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Defending the Homeland

Growing Foreign Challenges to the U.S. Missile Defense Posture

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Contents

Executive Summary 4

Purpose 5

Introduction 6

Key Findings 7

Key Finding 1: The primary benefit of the GMD system is the protection it provides the U.S. homeland against a limited but evolving rogue-state missile threat. 7

Key Finding 2: Potential adversaries continue to develop long-range ballistic missiles despite deployment of a U.S. homeland missile defense system. 10

Key Finding 3: While Russia has used the existence of a U.S. homeland missile defense system as a justification for its substantial and continuing weapon modernization program, neither Russian force modernization nor the limited U.S. homeland missile defense system has altered the strategic balance. 13

Key Finding 4: China's expansion and diversification of its nuclear and missile forces has been influenced by its concerns about U.S. homeland missile defense, but those concerns are only one of many factors in China's force planning. Although China's actions to preserve and expand its assured retaliation prospects have not fundamentally altered the strategic balance, its buildup and lack of transparency about its force modernization goals are troubling. 17

Key Finding 5: The basic finding that benefits have not so far been undermined by adverse reactions is a function of circumstances that are increasingly in flux. 20

Annex A: The Rationale for, and Concept of, U.S. Homeland Missile Defense Has Evolved over Time (Late Cold War Objectives Were Expansive in Nature, Ultimately Unrealized) 23

1980s: SDI Aimed To Render Nuclear Weapons Obsolete 23

Early 1990s: After the Cold War, Homeland Missile Defense Focused on Protection against a "Limited" Attack 24

Mid-1990s: A Growing Regional Challenge and Debate over Severity of Threat to the U.S. Homeland Arise 25

Late 1990s: Homeland Missile Defense Goals Are Made Yet More Modest as "Limited" Is Redefined 26

Early 2000s: Moving beyond the ABM Treaty 26

2010s: Homeland Missile Defense—New Priorities Arise for an Enduring Mission 30

2017 and After: The Homeland Is No Longer a Sanctuary 31

Annex B: Foreign Missile Capabilities Pose a Growing Challenge to the Homeland Defense Posture 34

North Korea 35

Iran 36

Russia 37

China 39

References 41

Executive Summary

The Office of the Secretary of Defense (OSD) for Policy requested that Lawrence Livermore National Laboratory conduct a Congressionally directed study on homeland missile defense, pursuant to Section 1692 of the fiscal year 2020 National Defense Authorization Act. In accordance with the statutory language, this study:

1. Considers whether the security benefits obtained by deployment of homeland missile defenses of the United States are undermined or counterbalanced by adverse reactions of potential adversaries.
2. Considers the effectiveness of homeland missile defense efforts of the United States to deter the development of ballistic missiles.

Almost a half-century has elapsed since the United States and the Soviet Union signed the Anti-Ballistic Missile (ABM) Treaty, and almost two decades since the former withdrew. Since withdrawing, the United States has sought to develop and deploy a layered missile defense system (1) to defend against regional threats to U.S. and allied interests abroad and (2) to counter limited threats to the U.S. homeland. As such, missile defense supports key national defense policy objectives:

- Protecting the U.S. homeland, forces abroad, allies, and partners.
- Deterring attacks against the United States, its allies, and partners.
- Assuring allies.
- Strengthening U.S. diplomatic activities in peacetime and crisis.

We offer five key findings:

1. **The primary benefit of the Ground-based Midcourse Defense (GMD) system is the protection it provides the U.S. homeland against a limited but evolving rogue-state missile threat**. While this system has never been tested in combat, it appears thus far to have effectively paced North Korea’s development and deployment of intercontinental ballistic missiles (ICBMs). In the absence of such a defensive capability, the United States would likely have been more heavily exposed to North Korean actions, would have operated at a much higher-risk posture, and would have had less negotiating room with which to navigate coercive tactics and crises. Its allies would have been more concerned about U.S. willingness in time of crisis and war to run the risks of protecting them. The GMD system also serves as a hedge against Iranian breakout.
2. **Potential adversaries continue to develop long-range ballistic missiles despite deployment of a U.S. homeland missile defense system.** This includes both rogue states and major power rivals whose long-range missile programs predated the deployment of U.S. missile defenses. While North Korea has continued its long-range missile developments and achieved an intercontinental capability, Iran has not yet reached this threshold. The broader proliferation of long-range missiles anticipated in the late 1990s has not materialized.
3. **While Russia has used the existence of a U.S. homeland missile defense system as a justification for its substantial and continuing weapon modernization program, neither Russian force modernization nor the limited U.S. homeland missile defense system has altered the strategic balance.** Russia has long considered U.S. missile defenses—both theater and homeland—as directed against its strategic forces and as a capability that could rapidly advance, thereby eroding Russian confidence in its nuclear deterrent. Russia’s political and military actions appear excessive and negatively impact areas such as arms control, but they do not undermine the primary benefit of the U.S. system cited in Key Finding 1.

4. **China's expansion and diversification of nuclear and missile forces has been influenced by its concerns about U.S. homeland missile defense, but those concerns are only one of many factors in China's force planning. Although China's actions to preserve and expand its assured retaliation prospects have not fundamentally altered the strategic balance, its buildup and lack of transparency about its force modernization goals are troubling.** Taken together, the aggregate pattern of China's modernization activities over the past two decades strongly suggests a concerted effort to develop a modern military force commensurate with its intended geopolitical status. Whatever China's legacy concerns over the survivability of its strategic nuclear forces, its ability to overwhelm the GMD system appears intact today and will be further strengthened in the years ahead as it continues its long-term modernization program. China's political and military actions negatively affect U.S. security interests but do not undermine the primary benefit of the U.S. system cited in Key Finding 1.

5. **The basic finding that benefits have not so far been undermined by adverse reactions is a function of circumstances that are increasingly in flux.** The existing GMD-centered system is under increasing pressure from the pace and scope of North Korean missile deployments. The proposed "layered" system seeks to mitigate this impending capability gap in the near term and to complement future capabilities, such as the Next Generation Interceptor, when they come online. Given the pace of U.S. missile defense developments since 2000, it is possible that adversary advances in capability will outpace the U.S. system's ability to adapt. Additionally, because this layered system is in principle more readily scaled, it will almost certainly be viewed skeptically by China and Russia. In a context of growing great-power security competition, the Department of Defense (DoD) should consider undertaking a broader net assessment of the U.S., Russian, and Chinese force balance.

Purpose

Section 1692 of the fiscal year 2020 National Defense Authorization Act requires that the OSD identify and select a Federally Funded Research and Development Center to conduct a Congressionally directed study on missile defense. In turn, OSD requested that Lawrence Livermore National Laboratory provide the required study as follows:

SEC. 1692. Independent Study on Impacts of Missile Defense Development and Deployment

a. Study—Not later than 30 days after the date of the enactment of this Act, the Secretary of Defense shall seek to enter into an agreement with a Federally Funded Research and Development Center to conduct a study on the impacts of the development and deployment of homeland missile defenses of the United States on the security of the United States as a whole.

b. Matters Included—The study under subsection (a) shall—

    1. Consider whether the security benefits obtained by the deployment of homeland missile defenses of the United States are undermined or counterbalanced by adverse reactions of potential adversaries, including both rogue states and near peer adversaries; and

    2. Consider the effectiveness of the homeland missile defense efforts of the United States to deter the development of ballistic missiles, in particular by both rogue states and near-peer adversaries.

c. Submission—Not later than one year after the date of the enactment of this Act, the Secretary shall submit to the congressional defense committees the study under subsection (a), without change.

d. Form—The study shall be submitted under subsection (c) in unclassified form, but may include a classified annex.

Introduction

Almost a half-century has elapsed since the United States and the Soviet Union signed the ABM Treaty, and almost two decades since the former withdrew. Consistent with the logic of mutual assured destruction, the Treaty initially limited the deployment of ABM systems capable of defending against "strategic ballistic missiles" to two sites nationally, and it capped deployment at no more than 100 interceptors at each site.

By the time the United States withdrew from the ABM Treaty, the strategic context had evolved considerably: the Berlin Wall had fallen, the Cold War had ended, the Soviet Union had dissolved, and a different set of security challenges had in the U.S. view come to dominate the U.S.-Russian strategic relationship. This increased U.S. interest in effecting a missile defense capability designed both to defend against regional threats to U.S. and allied interests abroad and to counter "limited" threats to the U.S. homeland.[*,1]

The U.S. missile defense posture has evolved since 2000 but remains geared toward these twin challenges (**annex A**). As such, it supports key national defense policy objectives:

- Protect the U.S. homeland, forces abroad, allies, and partners.
- Deter attacks against the United States, its allies, and partners.
- Assure allies.
- Strengthen U.S. diplomatic activities in peacetime and crisis.[2]

This study comes at a time when the security environment is rapidly evolving. The United States faces growing challenges from states such as North Korea, and a renewed era of great power competition is on the rise as Russia and China develop and field new offensive and defensive military systems. In this context, we take stock of the perceived benefits of homeland missile defense over the past two decades and at present, as well as potential costs as adversaries develop their own advanced strike and defensive capabilities. In light of changing technical and geopolitical factors, this study examines three interrelated areas:

1. The security benefits to the United States of developing and deploying homeland missile defense.
2. Whether the security benefits have been undermined or counterbalanced by the adverse reactions of potential adversaries.
3. The extent to which deployment of missile defense systems have affected or may affect the development of Russian, Chinese, North Korean, and Iranian ballistic missile capabilities.

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* In this respect, the Bush administration built upon the outgoing Clinton administration's commitment to develop "a limited National Missile Defense (NMD) system designed to protect all 50 states from the emerging ballistic missile threat from nations that threaten international peace and security" (reference 1). While their respective levels of effort, their evaluation of evolving regional threats, and their corresponding sense of time urgency for system deployment differed considerably, Democrat and Republican administrations found common cause in focusing on the evolving rogue-state missile threat (annex A).

This report offers a set of five key findings. Two annexes provide supplementary information on the evolution of U.S. homeland missile defense across successive administrations and on the evolving missile threat to the United States (annex A and annex B, respectively). Annex C, provided separately, addresses classified aspects of select matters discussed in the key findings below.

Before detailing our key findings, we note the following caveats:

- It is difficult in any study on missile defense to focus solely on defense of the homeland. We adopt a proximate focus on *homeland* missile defense, consistent with the statutory language, but with the caveat that the DoD missile defense posture is more comprehensive. The interrelationships between U.S. missile defense and foreign developments may, therefore, not be limited to homeland systems.
- Specific—and definitive—causality determinations related to specific systems or modernization paths chosen are challenging. While U.S. homeland missile defense capabilities may be one factor in their decision calculus, Russia, China, North Korea, Iran, and other states have multiple stated drivers for their continuing development of long-range missile systems.
- It is difficult to provide a credible assessment of deterrence efficacy for missile defenses apart from the broader suite of offensive and defensive capabilities fielded by the United States and, potentially, by key allies and/or theater partners. U.S. homeland missile defenses comprise just one salient element of a broader integrated defense posture, the totality of which comes into play for the tasking at hand.
- The strategic or operational relevance of U.S. homeland missile defenses to foreign actors must be placed in context. The specific reasons behind adversary decisions often remain unknown for an extended time, until or even after the eventual release of archival material. Actor- and context-specific determinations of their ability to effectively deter or dissuade foreign behavior are required, and they are not static but rather may evolve significantly over time.

Key Findings

Key Finding 1: *The primary benefit of the GMD system is the protection it provides the U.S. homeland against a limited but evolving rogue-state missile threat.*

The National Missile Defense Act of 1999[3] established the policy of the United States "to deploy as soon as technologically possible" an effective national missile defense system able to defend against limited ballistic missile attacks. Since then, successive administrations and Congresses—both Republican and Democrat—have seen value in developing a homeland missile defense system as one element of the nation's broader defense posture. On balance, there has been more policy continuity than change over this timeframe: the "limited," North Korea–sized defensive architecture has now been largely implemented, and North Korean developments continue to be the primary pacing threat. North Korea may not be the sole future threat, however, and the GMD system has some capability against potential future ICBM threats from Iran.[*,4] The DoD plans to extend GBI capacity by 20 additional interceptors in Alaska, bringing the outyears total to 64.[†]

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[*] The 44 ground-based interceptors (GBIs) are now in place at two homeland sites. The additional 10 GBIs slated for deployment in Poland to defend against Iranian long-range missile threats were not deployed (annex A). In parallel, the Iranian ICBM threat has not materialized as rapidly as the Intelligence Community estimated it might two decades ago (reference 4), although the various Iranian space launch vehicle (SLV) programs may provide Iran a pathway to an ICBM system (**annex B**).

[†] Congress has authorized a total of 104 interceptors, including possible expansion to other domestic sites, but has not yet provided the funding required to develop and field these additional systems.

Different administrations have disagreed over the appropriate balance between and the specific capabilities of theater and homeland systems, specific programmatic emphases have varied, and resource allocation for particular programmatic elements has ebbed and flowed. External observers across the political spectrum have also criticized the U.S. approach. For some, the United States has simply not progressed quickly enough or been aggressive enough in this undertaking in light of continuing adversary capability developments.[5,6] Other scholars have expressed chagrin over the financial costs to develop, field, and sustain the relevant capabilities;[7] have worried over adverse diplomatic reactions, potential negative effects on arms control, or other potential geopolitical considerations;[8] or have signaled their concern over operational reliability or other possible system performance issues.[9]

Over this time, U.S. officials have generally argued that the homeland missile defense system is important for at least four reasons—deterrence, dissuasion, assurance, and defense (annex A)—and that these benefits applied in various ways across the spectrum of conflict, from peacetime to crisis and war. As a starting point, the system serves as a defensive element of the broader U.S. deterrent posture. Its specific role is tied to the context in which it operates. In peacetime, for instance, the U.S. homeland missile defense system facilitates *general* deterrence of adversary missile use against U.S. states and territories; its presence is a factor that adversaries would need to consider in their decision calculus. In crisis or wartime, it may serve more *immediate* deterrent purposes as a tool against possible adversary coercion or blackmail, as a disincentive to adversary weapon employment against the U.S. homeland, or as a capability that could deny the ability of hostile parties to prevent or deter U.S. involvement in or escalation of a regional conflict. The dissuasion and assurance rationales similarly factor into this logic structure, addressing adversaries and U.S. theater partners, respectively (**table 1**).

A key rationale for U.S. homeland missile defense remains untested in practice: its ability to defend against limited but evolving missile threats, whether in the form of directed attacks or accidental or unauthorized launches. As early as the 1950s, the United States experimented with systems to provide air and missile defense for homeland sites and abroad. In the mid-1970s, the United States opted to terminate programs designed to protect its silo-based nuclear missiles from Soviet attack and rely fully on nuclear deterrence of missile threats to the U.S. homeland. In the 1980s and into the 1990s, the United States conducted large-scale research and development of ground-, air-, and space-based systems designed to provide a more robust defense or, potentially, to achieve defense dominance. Since the end of the Cold War, administrations have discussed whether and how best to protect against accidental or unauthorized launches. Subsequent to its withdrawal from the ABM Treaty, the United States has sought to deploy conventional ground-based interceptors that can defend against the ability of rogue states to hold U.S. states and territories at risk.

Since 2005, the GMD system has been available for its identified uses. Over the past two decades, the United States has witnessed North Korea's reported development of nuclear weapons[10] and seen substantial improvement in its ICBM capabilities,[*,11] mutually engaged in coercive diplomacy,[12,13,14] and considered military action.[15,16,17] In this context, the existence of even a limited homeland missile defense capability may have helped preserve U.S. freedom of action, mitigate the specter of North Korean nuclear blackmail, provide a viable defensive capability against a discrete but consequential threat, and ensure steadfast support for U.S. alliance commitments. **In the absence of such a defensive capability, the United States would likely have been more heavily exposed to North Korean actions, have operated at a much higher-risk posture, and have had less negotiating room with which to navigate coercive tactics and crisis contexts. U.S. allies also would have had additional concerns about whether the United States would accept the costs and risks of defending them in crisis and war.**

* ICBMs have operating ranges in excess of 5,500 kilometers, while intermediate-range ballistic missiles (IRBMs) operate within 3,000 to 5,500 kilometers. Although North Korean IRBMs would probably be able to range select U.S. territories or states, ICBMs from North Korea or Iran would be capable of ranging most or all of the continental United States. (See reference 11.)

Table 1. Evaluation of select security benefits.

