Republic of China
PrSM	Precision Strike Missile

RAF	Royal Air Force
RDT&E	research, development, testing, and evalution
SEAD	Suppression of Enemy Air Defenses
SRBM	short-range ballistic missile
SSA	Space Situational Awareness
TEL	transporter-erector launcher
THAAD	Terminal High Altitude Area Defense
TLAM	Tomahawk Land Attack Missile
VLS	Vertical Launch System

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