Framing purpose	Illustrative security benefit	Possible adversary reaction	Comment
Deter adversary offensive action against the United States, and missile use in particular, vs. U.S. states and territories	Make adversary missile use costlier, riskier, and/or less likely to succeed	Diversify type, quantity, and capability of missile forces; invest in own defenses; force strategic choice (e.g., arms control *or* missile defenses)	Deterring adversary missile use against U.S. states and territories is a credible argument in principle but difficult to prove in practice. Adversaries have engaged in theater hostilities against the United States and its theater partners but have not launched missiles against U.S. states or territories. The extent to which the presence of a U.S. homeland missile defense system has contributed to this outcome is difficult to measure.
Dissuade adversary development or acquisition of long-range missiles	Change or influence adversary decision calculus; encourage restraint; potential cost-imposition measure	Continue or accelerate missile development or acquisition; conduct information operations or public diplomacy offensive; collude with foreign partners	While North Korea has continued its missile and nuclear developments, Iran has not moved as anticipated two decades ago toward development of ICBM capabilities. While the U.S. homeland missile defense system may have imposed costs on North Korea—as it has steadily invested scarce resources in developing ICBM and nuclear capabilities—neither this nor the Iranian case provide compelling evidence that the U.S. homeland missile defense system has had a dissuasive effect. For their part, Russia and China have each engaged in significant force modernization and deploy extensive missile defense capabilities. While it is possible that U.S. homeland missile defense has influenced some developments, the scope and scale of their activities suggest other primary program drivers.
Assure U.S. allies and coalition partners of U.S. defense commitments and/or political support	Preserve U.S. freedom of action; mitigate blackmail or coercion; demonstrate solidarity with allies and partners	Diplomatic, military, economic, or other activities designed to weaken or split an alliance or coalition, including coercive or blackmail tactics; potential "charm offensive" with actual or prospective allies	The homeland missile defense system helped preserve U.S. freedom of action in multiple North Korea–related crises, reassuring theater security partners of U.S. commitments. The United States engages with its theater friends and partners on missile defense; in some cases they host U.S. assets, while in others they purchase U.S. systems or even co-produce them. Notably, both China and Russia have targeted U.S. theater allies, such as South Korea and Poland, for such activities and have sought to undermine allied confidence in the performance of such systems.
Defend against adversary use of missiles against U.S. states and territories should deterrence fail	Provide defense against limited strikes; create military options	Develop countermeasures or otherwise enhance missile capabilities; deploy greater quantities of missile systems	This is both the most important design criterion and an untested proposition. While North Korea continues to enhance by type and quantity its nuclear and missile capabilities, the U.S. homeland missile defense system appears to have credibly paced the evolving threat. Although this system is not designed to hold Russian or Chinese strategic forces at risk, those forces have nevertheless reportedly included countermeasures in their modernization programs. Each retains a secure nuclear second-strike capability.

The U.S. homeland missile defense system has not been a panacea, but its limited capabilities have provided important security benefits. **Ultimately, the GMD system has done what it was designed to do: provide a defense for the U.S. homeland against a limited but evolving rogue-state missile threat**.

While North Korea continues to develop and field missile capabilities that pose a growing challenge to the U.S. homeland missile defense posture, and while Iran or others may eventually pursue a similar course of action, such developments have thus far lagged the U.S. system's installed capacity. Their actions thus far have challenged the deployed U.S. system but have neither undermined nor effectively counterbalanced it.

Key Finding 2: *Potential adversaries continue to develop long-range ballistic missiles despite deployment of a U.S. homeland missile defense system.*

It is difficult to ascribe definitive *causal* relationships between U.S. homeland missile defense and adversary capabilities for at least four reasons:

- States develop and field offensive weaponry for multiple reasons, and it is often difficult to reach high-confidence judgments on the extent to which any single variable, in isolation, serves as a root cause, a contributing variable, or a convenient but potentially unwarranted justification.
- U.S. homeland missile defense is one element of the broader U.S. defense and deterrence posture, so it is challenging to isolate its role from, for instance, theater missile defense (TMD) systems, forward-deployed combat power, strategic strike capabilities, or even broader whole-of-government actions designed to influence, counter, or combat the particular actions of any foreign actor. Other elements of national power, such as sanctions or technology control regimes, are also employed with mixed results against this problem set.
- Given the timelines for development and production of strategic systems like ICBMs and their core importance for deterrence, adversary ballistic missile systems are designed in light of their perceptions of the *potential* future missile defense environment rather than the *existing* one. In this context, what may appear to U.S. observers as an overreaction to current or planned U.S. deployments may look different to adversaries who may seek to hedge against technological, political, or other uncertainties.
- Potential U.S. adversaries have had long-range missile programs for many years; in some cases, they predate deployment of U.S. homeland missile defense capabilities and were, therefore, unlikely to be cancelled due to emergent, unproven, or prospective U.S. capabilities.

Deterring—or *dissuading*—adversary development of ballistic missiles was an identified objective of the George W. Bush administration.[*,18] Under National Security Presidential Directive-23, issued in December 2002, U.S. officials established two relevant policy goals in this context: (1) deterring coercion by devaluing missiles as tools of extortion and aggression, undermining the confidence of our adversaries that threatening a missile attack would succeed in blackmail; and (2) dissuading countries from pursuing ballistic missiles in the first place by undermining their military utility.[19] **Looking across multiple administrations (annex A), the record suggests that while the limited U.S. homeland missile defense system has been designed primarily to defend the U.S. homeland against limited missile attacks, other stated goals have included dissuasion, deterrence, and assurance related to foreign missile developments**. The most recent *National Defense Strategy* presented the "undeniable" conclusion that the

* According to Richard Kugler, dissuasion is "an effort by the United States to convince a country or coalition to refrain from courses of action that would menace our interests and goals or otherwise endanger world peace." (See reference 18).

homeland "is no longer a sanctuary,"[20] which suggests that the early dissuasion policy objectives were unsuccessful at least with respect to North Korea.

The U.S. homeland missile defense system established following the National Missile Defense Act of 1999 sought to provide a defense against regional rogue-state ICBM capabilities. In 1999, the National Intelligence Council (NIC) estimated that by 2015, the United States "most likely" would face ICBM threats from Russia, China, and North Korea; "probably" from Iran; and "possibly" from Iraq.[21] Of particular note, the report stated the following:

- North Korea could convert its Taepodong-1 (TD-1) SLV into an ICBM able to deliver a light payload to the United States. It is more likely to weaponize the TD-2 as an ICBM able to deliver a several-hundred-kilogram payload.
- Iran could test an ICBM able to deliver a several-hundred-kilogram payload to many parts of the United States by 2010, and it potentially could test an ICBM able to deliver a light payload to the United States years earlier. NIC analysts differed on the specific timing of Iran's first test of an ICBM that could threaten the United States, with views ranging from "very likely" to "less than an even chance" before 2015.
- Iraq could test a North Korea–type ICBM able to deliver a several-hundred-kilogram payload to the United States by 2010, depending on the level of foreign assistance. NIC analysts differed on the specific timing of Iraq's first test of an ICBM that could threaten the United States, with views ranging from "likely" to "unlikely" before 2015.

The 1999 NIC-forecast missile threat to the U.S. homeland has materialized differently, but the original homeland missile defense design construct has remained relevant since its inception (**table 2**). Iraq's efforts to develop an ICBM ended with the demise of Saddam Hussein. For their part, China and Russia has each substantially improved its offensive missile capabilities over the past two decades, and each has also invested heavily in its own homeland missile defense systems. In each case, extensive development of new strategic weapons and improved long-range missile capabilities—ballistic, cruise, and boost-glide—suggest that U.S. defensive capabilities have neither dissuaded nor prevented their development, but rather have influenced Russian and Chinese programmatic developments with respect to missile defense countermeasures. In China's case, the past two decades show a consistent and sustained pattern of robust military investment in theater-focused conventional force posture.[22,23] In neither case was this the design basis for, or primary focus of, the U.S. homeland missile defense system over the past two decades.

Rather, Iranian and North Korean developments are of central importance in this context. Over this timeframe—and especially since 2015—North Korea has reportedly developed the ability to conduct long-range nuclear strikes on the continental United States, as well as U.S. territories in the Asia-Pacific. Between 2006 and 2017, North Korea conducted a series of six nuclear tests. In 2012, North Korea used a TD-2 SLV to put a satellite into orbit and publicly displayed a road-mobile ICBM. In 2016 and 2017, it tested at least two IRBMs, an SLBM, and the Hwasong-14 and Hwasong-15 ICBMs, capable of ranging the continental United States. In 2020, North Korea publicly displayed a new ICBM during a celebration of the 75th anniversary of the country's ruling party. Based on the system's size and contours, some analysts speculate that the vehicle may be capable of delivering a 2,000- to 3,500-kilogram payload anywhere in the United States, potentially with multiple warheads.[24,25]

Table 2. Select foreign missile capabilities that could threaten the United States.

Actor	Principal drivers	Representative capabilities	Comment
Russia	Legacy system replacement; perceived deterrence requirements (specifically, the ability to defeat missile defenses); great power competition; sustainment and promotion of Russian defense and technology sector	New ICBM, sea-launched ballistic missile (SLBM), sea-launched cruise missile (SLCM), air-launched cruise missile (ALCM), next-generation heavy bomber, air-launched ballistic missile (ALBM), ground-launched cruise missile (GLCM), and hypersonic glide vehicle (HGV) weapon types	Continuing large-scale modernization of both long-range strike and missile defense capabilities. Current and expected U.S. homeland missile defense capabilities are not focused on Russia, have not dissuaded Russian developments, and do not threaten its nuclear second-strike capability. However, Russia appears to hedge against possible U.S. missile defense developments by equipping strategic weapons with technologies (and developing novel delivery systems) designed to defeat or circumvent missile defenses.
China	Expanding security interests driving enhanced deterrence and defense requirements; great power competition; sustaining and promoting Chinese defense and technology sector	New SLBM, ALCM, IRBM, and HGV weapon types; multiple, independently targetable reentry vehicles (MIRV) and other ICBM enhancements	Continuing large-scale modernization of both long-range strike and missile defense capabilities. Current and expected U.S. homeland missile defense capabilities are not focused on China and have not dissuaded Chinese developments. China's stockpile of strategic weapons is modest in number, but its ICBMs and SLBMs are sophisticated enough that U.S. homeland missile defenses do not threaten China's nuclear second-strike capability.
North Korea	Security competition with the United States and U.S. theater allies; coercion; international/regional status	Nuclear tests; new ICBM, SLBM, and IRBM weapon types	North Korea perceives the United States as an existential threat and continues to develop and field improved military capabilities. For the United States, North Korea poses an acute threat to U.S. regional security interests; its long-range nuclear strike systems remain the design basis for the U.S. homeland missile defense system.
Iran	Regional security competition; international/regional status	Iranian missile systems threaten U.S. theater forces and allies; demonstrated SLV capabilities	Current theater threat to U.S. forces and allies. Iran has apparently not developed an ICBM, but it may pose longer-term strategic challenge to the U.S. homeland.

While the Defense Intelligence Agency (DIA) assessed in 2018 that the reliability of current-generation North Korean ICBMs is low without additional flight testing, it underscores North Korea's commitment to develop and field ground-based and potentially other nuclear-capable systems that threaten the United States.[26] There are no direct linkages evident in the respective timing of particular North Korean nuclear and long-range missile developments on the one hand, and U.S. homeland missile defense activities on the other (**figure 1**). Nevertheless, North Korea's overall commitment to achieve a viable ICBM capability and likely its push for more modern and capable offensive systems are almost certainly informed by the U.S. homeland missile defense system and the U.S. defense posture more generally.

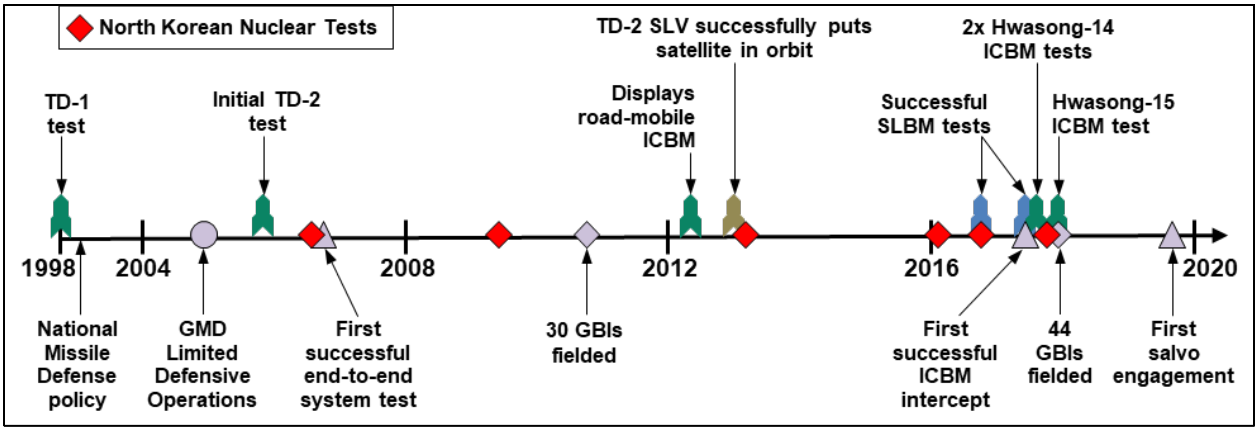

Figure 1. Timeline of select North Korean missile and nuclear developments (top) and select U.S. homeland missile defense milestones (bottom). (Data compiled by authors from numerous sources cited in this report.)

The Director of National Intelligence found in 2019 that Iran fields the Middle East's largest arsenal of ballistic missiles and "continues to pose a threat to countries across the Middle East" although it has not yet demonstrated an ICBM capability. Instead, Iran's work on an SLV shortens its potential timeline to an ICBM because SLVs and ICBMs use similar technologies.[27] A 2001 NIC assessment and a January 2020 Congressional Research Service (CRS) report found that Iran has the technical capability and resources to demonstrate an ICBM, possibly within four to five years of a decision to do so.[28,29] While it is possible that U.S. homeland missile defense has been a factor in Iran's decision not to prioritize such a capability, it is more likely that other variables—such as potential U.S. reactions including sanctions or even military action, together with Iran's evidently greater theater priorities—factor as much and probably much more into Iran's decision.

Recent history suggests a more measured pace of long-range missile proliferation than anticipated in the late 1990s. While North Korean developments have generally materialized as forecast, Iran's ICBM-class developmental activities have taken comparatively longer to mature; and other regional states, such as Iraq, Syria, Pakistan, or Libya, have not thus far pursued such a capability. Whether Iran will continue to refrain from ICBM-class missile developments, or whether it will instead seek to prioritize them, remains an important question for the future U.S. homeland missile defense posture.

Key Finding 3: *While Russia has used the existence of a U.S. homeland missile defense system as a justification for its substantial and continuing weapon modernization program, neither Russian force modernization nor the limited U.S. homeland missile defense system has altered the strategic balance.*

The United States and Russia have disagreed on missile defense since at least 1992, when President George H.W. Bush and President Boris Yeltsin considered collaborating to develop a global system able to protect against limited ballistic missile attack (**annex A**). Since then, the record shows substantial bilateral disagreements on the scope and capabilities of U.S. theater systems, the desirability of maintaining the ABM Treaty, the rationale for and capabilities of the U.S. homeland missile defense system, and U.S. concerns over Russia's own extensive homeland missile defense posture. At various times over the 1990s and 2000s, the United States conveyed to Russia that the objectives of U.S. homeland missile defense were limited to defending against a perceived threat from rogue states and that the GMD-based system is nether designed to counter nor capable of countering a deliberate Russian nuclear strike. Bilateral discussions led to a series of ABM Treaty demarcation agreements in the 1990s,* as well as subsequent offers for technical exchanges and associated transparency measures. The planned capability of the U.S. missile defense architecture was further reduced when the United States unilaterally cancelled missile defense programs (such as the space-based laser, the airborne laser, and the ground-based mid-infrared advanced chemical laser) in favor of the more constrained ground-based conventional hit-to-kill approach that GMD represents.

Russian President Vladimir Putin called the U.S. decision to withdraw from the ABM Treaty "erroneous" but underscored in December 2001 that "the decision taken by the president of the United States does not pose a threat to the national security of the Russian Federation" because "Russia and the U.S., unlike other nuclear powers, have for a long time possessed effective means to overcome missile defenses."[30] As U.S. interlocutors have repeatedly observed to their Russian counterparts, the sheer quantity of Russian strategic nuclear weapons would readily overwhelm the capacity of the very limited system envisioned by the United States. Because the U.S. defensive system would not field the asset density required to jeopardize Russia's ability to conduct a successful and overwhelming retaliatory nuclear strike, and because the ground-based conventional hit-to-kill system does not readily scale to do so, it should not meaningfully affect Russia's strategic calculus. **The bilateral strategic nuclear balance is unchanged by the limited U.S. homeland missile defense system. That it has taken the United States almost two decades to field just 44 GBIs underscores that the system is not poised to scale quickly and does not offer a credible breakout option**.

Despite U.S. engagement on the subject, Russian officials apparently remain deeply committed to the belief that missile defense is directed at negating its nuclear deterrent and that technological breakthroughs in this area could be rapid. As such, missile defense has long been an irritant in the bilateral relationship and an impediment to progress in areas related to strategic stability and arms control. In 2017, for instance, Putin argued that the U.S. homeland missile defense system "destroys the strategic balance in the world."[31] He subsequently boasted of "invincible" new Russian weapons able to overcome U.S. defenses.[32] In part, such criticisms advance Russian strategic messaging, tied closely to its perceptions of an evolving regional and international security landscape reflected in specific missile defense capabilities, such as the forward-deployed interceptors and associated missile tracking capabilities called for under the European Phased Adaptive Approach.[33] At the same time, such capabilities reflect Russian concerns over a hypothetical future (presumably much more capable) U.S. system—one which Russian strategists appear to believe would be scaled against them. President Putin, in his well-publicized March 2018 speech announcing the development of new strategic delivery systems, compared U.S. missile defense to a machine in motion or a conveyer belt moving forward and noted that the combination of uncontrolled quantitative growth, qualitative improvements, and the creation of new missile defense deployment areas would result in "the complete devaluation of Russia's nuclear potential" absent offensive advances by Russia (see **sidebar** on the next page).

Russia has sought to use the existence of a U.S. homeland missile defense system to justify and inform its substantial and continuing weapon modernization program (annex B). Modernization of Russia's strategic nuclear forces has been a long-standing priority for Russian leadership, as Moscow views its nuclear arsenal—and the strategic forces in particular—as integral to its national defense and to its status as a global power. Even in the absence of U.S. homeland missile defense, Russia would most likely still have engaged in legacy system replacements and widespread force modernization. Many of the systems Russia deployed from about 2000 through the early-to-mid-2010s were aimed at modernizing its strategic forces and replacing aging Soviet systems. For example, the SS-27 Mod-1 and Mod-2 silo and road-mobile ICBMs, the SS-N-32 SLBMs, and the AS-23A/B ALCMs were likely intended to replace the

* In the 1990s, U.S. assurances and negotiations were geared toward establishing technical constraints to differentiate *national* from *theater* missile defense systems.

Soviet SS-25 ICBM (first deployed in 1988), the SS-19 Mod 3 ICBM (first deployed in 1980), the SS-N-18 SLBM (first deployed in 1978), and the AS-15 ALCM (first deployed in the 1980s).[34–43] In parallel, Russia has fielded and continues to improve its advanced missile defense capabilities in St. Petersburg, Kaliningrad, and Moscow, including enhancements to its 68 nuclear-armed ABM interceptors. Western observers have noted that Russia's criticisms of the U.S. homeland missile defense system "ring hollow" in this context.[44]

March 2018 Statement by Russian President Vladimir Putin

President Putin made the following statement on March 2018:[45]

All these years, the entire 15 years since the withdrawal of the United States from the Anti-Ballistic Missile Treaty, we have consistently tried to reengage the American side in serious discussions, in reaching agreements in the sphere of strategic stability.

We managed to accomplish some of these goals. In 2010, Russia and the US signed the New START treaty, containing measures for the further reduction and limitation of strategic offensive arms. However, in light of the plans to build a global anti-ballistic missile system, which are still being carried out today, all agreements signed within the framework of New START are now gradually being devaluated, because while the number of carriers and weapons is being reduced, one of the parties, namely, the US, is permitting constant, uncontrolled growth of the number of anti-ballistic missiles, improving their quality, and creating new missile launching areas. If we do not do something, eventually this will result in the complete devaluation of Russia's nuclear potential. Meaning that all of our missiles could simply be intercepted.

Despite our numerous protests and pleas, the American machine has been set into motion, the conveyer belt is moving forward. There are new missile defence systems installed in Alaska and California; as a result of NATO's expansion to the east, two new missile defence areas were created in Western Europe: one has already been created in Romania, while the deployment of the system in Poland is now almost complete. Their range will keep increasing; new launching areas are to be created in Japan and South Korea. The US global missile defence system also includes five cruisers and 30 destroyers, which, as far as we know, have been deployed to regions in close proximity to Russia's borders. I am not exaggerating in the least; and this work proceeds apace.

So, what have we done, apart from protesting and warning? How will Russia respond to this challenge? This is how.

During all these years since the unilateral US withdrawal from the ABM Treaty, we have been working intensively on advanced equipment and arms, which allowed us to make a breakthrough in developing new models of strategic weapons.

At the same time, Russian perceptions about the "logical," presumably more capable, endpoint of the U.S. missile defense posture appear to have influenced its modernization activities. Russia's force modernization has sought not only to replace legacy systems and to develop novel nuclear attack options, but also to enhance the ability of its strategic systems to overcome current, planned, and even possible future missile defense capabilities, such as through advanced countermeasures and maneuverability. Such capabilities enhance Russia's ability to strike the United States and its theater allies and partners; in Russia's estimation, these capabilities provide an additional hedge against potential (if unanticipated) future U.S. defensive capability enhancements. In unveiling Russia's Avangard HGV, for instance, Deputy Prime Minister Yuri Borisov stated that the new weapon "essentially makes missile defenses useless." Similarly, former Russian Defense Minister Sergei Ivanov argued that "we aren't involved in saber-rattling, we simply ensured our security for decades to come."[46] None of these developments, however, materially *counterbalance* the security benefits accrued to the United States by fielding its limited homeland missile defense system, foremost of which is the ability to defend against a North Korean or Iranian missile attack. **Neither Russia's improved offensive strike posture nor U.S. deployment of a limited homeland missile defense system has altered the enduring potential for mutual assured destruction** (**table 3**).

Table 3. Select U.S. and Russian nuclear and missile capabilities.[47,48]

Capability	United States	Russia
Deployed strategic delivery systems	675	510
Deployed strategic nuclear warheads	1,457	1,447
Strategic missile defenses	GMD system, 44 interceptors (conventionally armed)	A-135 ABM system, 68 interceptors (nuclear-armed)
Additional missile defense capabilities of interest	Considering theater high-altitude area defense (THAAD), SM-3 block IIA homeland "underlayer" augmentation	Deployed S-400; developing S-500 for Moscow, St. Petersburg, and Kaliningrad defense

The United States has long accepted the principle of mutual vulnerability with Russia and continues to rely on nuclear deterrence against an enduring long-range Russian missile threat. The most significant impact of Russia's enhanced strike capabilities likely is the new challenge these capabilities pose to U.S. early warning systems. For example, while launch-detection of a Russian Avangard HGV is reportedly similar to that of other ballistic missiles, its depressed trajectory and maneuverability make tracking more difficult and therefore increase target ambiguity.[49,50,51,52] Similarly, the Poseidon autonomous undersea vehicle and Burevestnik cruise missile likely also pose challenges to tracking and target determination.[53,54,55,56] In crisis or conflict scenarios, such early warning limitations—if not mitigated through an expanded detection architecture—could enhance concerns over the survivability of critical command-and-control (C2) systems.

As discussed in Key Finding 1 and table 2, the United States has sought varied benefits from its homeland missile defense posture: deterrence of missile use against the U.S. homeland, dissuasion of adversary development of long-range ballistic missiles, assurance of U.S. allies and theater partners, and defense of U.S. states and territories against enemy missile attack. Despite Russian criticism of the U.S. homeland missile defense system, Russia has not successfully *undermined* any of these objectives in the context of the limited but evolving threat for which it was designed. Russia certainly applied substantial pressure against Poland, Romania, the Czech Republic, and other North Atlantic Treaty Organization (NATO) allies, which ultimately led the United States to revise its proposal to field a small complement forward-based interceptors in Europe. As Key Finding 2 noted, however, Iran has not successfully developed and fielded an ICBM capability, which curtails the real-world impact of Russia's actions. Nor were Russian actions particularly effective as undermining the integrity or cohesion of the NATO alliance.

More broadly, missile defense remains a long-standing irritant in U.S.-Russia security relations, with occasional spillover to arms control, nonproliferation, or other policy areas. Multiple U.S. administrations have spent considerable time and energy in the bilateral relationship to address Russian concerns related to missile defense through various transparency- and confidence-building proposals. Their Russian counterparts have proven dissatisfied with such approaches, preferring instead legally binding qualitative, quantitative, and geographical restrictions. Russia may be interested in potential future arms control agreements, but Moscow's rhetoric signals both that the cost of any such deal remains high and that U.S. missile defense remains a focal point of its future concerns related to strategic stability. While the Russian position has hardened, "novel" Russian systems developed to defeat or evade U.S. missile defenses have strained a fifty-year-old arms control regime centered on the traditional nuclear delivery platforms of ICBMs, SLBMs, and heavy bombers. Missile defense disputes are just one noteworthy area of disagreement in a target-rich environment. Despite repeated efforts over the past three decades to develop, reset, or advance an effective bilateral strategic partnership, both parties have substantial concerns in varied foreign and defense policy areas. Any potential future agreement on missile defense will more likely follow than lead in this context, so prolonged disagreement appears a likely outcome.

Key Finding 4: *China's expansion and diversification of its nuclear and missile forces has been influenced by its concerns about U.S. homeland missile defense, but those concerns are only one of many factors in China's force planning. Although China's actions to preserve and expand its assured retaliation prospects have not fundamentally altered the strategic balance, its buildup and lack of transparency about its force modernization goals are troubling.*

China's political and military leaders have been critical of U.S. missile defense, criticizing the United States for, among other things, pursuing what President Xi Jinping calls a quest for "absolute security."[57] In this view, as explained in 2019 in the *PLA Daily*, the United States attaches "great importance" to missile defense to ensure that no other state can threaten its national security.[58] For some, there is an urgent need to narrow the perception gap between the United States and China on missile defense.[59] For others, it is time for the United States to publicly accept the principal of mutual vulnerability with China.[60] This is not a new consideration: defense analysts since 2000 have long wrestled with the proposition that U.S. missile defense deployments might influence the size, composition, and employment doctrine of China's nuclear arsenal, catalyze conflict in outer space, contribute to theater conflict, or otherwise undermine strategic stability.[61,62]

Unlike Russia or the United States, China has never been constrained by international accords such as the ABM Treaty, the Intermediate-Range Nuclear Forces Treaty, or the New START Treaty. In January 2001—before the U.S. decision to withdraw from the ABM Treaty—the DoD observed qualitative People's Liberation Army (PLA) strategic force modernization activities, including its development of two new road-mobile ICBMs and a solid-propellant SLBM. It publicly noted that China had "more than 100" nuclear warheads, "likely will have tens of missiles capable of reaching the United States" by 2015, considered it likely that the number of deployed PLA theater and strategic nuclear systems would increase over the next several years, and noted that China sought to increase the size, accuracy, and survivability of its nuclear missile force.[63] While China's ballistic missile modernization began before the United States deployed a homeland missile defense system, DoD anticipated that China "likely will take measures to improve its ability to defeat the defense system in order to preserve its strategic deterrent."[64] Two decades later, DoD sees continued modernization, diversification, and quantitative increases to the PLA's nuclear delivery platforms, a doubling of its nuclear warheads from today's "low-200s," and activities to increase its nuclear readiness posture.[65] **Table 4** lists the current PLA Rocket Force missile systems as reported by DIA in 2019.[66]

Table 4. Current PLA Rocket Force missile systems, as reported by DIA in 2019.[67] (Does not include systems in development).

System	Type	Warheads	Propellant	Deployment mode	Maxs range (km)
CSS-3/DF-4	ICBM	Nuclear	Liquid	ROTL**	5,500+
CSS-3/DF-5	ICBM	Nuclear	Liquid	Silo	12,000 to 13,000
CSS-7/DF-11	SRBM	Conventional	Solid	Mobile	300 to 600
CSS-6/DF-15	SRBM	Conventional	Solid	Mobile	600 to 850+
CSS-11/DF-16	SRBM	Conventional	Solid	Mobile	800 to 1,000
CSS-5/DF-21	MRBM	Nuclear and conventional variants	Solid	Mobile	1,500 to 1,750+
CSS-5Mod-5/DF-21D	ASBM	Conventional	Solid	Mobile	1,500+
DF-26	IRBM	Nuclear and conventional variants	Solid	Mobile	4,000
CSS-10/DF-31	ICBM	Nuclear	Solid	Mobile	7,200 to 11,200
CJ-10	GLCM	Conventional	Solid	Mobile	1,500+

** ROTL = Rollout to Launch FN.

In 2019, the Director of National Intelligence publicly testified that the PLA's nuclear force modernization is "intended to ensure the viability of China's strategic deterrent by providing a second strike capability and a way to overcome missile defenses."[68] DoD assesses that China's "strategic ambitions, evolving view of the international security landscape, and concerns over survivability are driving significant changes to the size, capabilities, and readiness of its nuclear forces."[69] While China's broad-based nuclear modernization activities may have been influenced in part by the limited homeland missile defense system fielded by the United States, its efforts have outpaced and far exceed the current and prospective capacity of the U.S. GMD-centered system. **Whatever China's legacy concerns over the survivability of its strategic nuclear forces, its ability to overwhelm the GMD system appears intact today and will be enhanced in the years ahead as it continues its long-term modernization program (annex C)**. Still, as the United States considers augmenting its GMD-based system with a homeland missile defense "underlayer" of terminal defense assets (discussed in Key Finding 5), Chinese military planners will carefully consider the implications of potential enhancements for their continued ability to conduct strategic nuclear retaliatory strikes.

As significant as these nuclear-force modernization efforts have been, China's conventional-force modernization efforts have been comparatively greater. The record over the past two decades is clear: China has engaged in a strategic competition with the United States and its theater allies. It has developed and fielded an array of modern military systems, both in type and quantity.[70,71] As a result, China's ability to successfully prosecute attacks on U.S. air and naval bases in theater, to conduct offensive surface naval warfare, to conduct counterspace and cyber attacks, to defend against U.S. air and naval strikes, and to undertake other military actions all show marked improvement over this timeframe.[72] **Table 5** shows a comparison of key elements of China's defense posture in 2002 and 2020.

Table 5. Comparison of key elements of China's defense posture in 2002 and 2020. ($ = US dollars.)

Element	2002	2020	Comment
Defense spending	$60.4B	$266.4B	Estimate is from the Center for Strategic and International Studies covering 2002 and 2019, respectively, showing a nearly seven-fold increase. By 2019, Chinese defense spending comprised about 70.5 percent of total East Asian defense spending.[73] The World Bank estimates that China's gross domestic product rose from approximately $1.471 trillion in 2002 to $14.343 trillion in 2019, an almost 10-fold increase.[74]
Nuclear force modernization	20 ICBMs	100 ICBMs, ≥12 SLBMs; developing ALBM	Estimate is from DoD, which further estimates that the number of nuclear warheads on Chinese ICBMs capable of reaching the United States over the next five years will grow to over 200.[75]
Conventional long-range strike systems	350 SRBMs	>1,250 ballistic and cruise missiles (various ranges)	Estimate is from DoD. Some of the latest Chinese conventional long-range strike systems have ranges well over 1,000 kilometers, capable of targeting Guam or other U.S. territories, partner nations, or deployed U.S. theater naval forces.[76]
Missile defense capabilities	S-300	S-300, S-400; developing HQ-19 and midcourse interceptor	Estimate is from DoD. Although the S-300 is only potentially effective against cruise missiles, current Chinese missile defense developments may be capable against IRBMs or ICBMs.[77]

For purposes of this study, three observations are particularly important:

1. PLA modernization activities appear designed primarily to advance Chinese regional hegemony and to support broader Chinese Communist Party centennial objectives.[78,79,80,81]
2. China's multidecade modernization program has centered on a substantially improved conventional strike posture. According to a 2018 DIA report, China has the most active and diverse ballistic missile development program in the world.[82] While some developments have enhanced its nuclear posture, most developed over the past 20 years have been conventional systems designed for theater warfighting purposes (table 4 and annex B). These include the DF-17 HGV, CJ-20 ALCM, and DF-21 C/D and DF-26 ballistic missiles, which together will provide the PLA with new long-range conventional weapon options to strike U.S. or allied territories and deployed naval forces.
3. Although Chinese leaders have criticized the United States for pursuing missile defense, such objections are inconsistent with China's own large-scale air and missile defense deployments, including development of a midcourse interceptor.

The aggregate pattern of China's modernization activities over the past two decades strongly suggests a concerted effort to develop a modern military force commensurate with its status as a great power (table 5). **While China may have sought to counterbalance perceived U.S. military strengths through its military modernization program, the U.S. homeland missile defense posture is best viewed as only one contributing factor in the PLA's strategic calculus.** Until recently, China's force modernization has not caused the United States to reconsider the fundamental purpose, scope, or composition of its GMD-based homeland missile defense posture—which for two decades has been sized to counter a North Korean missile threat. In parallel, China has engaged in economic coercion and other pressure tactics to dissuade states such as South Korea from deploying the U.S. THAAD system.[83,84] Such efforts have not undermined the U.S. homeland missile defense posture, but rather reflect China's long-standing efforts to limit or impair missile defense cooperation between the United States and its theater partners.[85,86,87] Even in the absence of a U.S. homeland missile defense capability, TMD would still have been a significant area of disagreement in the bilateral security relationship. Looking ahead, absent a significant but unanticipated change to either the Chinese or U.S. strategic postures, missile defense will most likely remain one among several bilateral areas of disagreement in the years ahead.

Key Finding 5: *The basic finding that benefits have not so far been undermined by adverse reactions is a function of circumstances that are increasingly in flux.*

The original design basis for the GMD system centered on a small quantitative and qualitative threat from prospective North Korean ICBMs. Over the past two decades, that state's long-range missile systems have improved, and nuclear payloads have reportedly been developed (annex B). In parallel, the GMD system has been upgraded and deployed in increased quantities. While the homeland missile defense architecture appears to have effectively paced this evolving threat thus far, North Korean developments may now be outpacing the GMD system's ability to scale and to adapt. As of January 2020, the U.S. Northern Command estimates that North Korea "could challenge the ability of the Ground-based Midcourse Defense system to protect the U.S. homeland as soon as 2025."[88] The key strategic question facing U.S. national security leaders in this context is whether this remains an appropriate design basis for the future architecture and, if so, how best to scale the U.S. system for an expanding threat environment.

As a starting point, the DoD seeks to expand the number of GBIs from 44 to 64. To improve the performance of its ground-based systems, the Missile Defense Agency (MDA) has conducted research into multikill vehicle and other advanced technologies.[89] Although payload design is not yet set, it also is modernizing with the Next Generation Interceptor, slated for initial fielding before 2030.[90,91] **These types of system enhancement primarily seek to ensure that the GMD-centered homeland missile defense system remains able to effectively counter an expanding North Korean threat in the years ahead**.

More broadly, the DoD has begun to move toward a "layered" homeland missile defense posture in response to growing foreign missile threats (**figure 2**). While the envisioned system remains centered on GMD, it will be augmented by Aegis- and Aegis Ashore-equipped SM-3 block IIA systems and potentially THAAD units, along with a space sensor layer.[92,93] In addition, should deterrence fail, the DoD is enhancing its capabilities to locate, target, and destroy mobile missiles before launch.[94]

Since 2018, U.S. officials have steadily warned of key emerging threats:

- Vice Admiral Jon Hill, director of the MDA, anticipates greater "complexity" in the threat landscape ahead.[95,96] Among other things, this may include multiple-warhead enemy ballistic missile systems, which could require either multiwarhead kinetic interceptors or substantially increased interceptor capacity. They may also call for alternative approaches, such as the development of laser-based boost-phase or other enhanced intercept capabilities.[97,98,99]
- The U.S. Northern Command seeks to extend existing homeland missile defense capabilities beyond the evolving North Korean threat. Brigadier General Pete Fesler, North American Aerospace Defense Command operations deputy, emphasizes growing concern over emerging long-range conventional Russian and Chinese strike systems, such as advanced air- or sea-launched cruise missiles.[100]
- Mike Griffin, former Under Secretary for Research and Engineering in the Office of the Secretary of Defense, frequently highlighted the growing threat to U.S. interests posed by Russian and Chinese development of hypersonic weapon systems. "We are behind in hypersonic defense," he noted in 2019; "we need to catch-up, and we will."[101] Vice-Chairman of the Joint Chiefs of Staff General John Hyten notes that "we can't just wait and have this magic capability developed in 15 years that's going to last for 20 years because that will not work with the adversaries we face."[102]

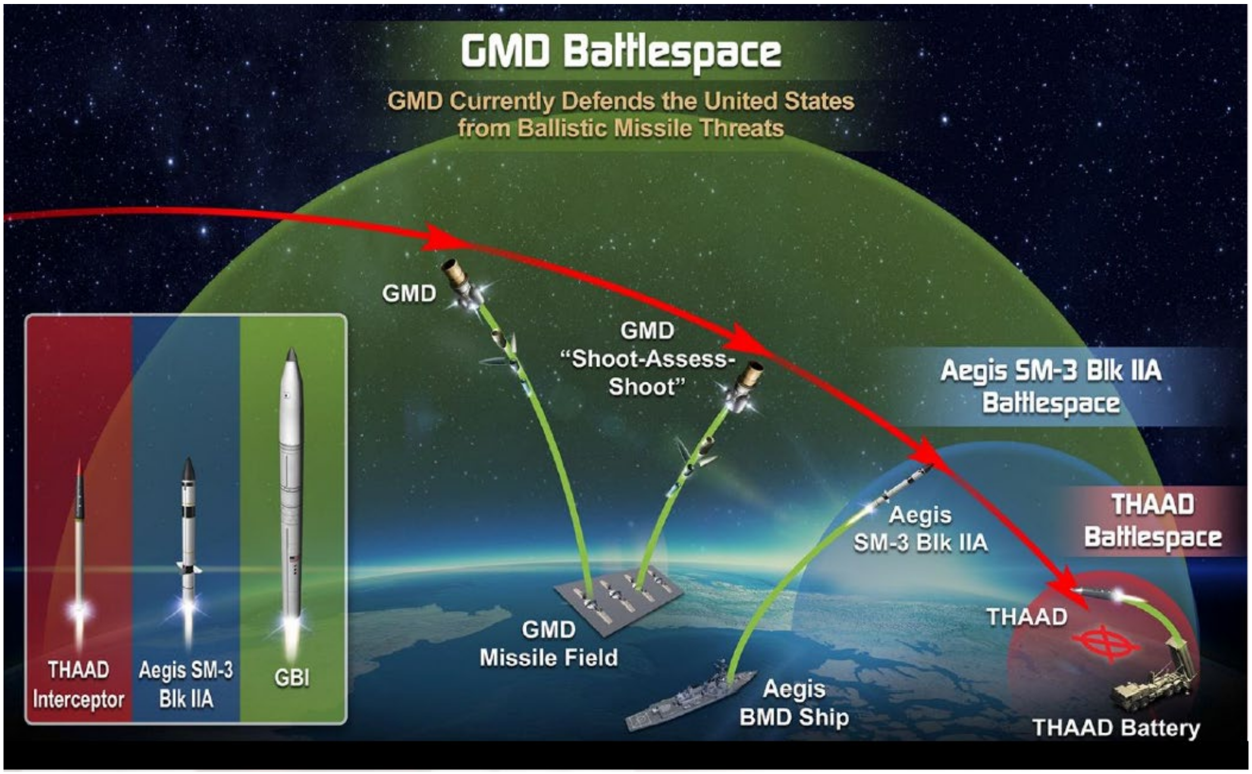

Figure 2. DoD illustration of layered homeland missile defense architecture, June 2020.[103]

If successfully implemented, this layered approach will add both strategic depth and enhanced interceptor capacity to the existing GMD-based architecture. In initial testing, MDA has successfully demonstrated the potential utility of an SM-3 block IIA interceptor against an ICBM-class target.[104] The extent to which planned capability improvements to the homeland missile defense system will effectively pace the evolving missile threat is not yet clear, however, and such improvements may lead to offensive countermeasures from other states. Beyond the GMD core, the DoD has not publicly identified the size of its proposed homeland underlayer; anticipated underlayer deployment locations, whether forward-deployed to U.S. states and territories or instead emplaced within the continental United States; or the expected performance of Aegis-based or THAAD systems against potential targets. The available budget data suggests an average annual cost of between $5 billion and $6 billion per year for GMD, SM-3 block IIA, and THAAD procurements through fiscal year 2025.[105]

To address emerging new threats to the U.S. homeland, DoD is exploring options for defending the U.S. homeland against advanced cruise missiles and conducting research on technologies to defend against hypersonic systems.[106] Near-term activities are focused on C2 upgrades and sensor capabilities for early warning and tracking, such as the Space Development Agency's Wide Field of View space vehicles[107] and MDA's Hypersonic and Ballistic Tracking Space Sensor.[108] Neither homeland cruise missile defense nor early-stage research into hypersonics defense is designed to jeopardize Russia's or China's ability to conduct strategic attacks against the U.S. homeland. However, homeland cruise missile defense is intended to defend against the increasingly transregional threat of conventional cruise missiles,[109,110] and research into hypersonic defense is intended to keep pace with evolving Russian and Chinese capabilities.[111]

The U.S. homeland missile defense system has clearly arrived at an inflection point, one in which rogue-state missile developments may—temporarily or otherwise—outpace homeland defensive capacity or associated capability upgrades. While this enduring task remains central to the GMD system, the underlayer would presumably provide both a hedge against enhanced rogue-state capabilities and homeland cruise and hypersonic missile defense could, in principle, be used to counter select Russian and Chinese missile systems. In this context, the DoD has argued the following: *if* the homeland is no longer a sanctuary, *because* the North Korean ICBM threat continues to expand, and *since* Russia and China continue to develop and field hypersonic and advanced cruise missiles able to hold U.S. states and territories at risk, *then* it makes sense to invest a small portion of the defense budget in a modern layered homeland missile defense system and invest in capabilities to counter advanced threats. Provided that this evolution of the homeland missile defense architecture remains "limited," it could help ensure continued U.S. freedom of action against discrete nuclear-armed missile threats; preserve both diplomatic and military options in peacetime, crisis and wartime; and potentially avoid a catastrophic outcome should deterrence fail. At the same time, deployment of such an underlayer would likely bring new complaints from Russia and China—irrespective of ground truth—about the perceived impact of U.S. homeland defenses on strategic stability. This will likely lead to additional questions from each party about the perceived and actual effectiveness of such an underlayer against advanced and large-scale threats.

The 2019 *Missile Defense Review* established that while the United States would continue to rely on deterrence against the "large and technically sophisticated Russian and Chinese intercontinental ballistic missile threats to the U.S. homeland," U.S. missile defense "must outpace existing and potential rogue state offensive missile capabilities."[112] Deputy Assistant Secretary of Defense Rob Soofer says that "the risks are anything but static."[113]

The United States is at an inflection point with respect to the performance of its homeland missile defense architecture relative to the evolving missile threat. For the last two decades, the balance of benefits and costs has been reasonably clear. The GMD-based architecture effectively paced the evolving North Korean threat and achieved its main stated purpose. This benefit has been neither undermined nor counterbalanced by the actions of rogue states and peer competitors, but Russia and China have each undertaken broader political and military actions that adversely affect U.S. security interests.

At this point, the primary benefit of U.S. homeland defense identified in Key Finding 1 appears to be under increasing pressure. In addition to North Korea's unfolding nuclear ICBM capabilities, advanced cruise missiles and hypersonic weapons are coming online, expanding the focus of U.S. homeland defense beyond ballistic missiles alone. In parallel, Russia's expansive nuclear modernization program, China's purported doubling of its deployed nuclear forces in the years ahead, and Russian and Chinese development of their own integrated missile defense architectures foreshadow important changes to the international security landscape. Determining how best to size U.S. homeland missile defense for the next two decades, and taking stock of its role in the defense relationships between the U.S. and potential adversaries, likely will require a focused net assessment. Ultimately, U.S. national security stakeholders in both the Executive and Legislative branches will need to consider against which threats, under which circumstances, and in which form, the homeland missile defense system should be able to credibly defend.

Annex A: The Rationale for, and Concept of, U.S. Homeland Missile Defense Has Evolved over Time

The United States has pursued missile defense as an element of its defense posture since the early days of the Cold War, when Soviet nuclear tests and rapid Soviet progress in the development of ICBM capabilities created new U.S. vulnerabilities to Soviet attack. The United States variously developed and fielded defensive capabilities to protect potentially vulnerable civilian and military populations, to protect deployed military assets, and to ensure the survivability of ground-based strategic deterrent capabilities. Yet the nation ultimately chose during the Cold War to cancel deployment of the limited ballistic missile defense capabilities allowed under the ABM Treaty to defend the homeland. And even today—roughly two decades after the U.S. decision to withdraw from the ABM Treaty (**sidebar** on next page)—the U.S. system is not fielded in ABM Treaty-allowed quantities. Over the past several decades, U.S. missile defense deployments in the homeland have faced persistent scrutiny over system cost and operational effectiveness, military strategy and concepts of risk and vulnerability, the pace and scope of technology advancement, geopolitical developments, an evolving threat landscape, and other variables. This annex discusses the perceived rationale for and security benefits associated with U.S. development and deployment of homeland missile defenses over time.

1980s: SDI Aimed To Render Nuclear Weapons Obsolete

The missile defense systems developed, fielded, and retired in the 1970s were typically designed for point defense: discrete defenses against limited threats. This changed with President Ronald Reagan's 1983 announcement of a new Strategic Defense Initiative (SDI), which laid out an ultimate goal of "eliminating the threat posed by strategic nuclear missiles" and called upon the scientific community to "give us the means of rendering these nuclear weapons obsolete."[114] The administration stood up a new Strategic Defense Initiative Organization (SDIO) to oversee the long-term research and development necessary for a deployment decision anticipated in the 1990s.[115] However, technology challenges, geopolitical change, resource constraints, and an evolution in U.S. national security priorities ultimately precluded Reagan's vision of a defense-dominated strategic posture. For example, many of the high-profile directed-energy programs associated with SDI would have required extensive, multiyear research and development campaigns until their feasibility could even be credibly assessed (much less fielded).[116,117,118]

In this context, the political and military need for near-term security benefits led to the establishment of a phased approach to the Strategic Defense System (SDS). The objective of the phase I SDS architecture was to help ensure the survivability of forces sufficient for a controlled, flexible, and deliberate U.S. and allied retaliatory response, according to a 1987 SDIO report.[119] The same report states that the operational requirement was to limit damage from the leading edge of a major Soviet attack and to provide "near-perfect" defense against limited attack, including accidental and unauthorized launches, third-party attack, and limited Soviet attack. The phase I architecture was to comprise a two-tier system: a low-Earth orbit (LEO) constellation of space-based interceptors (SBIs) for boost-phase engagement and ground-based interceptors for mid-course intercept. The architecture later evolved to incorporate the "Brilliant Pebbles" concept of space-based, autonomous, independently targetable interceptors in an effort to provide distributed survivability at lower cost.

Early 1990s: After the Cold War, Homeland Missile Defense Focused on Protection against a "Limited" Attack

The Cold War ended before successful development of the SDS phase I architecture. With the disintegration of the Soviet Union at Cold War's end, concerns over unauthorized or accidental nuclear launches and protection of U.S. forward-deployed forces against conventional short- and medium-range ballistic missiles took on greater salience than a large-scale, deliberate nuclear first strike. Political instability in the states of the former Soviet Union and regional proliferation of ballistic missiles and associated weapon-of-mass-destruction technologies with uncertain use controls drove concerns about accidental and unauthorized launch. Iraqi launches of Scud missiles against Israeli cities and coalition forces in the region during the 1991 Gulf War also highlighted the need for TMD capabilities to protect U.S. and allied forces.[120]

During his 1991 State of the Union address, President George H.W. Bush directed that the SDI program "be refocused on providing protection from limited ballistic missile strikes, whatever their source,"[121] a new programmatic direction that became known as Global Protection Against Limited Strikes (GPALS). This post–Cold War focus represented the beginning of the strategic shift from comprehensive defense to the present-day ballistic missile defense program's focus on limited protection, albeit with a few key differences. In this context, "limited" was defined as attacks of up to 200 ballistic missile warheads, such as the unauthorized launch of a regiment of ICBMs or a submarine load-out of SLBMs.[122] **This understanding of *limited* is significantly greater than the construct used for sizing today's homeland missile defense system**.

ABM Treaty

The United States and Soviet Union signed the Treaty on the Limitation of Anti-Ballistic Missile (ABM) Systems on 26 May 1972.

The Treaty prohibits the deployment of ABM systems for the defense of the nations' entire territory but permits each side to deploy limited ABM systems at two locations, one centered on the nation's capital and one at a location containing ICBM silo launchers. A 1974 Protocol further limited each nation to one ABM site either at the nation's capital or around an ICBM deployment area. The Treaty specifies that the radius of the deployment area for each ABM system cannot exceed 150 kilometers and that each site can contain no more than 100 ABM launchers and 100 ABM interceptor missiles. The Treaty also limits the number and power of the ABM radars at each ABM site and specifies that, in the future, any radars that provide early warning of strategic ballistic missile attack must be on the periphery of the national territory and oriented outward. Furthermore, the Treaty bans the development, testing, and deployment of sea-based, air-based, space-based, or mobile land-based ABM systems and ABM system components (the Treaty lists these components as interceptor missiles, launchers, and radars or other sensors that can substitute for radars).

The numerical limits and deployment restrictions in the ABM Treaty do not apply to other types of defensive systems, such as defenses against aircraft or defenses against ballistic missiles that are not strategic ballistic missiles (such as shorter-range battlefield or theater ballistic missiles). However, the Treaty does state that the parties cannot give these other types of defenses ABM capabilities. In particular, the parties agreed that they would not give these types of systems the capabilities to counter strategic ballistic missiles or their elements in flight trajectory. The parties also cannot test these other types of defenses "in an ABM mode."

The United States withdrew from the Treaty in June 2002.

Adapted from Report for Congress 98-496F, A.F. Woolf, Congressional Research Service, Anti-Ballistic Missile Treaty Demarcation and Succession Agreements: Background and Issues, 27 April 2000.

The planned GPALS system derived from the SDS phase I architecture. It consisted of three elements: theater ballistic missile defenses, a ground-based defense system with mid-course exoatmospheric interceptors deployed at up to seven sites in the United States, and a constellation of approximately 1,000 Brilliant Pebbles SBIs for boost-phase and mid-course intercept, supported by a constellation of LEO tracking satellites called Brilliant Eyes. While the GPALS system was considerably smaller than that originally envisioned under SDI, the effectiveness requirement was more stringent. The identified policy objective of "protection" called for high-confidence missile intercepts; however, even if the system allowed a modest number of warheads through, it would still enhance the survivability of counterforce capabilities.[123]

Mid-1990s: A Growing Regional Challenge and Debate over Severity of Threat to the U.S. Homeland Arise

The Clinton Administration reoriented U.S. missile defense activities, prioritizing TMD but retaining select National Missile Defense (NMD) research and development programs to "support deployment no earlier than 2002 of a defensive capability for the continental United States."[124] The administration renamed SDIO the Ballistic Missile Defense Organization (BMDO) to reflect its new priorities. The administration also sought to balance missile defense with other foreign policy objectives, including cooperative threat reduction, by mandating strict adherence to a "narrow interpretation" of the ABM Treaty. As a result, the Clinton administration cancelled Brilliant Pebbles and spent years negotiating the ABM Treaty Demarcation and Succession Agreements to delineate "theater" and "strategic" systems—never specifically defined in the original ABM Treaty text—based on interceptor velocities and associated test targets. The United States and Russia signed the relevant agreement in 1997, and the Russian Duma ratified the agreement in 2000; it was never transmitted to the U.S. Senate for ratification.

Intelligence estimates in the mid- to late-1990s led to significant policy controversy over the nature, severity, and timing of the threat posed by rogue-state ballistic missiles to the U.S. homeland. The *National Intelligence Estimate on Emerging Missile Threats to North America* found in 1995, for instance, that "no country, other than the major declared nuclear powers, will develop or otherwise acquire a ballistic missile in the next 15 years that could threaten the contiguous 48 states and Canada."[125] For some, this provided top-cover for a revised focus on regional missile threats.[126] For others, the assessment's exclusion of Alaska and Hawaii, along with other U.S. territories, suggested an inherently flawed assessment of threats to the nation.[127] The Commission to Assess the Ballistic Missile Threat (also known as the Rumsfeld Commission), formed by the 1997 National Defense Authorization Act in response to this threat dichotomy, concluded that the rogue-state missile threat was "broader, more mature and evolving more rapidly than has been reported in estimates and reports by the Intelligence Community."[128] The Commission estimated that rogue states could develop a ballistic missile capable of inflicting major damage on the United States within five years of a decision to do so, with potentially little warning.[129] One key assumption, grounded in limited data, was that other states may not seek comparable levels of accuracy or reliability commensurate with the U.S. approach to developing, testing, and fielding such systems.[130] In parallel, contemporaneous events served to reinforce the sense that threat was closer at hand than previously estimated, including Iran's successfully July 1998 test of its Shahab-3 medium-range ballistic missile,[131] North Korea's August 1998 launch of its three-stage TD-1 rocket,[132] and evidence of secondary supplier coordination between North Korea, Pakistan, and Iran.[133]

Late 1990s: Homeland Missile Defense Goals Are Made Yet More Modest as "Limited" Is Redefined

Ultimately, legislative and political pressure and the evolving security environment cited above pushed the Clinton Administration to adjust its approach to NMD. In April 1996, Secretary of Defense William Perry announced the transition of NMD as a *technological* readiness program to a *deployment* readiness program, with the objective of defending against a "smaller and relatively unsophisticated ICBM threat that a rogue nation or a terrorist could mount any time in the foreseeable future," and to be capable of intercepting an unauthorized or accidentally launched missile.[134] This objective was significantly more modest than the limited protection envisioned previously under GPALS.

In this context, the Clinton Administration established the "3 + 3 plan" for NMD. Under this plan, the administration sought to develop within three years the elements of an NMD system—radars, interceptors, battle management capabilities, and space-based early warning—for an integrated system test-and-deployment readiness review. Thereafter it would continue to develop the system but be ready to deploy within three years, should threat conditions warrant. Under this evolutionary approach, DoD would adopt a phased approach to system architecture development:[135]

1. *Capability-1 (as early as 2003):* an **initial** capability to defeat an unsophisticated threat, comprising 20 GBIs at a single site in Alaska to protect the entire 50 states, along with associated radars, battle management, and space-based early warning via Defense Support Program (DSP) satellites. An Expanded Capability-1 phase was later included for deployment in 2008. EC-1 would include:
    a. Expansion to 100 GBIs.
    b. Incorporation of DSP-replacement SBIRS-high satellites for detection and cueing.
    c. Upgraded early-warning radars at Beale Air Force Base, California; Clear, Arkansas; Cape Cod, Massachusetts; Fylingdales, United Kingdom; Thule, Greenland; and the COBRA DANE X-band radar in Shemya, Arkansas.
2. *Capability-2:* an **enhanced** capability to handle more complex countermeasures, with three additional X-band radars and 24 SBIRS-low satellites capable of providing midcourse tracking information and supporting warhead discrimination.
3. *Capability-3:* an **expanded** capacity with an additional 150 GBIs at a second site in Grand Forks, North Dakota, with additional radars, communications facilities, and improved software.

The National Missile Defense Act of 1999 established as the official policy of the United States to deploy an effective NMD system against limited ballistic missile attack as soon as technologically possible.[136] That year, a missile-defense prototype system achieved the first successful intercept of a mock warhead mounted on a Minuteman III ICBM.[137] This first intercept solely tested the kill vehicle, not the boosters, sensors, or radars, and warhead transponders emulated tracking data that would be provided by ground-based radars.[138] However, two additional intercept tests in 2000 failed, and President Clinton ultimately decided to defer a deployment decision to the next administration.[139,140]

Early 2000s: Moving beyond the ABM Treaty

In 2001, President George W. Bush called for new concepts of deterrence predicated on both offensive and defensive capabilities, including a missile defense component, suitable to the evolving demands of the international security landscape.[141] His May 2001 speech at the National Defense University described a strategic environment characterized by increasing weapons of mass destruction and missile proliferation to the “world’s least-responsible states” as deleterious to the nation’s security. He articulated the purpose of missile defense as one of countering the use of weapon-of-mass-destruction threats by regional states to “intimidate their neighbors, and keep the United States and other responsible nations from helping allies and friends in strategic parts of the world.”[142] In this context, President Bush announced that the United States would develop missile defenses unconstrained by the ABM treaty: “We need a new framework that allows us to build missile defenses to counter the different threats of today’s world,” and to do so, “we must move beyond the constraints of the 30-year-old ABM treaty.”[143] The United States notified Russia of its intent to withdraw from the ABM treaty, a process which culminated in June 2002.

Following four of five successful intercepts by the embryonic NMD system in 2001 and 2002 that demonstrated kill-vehicle performance and sensor operations, President Bush issued NSPD-23, directing the Secretary of Defense to “proceed with fielding an initial set of missile defense capabilities” by 2004.[144] Under this strategic concept, this capability would do the following:

- Deter coercion by devaluing missiles as tools of extortion and aggression, undermine the confidence of our adversaries that threatening a missile attack would succeed in blackmail.
- Assure allies and friends.
- Dissuade countries from pursuing ballistic missiles in the first instance by undermining their military utility.
- Provide protection should deterrence fail.

Among other things, the Bush Administration eliminated the canonical distinction between theater and strategic missile defenses reflected in the ABM treaty and continued varied “boost-phase,” “midcourse,” and “terminal” defense programs under a new MDA (**table A1**).

Table A1. Missile-defense intercept phases.[145]

Phase of intercept	Description
Boost: launch to final stage burnout; typically 3 to 4 minutes	Advantages: large target, easy to track heat signature, limited countermeasures available, intercept occurs over/near adversary territory. Challenges: Short timescales mean intercept capabilities need to be pre-positioned, posing risks to the defensive platform. Kinetic interceptors need very high velocity to intercept. Current interceptors: none. Cancelled systems: Brilliant Pebbles SBIs (SDI + GPALS), Airborne Laser Program, Kinetic Energy Interceptor.
Midcourse: after boost until warhead reenters the atmosphere; longest phase of flight	Advantages: longest phase of flight, interceptors can cover a broad geographical area. Challenges: Low heat signatures make detection and tracking more difficult, requires discrimination, countermeasures most effective during this phase, interceptor boosters are larger and more expensive than interceptors for other stages. Current interceptors: Ground-Based Midcourse Defense, Aegis and Aegis Ashore SM-3 IIA and SM-3 IA/IB (limited). Cancelled systems: Brilliant Pebbles, Sea-Based Midcourse Defense.
Terminal: once warhead reenters atmosphere until it reaches its target	Advantages: warheads are easy to track in this phase, and the atmosphere helps filter out countermeasures. Challenges: Terminal-phase interceptors can only cover a limited geographical area, kinetic interceptors need high velocity, intercept occurs over defender’s territory. Current systems: THAAD, Aegis SM-6, Patriot Advanced Capability-3.

In his January 2002 Missile Defense Program Direction memo, Secretary of Defense Rumsfeld laid out four key missile defense priorities:

1. To defend the United States, deployed forces, allies, and friends.
2. To employ a ballistic missile defense system (BMDS) that layers defenses to intercept missiles in all phases of their flight (i.e., boost, midcourse, and terminal).
3. To enable the Services to field elements of the overall BMDS as soon as practicable.
4. To develop and test technologies, use prototype and test assets to provide early capability, if necessary, and improve the effectiveness of deployed capability by inserting new technologies as they become available or when the threat warrants accelerated development.

While specific programmatic directions, associated resource allocation, and deployment concepts have evolved over the past two decades, the roles for and purposes of missile defense outlined by the Bush Administration, and the layered defense architecture that supports those roles, have remained reasonably consistent. In this integrated approach, systems designed for homeland and theater deployments are distinct but mutually reinforcing. For example, the policy objectives of homeland missile defense capabilities included the following:

- Counter adversary threats to the U.S. homeland, denying the ability of hostile parties to prevent or deter U.S. involvement in or escalation of a regional conflict.
- Reassure allies that U.S. security interests remain coupled to their own.
- Defend the U.S. homeland should deterrence fail.

In parallel, the policy objectives of regional missile defense capabilities included the following:

- Focus adversary and allied perceptions of U.S. resolve by supporting the U.S. ability to project power and reducing the potential costs to the United States of conflict.
- Mitigate the effectiveness of coercion tactics against U.S. allies by supporting defense of potentially vulnerable forces or, in some cases, civilian populations.
- Defend U.S. and allied forces in theater, providing freedom of maneuver in crisis, conflict, and war.

At the same time, this synergistic approach has enabled flexibility in the nation's missile defense posture. For example, successfully developed and fielded boost-phase intercept capabilities could in principle target both intercontinental and theater-range missiles. While homeland missile defense would primarily be provided by the Ground-Based Midcourse Defense system, it would be supported by boost- and terminal-phase interceptors. Assets such as the Army's THAAD system and the Navy's Aegis system are relocatable, which enables use in a range of contingencies and against threats to both deployed forces and potentially to the U.S. homeland. An interconnected network of sensors and a command, control, battle management, and communication (C2BMC) system serve both theater and homeland defensive purposes.

The initial GMD system was sized primarily for North Korean ICBM threats—a prospective long-range, missile-delivered nuclear threat to the U.S. homeland. The Bush Administration planned for a total of 44 GBIs for the GMD system fielded between Fort Greeley in Alaska and Vandenberg Air Force Base in California. The administration later decided to field an additional 10 two-stage GBIs in Poland and a fire control radar in the Czech Republic to improve protection against future missiles from Iran.

By September 2004, GMD achieved Limited Defensive Operations, with five GBI interceptors in silos at Fort Greely and an upgraded Cobra Dane phased-array radar in Shemya, which became the principal fire control radar for tracking missiles out of Northeast Asia. By the end of the Bush Administration, 24 GBIs were fielded at the two sites. The Beale and Fylingdales upgraded early warning radars were operational, and the sea-based X-band radar was available for theater contingencies.[146] Two AN/TPY-2 forward-based X-band radars were deployed to Japan and Israel, and two SBIRS-high highly elliptical orbit sensors were launched in 2006 and 2008. Thus, the United States developed and deployed an initial homeland missile defense capability in advance of a demonstrated North Korean nuclear weapon capability.

At the same time, the effectiveness of the nascent GMD-centered homeland missile defense system faced persistent challenges. Between December 2002 and January 2009, MDA conducted six intercept tests, of which three failed. The September 2006 FTG-02 test represented the first end-to-end intercept test in a realistic engagement scenario, with an operationally representative missile, command-and-control network, and associated sensor suite.[147] The following year, FTG-03a successfully demonstrated the first operational use of the Beale tracking radar.[148] By 2010, however, MDA testing had only demonstrated GMD capability against intermediate-range–class targets and had not yet demonstrated an ability to overcome simple countermeasures.

Over the course of the Bush Administration, resources allocated to the development and fielding of missile defense capabilities expanded substantially (**figure A1**). While more limited than the system envisioned at the end of the Cold War, the initial system developed nonetheless represented a clear milestone: for the first time since the 1970s, the United States had fielded an operational ground-based missile defense system for the U.S. homeland.

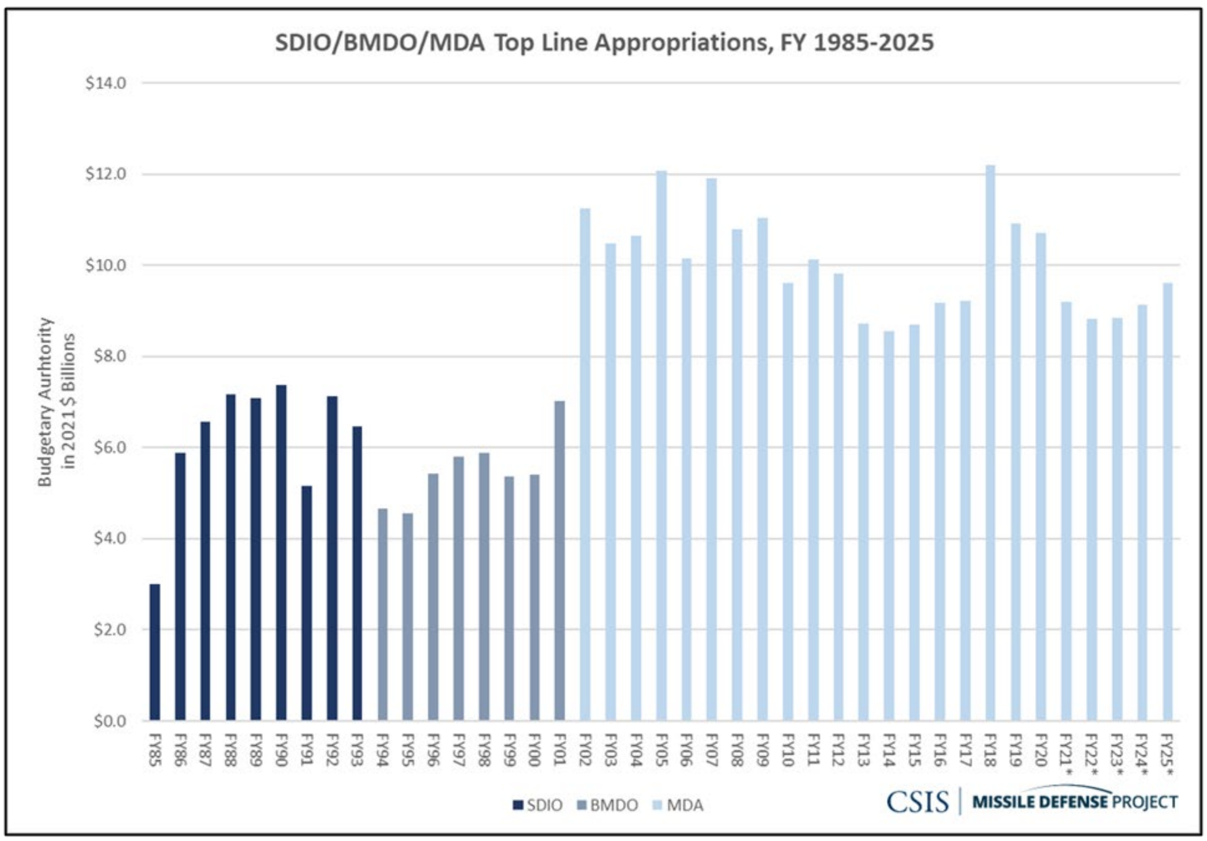

Figure A1. Budget authority for MDA and preceding agencies from Center for Strategic and International Studies.[149] (* = number based on 2021 budget request.)

2010s: Homeland Missile Defense—New Priorities Arise for an Enduring Mission

The 2009 National Defense Authorization Act obliged the next administration to conduct the first ever Ballistic Missile Defense Review (BMDR). The Obama administration initiated this review in March 2009 and issued its report a year later.

Before that review geared up, Secretary of Defense Robert Gates took a number of missile defense decisions as part of a larger initiative to cut or curtail underperforming programs, including the Air-Borne Laser (ABL) and the Kinetic Energy Interceptor (KEI).* Gates also decided to discontinue programs for boost-phase intercept of ICBM-class missiles. Gates concluded that these programs were costly, had proven technically immature, required unrealistic concepts of operation to be effective, or were oriented toward lower-priority or not-yet-realized foreign missile threats.[150]

Gates also chose to curtail the deployment of GBIs at 30 rather than the full planned 44. He did so for two primary reasons. First was the recognition that North Korea had not sprinted to nuclear ICBM deployments by 2005; indeed, by 2009 North Korea had made no deployments, and the United States maintained 30 interceptors. Second was the recognition that it made sense to pause and fix the GBIs rather than simply plus-up a challenged program. Recognizing the need for potential future growth in the system with a more reliable interceptor, Gates opted to complete construction of the associated missile field at Fort Greely and to continue development of a two-stage GBI.

As an early result of its BMDR, in September 2009 the Obama administration announced a decision to replace the Bush administration's third site in Europe (that is, the third site for GBI deployments) with the European Phased Adaptive Approach (EPAA) to missile defense. Its purpose was to better use emerging theater defense capabilities to secure early and effective coverage of U.S. forces in Europe while also providing a means for European allies wishing to contribute to their defense to do so. In announcing these steps, President Obama highlighted that improvements in U.S. TMD capabilities would help address the threat of Iran's short- and medium-range missiles targeting Europe.[151]

In February 2010, the administration released its BMDR. The report observed a security environment characterized by an increasing quantity, quality, and proliferation of ballistic missile systems. It postulated "some uncertainty about when and how the [rogue-state] ICBM threat to the homeland will mature" but anticipated that existing and anticipated GMD investments would sufficiently protect against limited ICBM attack from North Korea or Iran. It set out the following policy framework for missile defense:[152]

1. The United States will continue to defend the homeland against the threat of limited ballistic missile attack.
2. The United States will defend against regional missile threats to U.S. forces while protecting allies and partners and enabling them to defend themselves.
3. Before new capabilities are deployed, they must undergo testing that enables assessment under realistic operating conditions.
4. The commitment to new capabilities must be fiscally sustainable over the long term.
5. U.S. BMD capabilities must be flexible enough to adapt as threats change.
6. The United States will seek to lead expanded international efforts for missile defense.

* The ABL program was descoped to a technology demonstration program in 2009, and later discontinued, although limited directed-energy research and development for missile defense continued at the laboratory level.

On homeland defense, the Obama administration invested in programs to address reliability problems with the GBI and in improvements to sensors. It also focused on improvements to planning and operational processes aimed at ensuring the effective operational integration of defenses into military preparations for war. It also provided a full explanation of its approach to hedging in case of new evidence that the "advantageous position" of the United States (with a ratio of 30 GBIs to 0 rogue-state ICBMs) might rapidly erode.[153]

In 2013, new evidence of North Korean progress in developing ICBMs led to a decision to both implement and reset the hedge. North Korea reportedly made noteworthy advances in its ICBM and associated nuclear weapon capabilities. In April 2012, North Korea displayed what appeared to be road-mobile ICBMs.[154] In December, North Korea used a TD-2 to put a satellite in orbit.[155] In February 2013, North Korea conducted its third nuclear test, claimed to be a "miniaturized and lighter nuclear device."[156] Various U.S. assessments at the time generally agreed that the KN-08 road-mobile ICBM likely had the range to reach the United States[157] and that North Korea had successfully miniaturized its nuclear warheads for ballistic missile employment.[158] However, assessments on the degree to which these systems were integrated, and whether they would be credible or reliable without having been tested, varied.[159]

In light of such advances, Secretary of Defense Chuck Hagel announced in March 2013 the administration decision to fill out the remaining 14 silos at Fort Greely. To reset the hedge, a decision was made to conduct environmental impact studies for a potential third GBI site in the United States.

During this period, efforts to improve the existing fleet of GBIs met many challenges.[160] In 2010, for instance, MDA executed two GMD intercept tests with the CE-II exoatmospheric kill vehicle (EKV). Each intercept failed: the first due to issues with the sea-based radar, the second to an EKV design and production issue in which high-frequency vibrations caused the kill vehicle to lose target tracking.[161,162] Following a pause, MDA resumed GMD intercept tests in July 2013 with the CE-I EKV. That test failed due to an EKV battery issue that resulted in the warhead not separating from the booster.[163] In June 2014, the modified CE-II EKV successfully intercepted an IRBM target with operationally realistic countermeasures.[164] This test also demonstrated the ability of the sea-based radar and an Aegis-class ship to provide tracking data to the command, control, and battle management system.

Installation of the 44th GBI in Fort Greely was completed in November 2017, with eight of the 14 new interceptors of the CE-II block-1 variant.[165] The next two SBIRS geosynchronous satellites were launched in March 2013 and January 2017.[166] A second AN/TPY-2 forward-based radar was deployed to western Japan.

2017 and After: The Homeland Is No Longer a Sanctuary

Continuing development of and substantial improvements in North Korea's long-range missile capabilities and possible associated nuclear payloads—including its highest-yield nuclear test in September 2017—encouraged the Trump Administration to expand the capacity of the existing GMD system.[167,168] Chairman of the Joint Chiefs of Staff General Joseph Dunford, Jr. argued that "based on the current capacity of the North Korean threat, both the type and the amount of missiles that they possess, we can protect Hawaii today against an ICBM…[and] we can protect the continental United States against an ICBM," but "as the capacity of the threat increases…we need to be concerned about ensuring that our ballistic missile defense capability keeps pace with that threat."[169] In turn, the 2018 National Defense Strategy came to the "undeniable" conclusion that the homeland "is no longer a sanctuary."[170]

The 2018 National Defense Authorization Act authorized deployment of an additional 20 GBIs and directed the administration to develop a plan to increase total missile field capacity to 104 GBIs, including identification of possible East Coast or Midwest deployment sites. Through the FY18 and supplemental appropriations bills, Congress increased funding to MDA by 46 percent over the President's budget request.

In January 2019, the Trump Administration released the results of its Missile Defense Review (MDR),[171] a name change highlighting an expanding missile threat beyond ballistic systems. The MDR reaffirmed the roles of homeland missile defense for deterring and defending against ballistic missile attacks from rogue states and for assuring allies by countering adversary capabilities. It maintained the system's long-standing design basis: a homeland missile-defense architecture sized to remain ahead of growing regional state threats, with reliance on nuclear deterrence for the large and technically sophisticated Russian and Chinese ICBM threats. While the GMD system does not have the capacity to defend against large-scale Russian or Chinese attacks, the MDR signaled that GMD and other missile defense could potentially be useful in limited-use scenarios.

The Trump Administration has argued that defending the homeland is DoD's number-one objective. It finds that rogue states seek to threaten or coerce the United States homeland with long-range missiles, restrict U.S. freedom of action, and undermine U.S. resolve to defend its allies and partners. Conversely, a secure U.S. homeland enables the United States to defend its interests at home and abroad, commit to the defense of others, resist coercion, and negotiate from a position of strength. Looking ahead, it anticipates that the threats posed by North Korea and Iran "are likely to increase in capability and capacity" by the mid-2020s.[172] In this context, the U.S. missile defense posture seeks to defend against real and growing threats—both in forward locations and in the homeland itself—and to hedge against prospective threats. In this context, missile defense can do the following:

- Complicate adversary attack planning, increasing uncertainty and diminishing the value of such attacks.
- Provide insurance against the failure of diplomacy and deterrence.
- Buy U.S. policymakers valuable decision space during crisis or conflict.
- Safeguard against unauthorized or accidental launches by others.
- Protect critical military systems that provide situational awareness and command and control.[173]

At the same time, recent GMD tests have been judged as successful. In May 2017, MDA achieved the first successful intercept of an ICBM target, while in March 2019 it successfully completed the first GBI salvo engagement.[174] Looking ahead, DoD leaders have highlighted the need to develop approaches for more complex missile threats, including the advanced cruise missiles and HGVs that pose a threat both to the U.S. homeland and to forward-deployed U.S. forces and theater allies.[175] Enhanced land- and space-based sensor capabilities to detect and track these systems is an identified first step toward a credible defensive capability. More broadly, DoD has emphasized the need to move toward more of a layered architecture for homeland missile defense. While this expanded architecture centers on GMD and anticipates a modernized Next Generation Interceptor starting in 2028,[*,176] it also incorporates an "underlayer" of other defensive assets; a "missile defense-in-depth" construct that calls for Aegis SM-3 block IIA and THAAD capabilities to perform both theater and homeland defense roles (figure 1 and **figure A2**).[177]

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* One element of DoD's long-planned GBI modernization was to swap out the legacy EKV for a new redesigned kill vehicle (RKV). In August 2019, DoD terminated the RKV program due to "technical design problems [that] were so significant as to be either insurmountable or cost-prohibitive to correct." In its place, DoD seeks to field a Next Generation Interceptor starting in 2028 (reference 176).

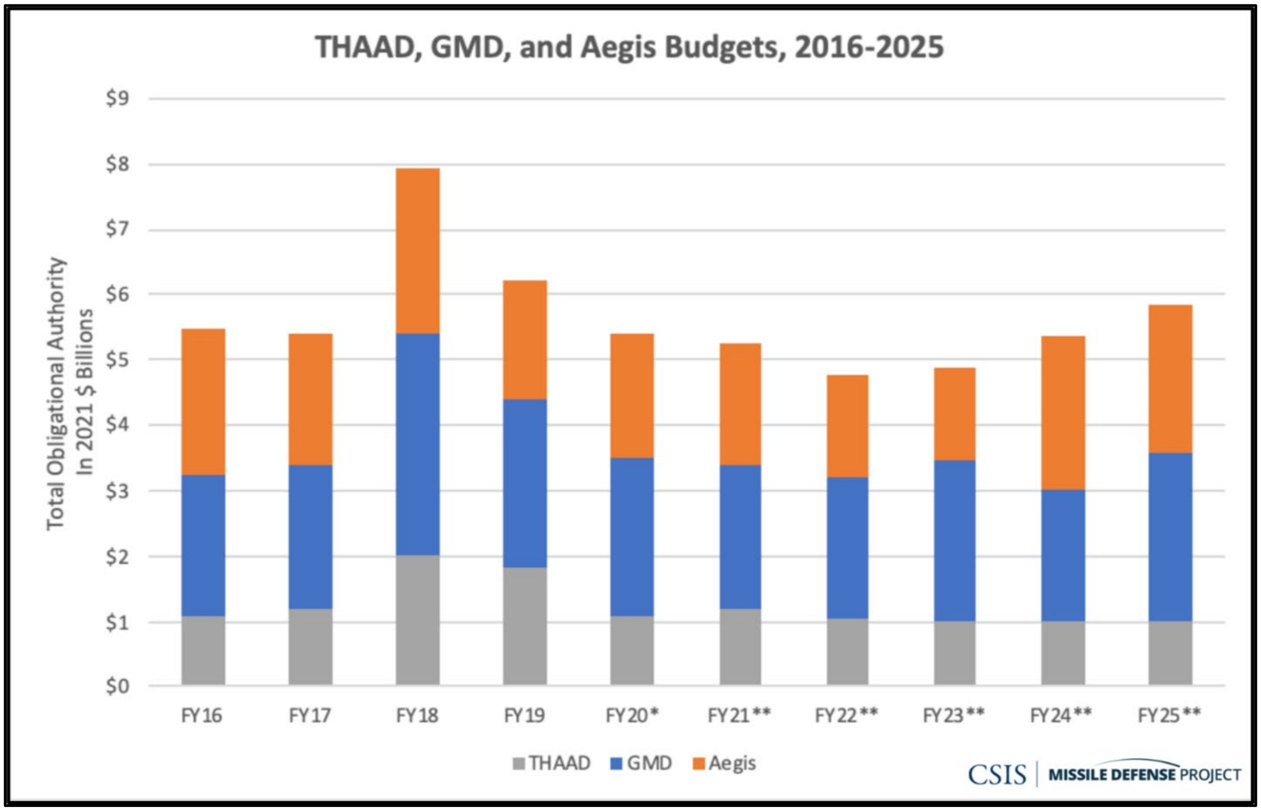

Figure A2. Anticipated budget request for homeland missile defense "underlayer" from Center for Strategic and International Studies.[178] (* = Appropriated dollars ** = Based on 2021 budget request.)

Annex B: Foreign Missile Capabilities Pose a Growing Challenge to the Homeland Defense Posture

This annex describes the evolving missile threat to the United States, centered on key missile-related developments in and potential challenges posed by North Korea, Iran, Russia, and China (**table B1**). Consistent with the rise of homeland missile defense as a policy concern over the past two decades, this annex emphasizes select foreign developments over that time. Annex C (available upon request) further considers key issues associated with the homeland missile defense posture.

Table B1. Select North Korean, Iranian, Russian, and Chinese long-range missile developments, testing, and deployment designed to range the U.S. homeland and territories since 2000. The entries note the earliest available date that a weapon was deployed, displayed, tested, or otherwise noted as in development. See individual country sections below for referencing information and additional detail. (NA = not applicable.)

Country	2000–2005	2006–2010	2011–2015	2016–2020
North Korea	TD-1 (SLV)	TD-2 (SLV)	KN-08	Musudan (Hwasong-10) Hwasong-12 Hwasong-13 Hwasong-14 Hwasong-15 Bukkeukseong-1
Iran	NA	Safir (SLV)	Simorgh (SLV)	NA
Russia	SS-27 Mod 1 (silo)	SS-27 Mod 1 (road-mobile) SS-N-23 (Sineva)	SS-27 Mod 2 Kh-101/Kh-102 Bulava	RS-26 Sarmat Avangard Kh-555 SS-N-30 Poseidon (Status-6) SSC-8 (9M729) SSC-X-9 Skyfall (Burevestnik) Kinzhal
China	CSS-9	CSS-10 Mod 1 CSS-10 Mod 2	CSS-N-3 JL-2	DF-17 DF-26 CSS-4 Mod 3 CSS-10 CSS-X-10 CSS-N-14 CSS-X-20 CJ-20 JL-3

For many decades, both Russia and China have fielded missile systems capable of long-range strikes against the U.S. homeland. Over the past two decades, each has developed and fielded new strategic nuclear weapons and improved long-range conventional weapons. Some of these new Russian weapon systems are explicitly designed to defeat, complicate, or circumvent missile defenses, while other Russian and Chinese systems include technologies useful for this purpose. In turn, the United States also faces growing challenges from some regional states to its homeland defense posture. Before the turn of the millennium, the ability of rogue regional states to threaten the U.S. homeland via long-range missile attack was limited. Over the past two decades, however, North Korea has substantially improved its ability to hold the U.S. homeland at risk. It has conducted several IRBM and ICBM tests, while Iran's development and launches of space-launch vehicles has provided a technology base from which an ICBM could be developed. Taken together, DoD's stated concern that the threat posed to the U.S. homeland by adversary missile systems may outpace U.S. homeland missile defense capabilities appears to be well-founded.

North Korea

North Korea remains committed to developing a long-range, nuclear-armed missile that can directly threaten the United States homeland, according to DIA.[179] The Intelligence Community (as cited by a 2019 CRS report) has characterized North Korean nuclear weapons as intended for deterrence, international prestige, and coercive diplomacy.[180] It continues to observe activities inconsistent with nuclear disarmament (see **sidebar**).

Director of National Intelligence Assessment of North Korea

The following assessment comes from a Statement for the Record by Director of National Intelligence D.R. Coats on 29 January 2019:[181]

Pyongyang has not conducted any nuclear-capable missile or nuclear tests in more than a year, has declared its support for the denuclearization of the Korean Peninsula, and has reversibly dismantled portions of its weapon-of-mass-destruction infrastructure. However, we continue to assess that North Korea is unlikely to give up its nuclear weapons and production capabilities, even as it seeks to negotiate partial denuclearization steps to obtain key US and international concessions. North Korean leaders view nuclear arms as critical to regime survival, according to official statements and regime-controlled media.

In his 2019 New Year's address, North Korean President Kim Jong Un pledged that North Korea would "go toward" complete denuclearization and promised not to make, test, use, or proliferate nuclear weapons. However, he conditioned progress on US "practical actions." The regime tied the idea of denuclearization in the past to changes in diplomatic ties, economic sanctions, and military activities.

In Singapore in June 2018, Kim said he sought the "complete denuclearization of the Korean Peninsula"—a formulation linked to past demands that include an end to US military deployments and exercises involving advanced US capabilities.

We continue to observe activity inconsistent with full denuclearization. North Korea has underscored its commitment to nuclear arms for years, including through an order to mass-produce weapons in 2018 and an earlier law—and constitutional change—that affirmed the country's nuclear status.

In 2012, North Korea established a Strategic Force, including units operating short-, medium-, intermediate-, and intercontinental-range ballistic missiles, according to DIA.[182] Over 2016 and 2017, North Korea tested at least two types of IRBMs, two types of ICBMs, and an SLBM—a significant increase over the past several years. As recently as October 2020, North Korea displayed a new, untested ICBM that appeared to be its biggest yet, according to press reports.[183]

- Initial flight testing of the Hwasong-10 (Musudan) IRBM in 2016 resulted in several failures, according to the National Air and Space Intelligence Center (NASIC). Testing of the Hwasong-12 IRBM commenced in April 2017.[184]
- Twice in July 2017, North Korea tested the Hwasong-14 ICBM, a missile capable of ranging the continental United States. In November 2017, North Korea tested a new type of ICBM, the Hwasong-15. DIA and NASIC assess that without additional flight testing, the reliability of these ICBMs would be low.[185,186,187]
- In September 2016 and May 2017, North Korea successfully tested the Bukkeukseong-1 (Polaris-1) SLBM from a submerged submarine.[188,189]
- North Korea continues to develop the TD-2, an SLV that could reach the United States if configured as an ICBM. The TD-2 was tested five times between 2006 and 2016, with two successes, according to NASIC.[190]
- North Korea has conducted six nuclear tests between 2006 and 2017, each successively demonstrating higher yield, according to DIA.[191]

Iran

While Iran clearly pays close attention to U.S. forces in theater and has fielded medium-range systems designed for theater use, the extent to which U.S. homeland missile defenses factor into Iran's calculus is unclear. While the NIC assessed in 2001 that Iran likely would have an ICBM capability by 2015,[192] we see no evidence that this has materialized. Since 2000, Iran's long-range missile development has been limited to flight tests of the Safir ("several" tests since 2008) and Simorgh (launched in 2017 and 2019) SLVs, with a mixed performance record, according to DIA.[193] Though not weapon systems, SLVs share key characteristics with ICBMs, which likely would aid development of an Iranian ICBM if Iran decided to prioritize such a capability. While the challenge of defeating U.S. homeland missile defense could factor into Iran's decision about whether and when to develop and field an ICBM, potential U.S. reactions, such as sanctions or even military action, likely would factor as much or more in Iran's decision calculus.

- Tehran perceives an existential threat from the United States, according to a 2019 DIA report. Tehran's desire for a strategic counter to the United States could lead it to eventually develop and field an ICBM.[194]
- In 2016, the Commander of U.S. Northern Command stated publicly that Iran might be able to deploy an ICBM by 2020 if it chose to do so.[195]
- Since the re-imposition of all secondary sanctions on Iran in 2018, Iran's oil exports have decreased dramatically, and its economy has fallen into a severe recession, according to CRS.[196]

Russia

Russia is currently engaged in the complete modernization of its strategic nuclear forces, to include new types of ICBMs, SLBMs, and ALCMs. In addition, Russia has deployed and is developing new types of nonstrategic nuclear and conventional long-range missiles, to include SLCMs, ALBMs, and GLCMs. In the absence of any meaningful U.S. homeland missile defense capability, Russia would most likely still have engaged in widespread force modernization. However, Russian military strategists and senior policymakers have long-standing perceptions about missile defense, grounded in the belief that a possible U.S. technological breakthrough in missile defense could undermine the Russian strategic nuclear deterrent. As a result of this perception and as a hedge against technological uncertainty, Russia has based its modernization program around its worst-case perception of U.S. homeland missile defense rather than the existing or planned architecture of the U.S. homeland missile defense system. This includes the development of countermeasures, such as penetration aids, for its strategic systems. In addition, Russia has also deployed and is developing new and unique capabilities specifically intended to defeat or circumvent missile defenses, to include an HGV, a nuclear-powered cruise missile, and a nuclear-powered autonomous undersea vehicle.

Russian deployment of new and improved long-range missiles through the early-to-mid-2010s primarily aimed at modernizing its strategic forces and replacing aging Soviet systems. However, beginning around 2015, Russia began to discuss more openly the development and deployment of systems with an increased emphasis on their ability to defeat, circumvent, or complicate missile defenses. Russian President Vladimir Putin specifically acknowledged this in March 2018, using the U.S. withdrawal from the ABM treaty to justify Russia's development of six new weapon systems, including a new heavy ICBM, ALBM, two nuclear-powered delivery systems, and an HGV.[197]

Modernization of Russia's strategic nuclear forces has been a top priority for Russian leadership. Moscow views its nuclear arsenal—and the strategic forces in particular—as integral to its national defense and to its status as a global power. Since 2000, new road-mobile and silo-based ICBMs, SLBMs, and ALCMs have replaced aging weapon systems inherited from the Soviet Union.

- Between 2000 and 2010, Russia deployed silo-based and road-mobile variants of the SS-27 Mod-1—at the time, its first new ICBM since the fall of the Soviet Union. Equipped with a single nuclear warhead, the SS-27 Mod-1 was designed with missile defense countermeasures, according to analysis by NASIC.[198] Also in this timeframe, Russia deployed a new variant of the SS-N-23 SLBM, designated Mod-3 or "Sineva."[199,200,201,202]
- Since 2010, deployments of new Russian strategic weapons have accelerated, to include silo-based and road-mobile versions of the MIRV-equipped SS-27 Mod-2 ICBM, the AS-23A (Kh-101, conventional) and AS-23B (Kh-102, nuclear) ALCMs, and Dolgorukiy (Borei)-class ballistic missile submarines (SSBNs) featuring the SS-N-32 "Bulava" SLBM.[203,204,205,206]
- These ICBMs, SLBMs, and ALCMs are likely intended to replace the Soviet SS-25 ICBM (first deployed in 1988), SS-19 Mod-3 ICBM (first deployed in 1980), SS-N-18 Mod-1 SLBM (first deployed in 1978), and AS-15 ALCM (first deployed in the 1980s).[207,208]

Russia's modernization program is evidently not yet complete, as it recently began production and deployment of an intercontinental-range HGV, is currently developing new ICBMs, is building updated variants of its latest ballistic missile submarine, and plans to modernize its strategic bombers.

- In December 2019, Russia deployed its first two "Avangard" HGVs, according to TASS. [209] The Avangard is deployed on SS-19 ICBMs and is designed to glide to target over intercontinental ranges, according to CRS and NASIC.[210,211,212] Its combination of a depressed trajectory and increased maneuverability compared to a traditional ICBM is intended to limit warning and stress missile defenses. In October 2020, the Chief Executive Officer (CEO) of the Russian Tactical Missiles Corporation claimed that work on Avangard began in 1985 in response to SDI, according to TASS.[213]
- Russia is currently developing "Sarmat," a liquid-fueled, silo-based, heavy ICBM intended to replace the aging SS-18 Mod-5 (first deployed in 1988). The SS-18 Mod-5 is equipped with up to ten nuclear warheads, and Sarmat is expected to have similar payload capabilities, as well as the potential ability to carry Avangard HGVs, according to CRS, NASIC, and DIA. [214,215,216] As of February 2020, Russia's Deputy Defense Minister stated that Sarmat is scheduled for 2021 deployment.[217] That timeline may slip since, as of April 2020, flight testing had yet to begin, according to the CEO of Roscosmos.[218]
- Russia is also developing a new ICBM designated RS-26 "Rubezh," according to analysis by NASIC and DIA.[219] The RS-26 is a smaller version of the SS-27 Mod-2, with the decreased weight aiding in mobility and survivability, and it is equipped with missile defense countermeasures. However, the RS-26's exclusion as of 2018 from Russia's State Armament Plan, according to TASS, raises some doubt as to its future.[220]
- Russia continues to modernize its SSBN force, and its latest submarines are upgraded Dolgorukiy-class (Borei-A, Project 955A), the first of which was delivered to the Russian Navy in May 2020, according to TASS.[221]
- Russia is planning to modernize and upgrade its strategic bombers, the Tu-95 and the Tu-160, according to analysis by DIA, both of which can be equipped with long-range ALCMs. In addition, Russia is in the early stages of developing its first stealth bomber, referred to as PAK-DA.[222]

In addition to modernizing its strategic nuclear forces, since at least 2000 Russia has developed and deployed modern, nonstrategic nuclear and conventional long-range missiles for varied naval, ground, and air platforms.

- Around 2017, Russia deployed the SS-N-30 (3M-14), an SLCM that can deliver both conventional and nuclear warheads, according to DoD and NASIC reporting. The SS-N-30 replaces the aging Soviet-era SS-N-21 SLCM.[223,224]
- Between 2015 and 2019, Russia finalized testing and deployed the SSC-8 "Screwdriver" (9M729) GLCM, according to DoD, CRS, and DIA.[225,226,227] With a range between 500 and 5,500 kilometers, the United States found that the SSC-8 violated the Intermediate Nuclear Forces (INF) Treaty, precipitating the 2019 U.S. withdrawal, according to the Department of State.[228]
- In March 2018, Russian President Vladimir Putin announced "Kinzhal," a new ALBM, declaring that it was on "experimental combat duty"—likely a reference to limited deployment and continued testing before full-scale deployment. Kinzhal is advertised as being capable of defeating missile defenses due to its high-speed and maneuverability, according to TASS.[229]

While many of these systems have features that can challenge missile defense systems—for example, multiple warheads, installed countermeasures, high maneuverability—Russia is also developing unique systems that are explicitly designed to circumvent adversary missile defenses.

- Russia is developing a nuclear-powered cruise missile dubbed “Burevestnik” that uses nuclear power to achieve transcontinental operating ranges and the ability to fly circuitous, long-loiter, or unexpected routes to any target globally. The United States determined that an explosion in the White Sea in August 2019 (which killed at least five Russians) resulted from an accident while recovering a test missile, according to the State Department.[230,231]
- Russia is also developing a nuclear-powered and nuclear-armed intercontinental-range autonomous undersea vehicle designated “Poseidon” or “Status-6,” intended to destroy coastal naval bases, infrastructure, and carrier strike groups, according to TASS and official Russian statements. As of June 2020, the second carrier submarine for Poseidon was nearing completion.[232,233]

Finally, Russia places a great deal of emphasis itself on aerospace defense, according to DIA, including development of a modern integrated air and missile defense system with a central command structure.[234] Far from just defending Russian airspace from enemy aircraft, this system increasingly includes capabilities to defend against missile strikes.

- DIA notes that some Russian systems are optimized for cruise missiles.[235]
- More generally, DoD finds that Russia is enhancing the nuclear-armed ABM system that has been deployed in the Moscow area since the Cold War. That system, which consists of 68 interceptors, received new radars and updated electronics.[236]
- Finally, DoD anticipates that around 2025 Russia will field the S-500 surface-to-air missile, which reportedly can defend against ballistic, cruise, and hypersonic missiles.[237]

China

China invests considerable resources to maintain a limited, survivable nuclear force that can execute retaliatory strikes, according to DIA. China has sought to improve both its theater and longer-range strike forces, both nuclear- and conventionally armed.[238,239] To that end, China has deployed multiple new types of long-range missiles, to include modernized nuclear-armed ICBMs, SLBMs, an IRBM, and a conventionally armed ALCM.[240] The bulk of China’s efforts over the past two decades appear to have been devoted to strengthening its conventional warfighting capabilities designed for theater employment.

- Beginning around 2009, China deployed its first road-mobile ICBM, the CSS-10 Mod-1 (DF-31), followed by an improved version that can reach most of the continental United States, the CSS-10 Mod 2 (DF-31A).[241]
- In 2015, China displayed the CSS-4 Mod 3 (DF-5B), a MIRV-equipped version of its liquid-fueled, silo-based ICBM.[242]
- In 2016, China fielded the DF-26, a new nuclear-capable IRBM capable of precision strikes and a range of 4,000 kilometers, according to DoD, and as of 2020 was expanding its inventory.[243,244,245]
- As of 2017, China fielded the JL-2 SLBM. Deployed on the JIN-class SSBN, this weapon system forms China’s first viable sea-based nuclear deterrent.[246,247]
- As of 2017, China had also deployed the conventionally armed CJ-20 ALCM, which is deployed on the H-6K bomber and can range Guam, according to NASIC.[248]

According to DIA, China has the most active and diverse ballistic missile development program in the world.[249] China is expanding both the quantity and type of long-range nuclear-capable missiles, and DoD assesses that the number of warheads on Chinese ICBMs capable of reaching the continental United States is likely to grow to roughly 200 over the next five years.[250] China's continued development of long-range missiles includes upgraded ICBMs, SLBMs, and an ALBM, which together comprises its first nuclear triad.[251] As with Russia, many of these new systems center on or feature a range of technologies to counter missile defense. And some of its developments, including the DF-17 HGV, CJ-20 ALCM, and DF-26 ballistic missile provide the PLA with new long-range conventional weapon options to strike U.S. or allied territories.

- China is developing the CSS-X-20 (DF-41), a new road-mobile ICBM equipped with MIRVs, and may be considering additional launch options, such as rail-mobile and silo-based. In addition, China may be developing a new variant of its CSS-4-class (DF-5) ICBM, designated DF-5C, and a new variant of its CSS-10-class (DF-31) ICBM, designated DF-31B, according to NASIC and DoD.[252,253,254]
- China is also developing its next generation of SLBM, designated JL-3, according to DIA.[255]
- To counter enemy missile defense systems, China is developing and equipping missile systems with a variety of technologies, featuring design characteristics such as maneuverable reentry vehicles (MaRVs), MIRVs, HGVs, decoys, chaff, jamming, or thermal shielding, according to DoD and DIA.[256,257]
- China probably intends to increase the peacetime readiness of its nuclear forces by moving an expanded silo-based ICBM force to a launch-on-warning posture, according to DoD.[258]

Finally, DoD notes that China continues to develop and deploy advanced air and missile defense capabilities in defense of its homeland. This includes endo- and exoatmospheric interceptors based on both land and sea platforms.[259] As a starting point, it has already acquired the S-300 and S-400 integrated air and missile defense system from Russia and continues to field increased quantities of these systems. Two other developments are occurring in parallel:

- China is developing the CH-AB-X-02 (HQ-19), which will likely have a ballistic missile defense role, according to DoD. This system may have begun preliminary operations in western China.[260]
- China is also developing a kinetic-kill vehicle for a mid-course interceptor, which will form the upper layer of a multitiered missile defense system, according to DoD. This system may be capable against IRBMs and possibly ICBMs.[261]

References

1. Website | Clinton White House Archives | National Missile Defense, September 1, 2000 | https://clintonwhitehouse4.archives.gov/textonly/WH/new/html/Wed_Oct_4_141122_2000.html | The source is publicly available information and contains no classification markings | US government website.
2. Report | DoD | *2019 Missile Defense Review* | 2019 | pp. 7–9 | https://media.defense.gov/2019/Jan/17/2002080666/-1/-1/1/2019-MISSILE-DEFENSE-REVIEW.pdf | The source is publicly available information and contains no classification markings | US government report.
3. Legislation | National Missile Defense Act of 1999 | Pub. L. No. 106-38 | 22 July 1999 | The source is publicly available information and contains no classification markings | Issued by the US government.
4. NIC | Foreign Missile Developments and the Ballistic Missile Threat to the United States Through 2015 | September 1999 | https://www.dni.gov/files/documents/Foreign%20Missile%20Developments_1999.pdf | The source is publicly available information and contains no classification markings | Prepared under the auspices of the National Intelligence Officer for Strategic and Nuclear Programs.
5. Article | The Heritage Foundation | J. DeMint | 33 Years and 33 Minutes: Why Missile Defense Is More Necessary Than Ever | 24 March 2016 | https://www.heritage.org/defense/commentary/33-years-and-33-minutes-why-missile-defense-more-necessary-ever | The source is publicly available information and contains no classification markings | Posted on public website.
6. Article | The Heritage Foundation | P.-J. Geller | Plotting a Path Forward for America's Homeland Missile Defense | 19 August 2020 | https://www.heritage.org/missile-defense/commentary/plotting-path-forward-americas-homeland-missile-defense | The source is publicly available information and contains no classification markings | Posted on public website.
7. Website | Center for Arms Control and Non-Proliferation | GMD: Frequently Asked Questions | https://armscontrolcenter.org/issues/missile-defense/gmd-frequently-asked-questions/ | The source is publicly available information and contains no classification markings | Posted on public website.
8. Website | Union of Concerned Scientists | US Missile Defense: Unproven, unaccountable, and unhelpful for reducing the nuclear threat | https://www.ucsusa.org/nuclear-weapons/missile-defense | The source is publicly available information and contains no classification markings | Posted on public website.
9. Article | *War on the Rocks* | J. Johnson-Freese and D.T. Burbach | The Best Defense Ever? Busting Myths About the Trump Administration's Missile Defense Review | 6 February 2019 | https://warontherocks.com/2019/02/the-best-defense-ever-busting-myths-about-the-trump-administrations-missile-defense-review/ | The source is publicly available information and contains no classification markings | Periodical posted on commercial website.
10. Article | *Washington Post* | J. Warrick, E. Nakashima, and A. Fifield | North Korea now making missile-ready nuclear weapons, U.S. analysts say | 8 August 2017 | https://www.washingtonpost.com/world/national-security/north-korea-now-making-missile-ready-nuclear-weapons-us-analysts-say/2017/08/08/e14b882a-7b6b-11e7-9d08-b79f191668ed_story.html | The source is publicly available information and contains no classification markings | Periodical posted on commercial website.
11. Article | *The Diplomat* | A. Panda | US Intelligence: North Korea's ICBM Reentry Vehicles Are Likely Good Enough to Hit the Continental US | 12 August 2017 | https://thediplomat.com/2017/08/us-intelligence-north-koreas-icbm-reentry-vehicles-are-likely-good-enough-to-hit-the-continental-us/ | The source is publicly available information and contains no classification markings | Periodical posted on commercial website.

12. Article | Brookings Institution | J.H. Pak | Kim Jong-un's tools of coercion | 21 June 2018 | https://www.brookings.edu/blog/order-from-chaos/2018/06/21/kim-jong-uns-tools-of-coercion | The source is publicly available information and contains no classification markings | Posted on public website.
13. Article | *Foreign Affairs* | P. Zelikow | How Diplomacy with North Korea Can Work | 9 July 2018 | https://www.foreignaffairs.com/articles/north-korea/2018-07-09/how-diplomacy-north-korea-can-work | The source is publicly available information and contains no classification markings | Periodical posted on commercial website.
14. Article | *Reuters* | D. Brunnstrom and M. Spetalnick | U.S. says North Korea diplomacy 'very much alive,' but it's watching rocket site | 11 March 2019 | https://www.reuters.com/article/us-northkorea-usa-nuclear/u-s-says-north-korea-diplomacy-very-much-alive-but-its-watching-rocket-site-idUSKBN1QS2BB | The source is publicly available information and contains no classification markings | Periodical posted on commercial website.
15. Article | *New York Post* | B. Fredericks | Trump: US ready for military action against North Korea | 24 May 2018 | https://nypost.com/2018/05/24/trump-us-ready-for-military-action-against-north-korea/ | The source is publicly available information and contains no classification markings | Periodical posted on commercial website.
16. Article | *Voice of America* | K. Bredemeier | Trump Warns North Korea's Kim on Hostile Actions | 8 December 2019 | https://www.voanews.com/east-asia-pacific/trump-warns-north-koreas-kim-hostile-actions | The source is publicly available information and contains no classification markings | Periodical posted on commercial website.
17. Article | CNN | B. Starr and Z. Cohen | Trump warns of 'devastating' military option as North Korea moves jets | 27 September 2017 | https://www.cnn.com/2017/09/26/politics/trump-north-korea-moves-fighters-missiles-fuel-tanks/index.html | The source is publicly available information and contains no classification markings | Periodical posted on commercial website.
18. Article | *Strategic Forum* | Kugler | Dissuasion as a Strategic Concept | Vol. 96 | December 2002 | www.dtic.mil/cgi---bin/GetTRDoc?AD=ADA421905 | The source is publicly available information and contains no classification markings | US military website.
19. US presidential directive | National Security Presidential Directive-23 | National Policy on Ballistic Missile Defense | 16 December 2002 | https://georgewbushlibrary.smu.edu/~/media/GWBL/Files/Digitized%20Content/2014-0390-F/t030-021-012-nspd23-20140390f.ashx | The source is publicly available information and contains no classification markings | Issued by the US government; declassified 20 August 2014.
20. Article | DoD | K. Lange | Summary of the 2018 National Defense Strategy of the United States of America | 8 October 2018 | https://www.defense.gov/Explore/Features/story/Article/1656414/what-is-the-national-defense-strategy/ | The source is publicly available information and contains no classification markings | US government website.
21. NIC | Foreign Missile Developments and the Ballistic Missile Threat to the United States Through 2015 | September 1999 | https://www.dni.gov/files/documents/Foreign%20Missile%20Developments_1999.pdf | The source is publicly available information and contains no classification markings | Prepared under the auspices of the National Intelligence Officer for Strategic and Nuclear Programs.
22. Report | DoD | 2020 | *Military and Security Developments Involving the People's Republic of China 2020* | https://media.defense.gov/2020/Sep/01/2002488689/-1/-1/1/2020-DoD-CHINA-MILITARY-POWER-REPORT-FINAL.PDF | The source is publicly available information and contains no classification markings | Annual report to Congress.
23. Report | RAND | RR-392-AF | E. Heginbotham, et al. | *U.S.-China Military Scorecard: Forces, Geography, and the Evolving Balance of Power, 1996-2017* | 2015 | https://www.rand.org/pubs/research_reports/RR392.html | The source is publicly available information and contains no classification markings | RAND Corporation is an American nonprofit

global policy think tank that offers research and analysis to the United States Armed Forces. It is financed by the U.S. government and private endowment, corporations, universities, and private individuals.

24. Article | *The Washington Post* | S. Denyer and M.J. Kim | North Korea parades huge new ICBM, but Kim Jong Un stresses deterrent nature | 10 October 2020 | https://www.cnas.org/press/in-the-news/north-korea-parades-huge-new-icbm-but-kim-jong-un-stresses-deterrent-nature | The source is publicly available information and contains no classification markings | Originally posted by the Washington Post (paid content); available elsewhere on the internet.
25. Article | *Real Clear Defense* | V.H. Van Dipen and M. Elleman | North Korea Unveils Two New Strategic Missiles in October 10 Parade | 10 October 2020 | https://www.realcleardefense.com/2020/10/12/north_korea_unveils_two_new_strategic_missiles_in_october_10_parade_580403.html | The source is publicly available information and contains no classification markings | Periodical posted on commercial website.
26. Report | DIA | DIA-05-1712-016 | Global Nuclear Landscape 2018 | February 2018 | The source is publicly available information and contains no classification markings | US government report.
27. Report | Director of National Intelligence D.R. Coats | Statement for the record: Worldwide threat assessment of the US Intelligence Community | 29 January 2019 | https://www.dni.gov/files/ODNI/documents/2019-ATA-SFR---SSCI.pdf | The source is publicly available information and contains no classification markings | Report to the Senate Select Committee on Intelligence.
28. Report | NIC | Foreign Missile Developments and the Ballistic Missile Threat Through 2015 | December 2001 | https://www.dni.gov/files/documents/missilethreat_2001.pdf | The source is publicly available information and contains no classification markings | Unclassified summary of a National Intelligence Estimate.
29. Report | CRS | IF10938 | Iran’s Ballistic Missile and Space Launch Programs | 9 January 2020 | https://crsreports.congress.gov | The source is publicly available information and contains no classification markings | US government report.
30. Article | *The New York Times* | T. Neilan | Bush Pulls Out of ABM Treaty; Putin Calls Move a Mistake | https://www.nytimes.com/2001/12/13/international/bush-pulls-out-of-abm-treaty-putin-calls-move-a-mistake.html | The source is publicly available information and contains no classification markings | Periodical posted on commercial website.
31. Article | CNBC | J. Daniels | US missile defense test triggers alarm in Russia, China as North Korea issues new warnings | 3 June 2017 | https://www.cnbc.com/2017/06/03/us-missile-defense-triggers-alarm-from-russia-china.html | The source is publicly available information and contains no classification markings | Periodical posted on commercial website.
32. Article | *Washington Post* | A. Taylor | Putin’s new missiles could probably strike the U.S. The old ones, too | 2 March 2018 | https://www.washingtonpost.com/news/worldviews/wp/2018/03/02/putins-new-missiles-could-probably-strike-the-u-s-he-old-ones-could-too/ | The source is publicly available information and contains no classification markings | Periodical posted on commercial website.
33. Article | *The National Interest* | D. Axe | Why Russia Is Angry at America’s Missile Defense Systems | 22 October 2019 | https://nationalinterest.org/blog/buzz/why-russia-angry-americas-missile-defense-systems-90111 | The source is publicly available information and contains no classification markings | Posted on public website.
34. Report | NIC | Foreign Missile Developments and the Ballistic Missile Threat Through 2015 | December 2001 | https://www.dni.gov/files/documents/missilethreat_2001.pdf | The source is publicly available information and contains no classification markings | Unclassified summary of a National Intelligence Estimate.

35. Report | NASIC | NAIC-1031-0985-00 | Ballistic and Cruise Missile Threat 2000 | September 2000 | The source is publicly available information and contains no classification markings | US government report.
36. Report | NASIC | NASIC-1031-0985-17 | Ballistic and Cruise Missile Threat 2017 | June 2017 | The source is publicly available information and contains no classification markings | US government report.
37. Report | DIA | DIA-05-1712-016 | Global Nuclear Landscape 2018 | February 2018 | The source is publicly available information and contains no classification markings | US government report.
38. Report | NASIC | NASIC-1031-0985-17 | Ballistic and Cruise Missile Threat 2017 | June 2017 | The source is publicly available information and contains no classification markings | US government report.
39. Report | DIA | DIA-05-1712-016 | Global Nuclear Landscape 2018 | February 2018 | The source is publicly available information and contains no classification markings | US government report.
40. Report | NASIC | NASIC-1031-0985-13 | Ballistic and Cruise Missile Threat 2013 | 2013 | The source is publicly available information and contains no classification markings | US government report.
41. Report | DoD | Nuclear Posture Review | February 2018 | The source is publicly available information and contains no classification markings | US government report.
42. Report | DIA | DIA-05-1712-016 | Global Nuclear Landscape 2018 | February 2018 | The source is publicly available information and contains no classification markings | US government report.
43. Report | CRS | Russia's Nuclear Weapons: Doctrine, Forces, and Modernization | 2 January 2020 | https://crsreports.congress.gov | The source is publicly available information and contains no classification markings | US government report.
44. Article | U.S. Army War College Strategic Studies Institute | K. Giles | *Russian Ballistic Missile Defense: Rhetoric and Reality* | June 2015 | https://www.hsdl.org/?view&did=768106 | The source is publicly available information and contains no classification markings | Posted on public website.
45. Speech | Government of Russia | Presidential Address to the Federal Assembly | 1 March 2018 | kremlin.ru | The source is publicly available information and contains no classification markings | Russian government website.
46. Article | AP News | V. Isachenkov | Official: Russian weapon 27 times faster than speed of sound | 28 December 2018 | https://apnews.com/article/ffb2032c9c034433bc6d42a62fc41177 | The source is publicly available information and contains no classification markings | Periodical posted on commercial website.
47. Fact sheet | Department of State | New START Treaty Aggregate Numbers of Strategic Offensive Arms | 1 October 2020 | https://www.state.gov/new-start-treaty-aggregate-numbers-of-strategic-offensive-arms-12/ | The source is publicly available information and contains no classification markings | Bureau of Arms Control, Verification, and Compliance.
48. Article | *DoD News* | J. Garamone | Missile Defense Becomes Part of Great Power Competition | 28 July 2020 | https://www.defense.gov/Explore/News/Article/Article/2291331/missile-defense-becomes-part-of-great-power-competition/ | The source is publicly available information and contains no classification markings | US government website.
49. Article | TASS | First regiment of Avangard hypersonic missile systems goes on combat duty in Russia | 27 December 2019 | https://tass.com/defense/1104297 | The source is publicly available information and contains no classification markings | Russian news agency.
50. Report | NASIC | NASIC-1031-0985-06 | Ballistic and Cruise Missile Threat 2006 | March 2006 | The source is publicly available information and contains no classification markings | US government report.

51. Report | NASIC | NASIC-1031-0985-17 | Ballistic and Cruise Missile Threat 2017 | June 2017 | The source is publicly available information and contains no classification markings | US government report.
52. Report | CRS | Russia's Nuclear Weapons: Doctrine, Forces, and Modernization | 2 January 2020 | https://crsreports.congress.gov | The source is publicly available information and contains no classification markings | US government report.
53. Article | Radio Free Europe | U.S. Concludes White Sea Radiation Explosion Came During Russian Nuclear-Missile Recovery | 12 October 2019 | https://www.rferl.org/a/u-s-concludes-white-sea-radiation-explosion-came-during-russian-nuclear-missile-recovery/30213494.html | The source is publicly available information and contains no classification markings | Posted on public website.
54. Report | CRS | Russia's Nuclear Weapons: Doctrine, Forces, and Modernization | 2 January 2020 | https://crsreports.congress.gov | The source is publicly available information and contains no classification markings | US government report.
55. Article | TASS | Russia to float out new sub to carry Poseidon nuke drone in late June — source | 6 May 2020 | https://tass.com/defense/1153699 | The source is publicly available information and contains no classification markings | Russian news agency.
56. Report | DIA | DIA-05-1712-016 | Global Nuclear Landscape 2018 | February 2018 | The source is publicly available information and contains no classification markings | US government report.
57. Article | Quartz.com | N. Sonnad | Read the full text of Xi Jinping's first UN address | Statement by H.E. Xi Jinping, President of the People's Republic of China, At the General Debate of the 70th Session of the UN General Assembly, 28 September 2015 | 29 September 2015 | https://qz.com/512886/read-the-full-text-of-xi-jinpings-first-un-address/ | The source is publicly available information and contains no classification markings | Statement by the Chinese government.
58. Article | *PLA Daily* | L. Shengli | Does the US know that 'absolute security' does not exist? | 14 February 2019 | http://eng.chinamil.com.cn/view/2019-02/14/content_9426859.htm | The source is publicly available information and contains no classification markings | Periodical posted on commercial website.
59. Article | Carnegie Endowment for International Peace | Tong Zhao | Narrowing the U.S.-China Gap on Missile Defense | 2020 | https://carnegietsinghua.org/2020/06/29/narrowing-u.s.-china-gap-on-missile-defense-how-to-help-forestall-nuclear-arms-race-pub-82120 | The source is publicly available information and contains no classification markings | Posted on public website.
60. Article | *War on the Rocks* | H. White | To Reassure U.S. Allies in Asia, Admit Mutual Vulnerability with China | 8 June 2018 | https://warontherocks.com/2018/06/to-reassure-u-s-allies-in-asia-admit-mutual-vulnerability-with-china/ | The source is publicly available information and contains no classification markings | Periodical posted on commercial website.
61. Article | C. Ferguson | *Arms Control Today* | Sparking a Buildup: U.S. Missile Defense and China's Nuclear Arsenal | March 2000 | https://www.armscontrol.org/act/2000-03/features/sparking-buildup-us-missile-defense-chinas-nuclear-arsenal | The source is publicly available information and contains no classification markings | Posted on public website.
62. Article | *Nonproliferation Review* | Jing-Dong Yuan | Chinese Responses to U.S. Missile Defenses: Implications for Arms Control and Regional Security | Spring 2003 | https://www.nonproliferation.org/research/nonproliferation-review/npr-10-1/ | The source is publicly available information and contains no classification markings | Posted on public website.
63. Report | Office of the Secretary of Defense | Proliferation: Threat and Response, January 2001 | https://fas.org/irp/threat/prolif00.pdf | The source is publicly available information and contains no classification markings | US government report.
64. Report | Office of the Secretary of Defense | Annual Report on the Military Power of the People's Republic of China | 2002 | Report to Congress, Pursuant to the FY2000 National Defense

Authorization Act | https://www.globalsecurity.org/military/library/report/2002/d20020712china.pdf | The source is publicly available information and contains no classification markings | US government report.

65. Report | DoD | 2020 | *Military and Security Developments Involving the People's Republic of China 2020* | https://media.defense.gov/2020/Sep/01/2002488689/-1/-1/1/2020-DoD-CHINA-MILITARY-POWER-REPORT-FINAL.PDF | The source is publicly available information and contains no classification markings | Annual report to Congress.
66. Report | DIA | *Military Power Publications* | ISBN 978-0-16-093972-3 | China Military Power: Modernizing a Force to Fight and Win | 2019 | https://www.dia.mil/Portals/27/Documents/News/Military%20Power%20Publications/China_Military_Power_FINAL_5MB_20190103.pdf | The source is publicly available information and contains no classification markings | US government report.
67. Report | DIA | *Military Power Publications* | ISBN 978-0-16-093972-3 | China Military Power: Modernizing a Force to Fight and Win | 2019 | https://www.dia.mil/Portals/27/Documents/News/Military%20Power%20Publications/China_Military_Power_FINAL_5MB_20190103.pdf | The source is publicly available information and contains no classification markings | US government report.
68. Report | Director of National Intelligence D.R. Coats | Statement for the record: Worldwide threat assessment of the US Intelligence Community | 29 January 2019 | https://www.dni.gov/files/ODNI/documents/2019-ATA-SFR---SSCI.pdf | The source is publicly available information and contains no classification markings | Report to the Senate Select Committee on Intelligence.
69. Report | DoD | 2020 | *Military and Security Developments Involving the People's Republic of China 2020* | https://media.defense.gov/2020/Sep/01/2002488689/-1/-1/1/2020-DoD-CHINA-MILITARY-POWER-REPORT-FINAL.PDF | The source is publicly available information and contains no classification markings | Annual report to Congress.
70. Report | DoD | 2020 | *Military and Security Developments Involving the People's Republic of China 2020* | https://media.defense.gov/2020/Sep/01/2002488689/-1/-1/1/2020-DoD-CHINA-MILITARY-POWER-REPORT-FINAL.PDF | The source is publicly available information and contains no classification markings | Annual report to Congress.
71. Report | DIA | *Military Power Publications* | ISBN 978-0-16-093972-3 | China Military Power: Modernizing a Force to Fight and Win | 2019 | https://www.dia.mil/Portals/27/Documents/News/Military%20Power%20Publications/China_Military_Power_FINAL_5MB_20190103.pdf | The source is publicly available information and contains no classification markings | US government report.
72. Report | RAND | E. Heginbotham et al. | RAND-RR-392AF | The U.S.-China Military Scorecard: Forces, Geography, and the Evolving Balance of Power, 1996–2017 | https://www.rand.org/pubs/research_reports/RR392.html | The source is publicly available information and contains no classification markings | RAND Corporation is an American nonprofit global policy think tank that offers research and analysis to the United States Armed Forces. It is financed by the U.S. government and private endowment, corporations, universities, and private individuals.
73. Article | CSIS, China Power | https://chinapower.csis.org/military-spending/ | What Does China Really Spend on its Military? | Published 28 December 2015; updated 15 September 2020 | The source is publicly available information and contains no classification markings |
74. Website | World Bank | https://data.worldbank.org/country/china | Accessed September 2020 | The source is publicly available information and contains no classification markings | Public website.
75. Report | DoD | 2020 | *Military and Security Developments Involving the People's Republic of China 2020* | https://media.defense.gov/2020/Sep/01/2002488689/-1/-1/1/2020-DOD-CHINA-

MILITARY-POWER-REPORT-FINAL.PDF | The source is publicly available information and contains no classification markings | Annual report to Congress.

76. Report | DoD | 2020 | *Military and Security Developments Involving the People's Republic of China 2020* | https://media.defense.gov/2020/Sep/01/2002488689/-1/-1/1/2020-DOD-CHINA-MILITARY-POWER-REPORT-FINAL.PDF | The source is publicly available information and contains no classification markings | Annual report to Congress.
77. Report | DoD | 2020 | *Military and Security Developments Involving the People's Republic of China 2020* | https://media.defense.gov/2020/Sep/01/2002488689/-1/-1/1/2020-DOD-CHINA-MILITARY-POWER-REPORT-FINAL.PDF | The source is publicly available information and contains no classification markings | Annual report to Congress.
78. Report | Council on Foreign Relations | R.D. Blackwill and A.J. Tellis | *Revising U.S. Grand Strategy Toward China* | Special Report No. 72 | March 2015 | https://www.cfr.org/report/revising-us-grand-strategy-toward-china | The source is publicly available information and contains no classification markings | Posted on public website.
79. Report | RAND | T.R. Heath et al. | RR1402 | The PLA and China's Rejuvenation | 2016 | http://www.rand.org/content/dam/rand/pubs/research_reports/RR1400/RR1402/RAND_RR1402.pdf | The source is publicly available information and contains no classification markings | RAND Corporation is an American nonprofit global policy think tank that offers research and analysis to the United States Armed Forces. It is financed by the U.S. government and private endowment, corporations, universities, and private individuals.
80. Book | Norton | A.L. Friedberg | ISBN 978-0-393-06828-3 | *A Contest for Supremacy: China, America and the Struggle for Mastery in Asia* | 2012 | The source is publicly available information and contains no classification markings | Author is experienced member of US government and authority in international affairs.
81. Report | RAND | RR1366 | M.S. Chase and A. Chan | China's Evolving Approach to 'Integrated Strategic Deterrence' | https://www.rand.org/content/dam/rand/pubs/research_reports/RR1300/RR1366/RAND_RR1366.pdf | The source is publicly available information and contains no classification markings | RAND Corporation is an American nonprofit global policy think tank that offers research and analysis to the United States Armed Forces. It is financed by the U.S. government and private endowment, corporations, universities, and private individuals.
82. Report | DIA | DIA-05-1712-016 | Global Nuclear Landscape 2018 | February 2018 | The source is publicly available information and contains no classification markings | US government report.
83. Article | Korea Economic Institute of America | M. Tokola | Why is China so upset about THAAD? | http://keia.org/why-china-so-upset-about-thaad | The source is publicly available information and contains no classification markings | Posted on public website.
84. Article | *South China Morning Post* | D. J. Volodzko | China wins its war against South Korea's US THAAD missile shield—without firing a shot | 18 November 2017 | https://www.scmp.com/week-asia/geopolitics/article/2120452/china-wins-its-war-against-south-koreas-us-thaad-missile | The source is publicly available information and contains no classification markings | Periodical posted on commercial website.
85. Article | *Nonproliferation Review* | Jing-Dong Yuan | Chinese Responses to U.S. Missile Defenses: Implications for Arms Control and Regional Security | Spring 2003 | https://www.nonproliferation.org/research/nonproliferation-review/npr-10-1/ | The source is publicly available information and contains no classification markings | Posted on public website.
86. Article | *The New York Times* | T. Shanker and I. Johnson | U.S. Accord With Japan Over Missile Defense Draws Criticism in China | 17 September 2012 | https://www.nytimes.com/2012/09/18/world/asia/u-s-and-japan-agree-on-missile-defense-system.html | The source is publicly available information and contains no classification markings | Periodical posted on commercial website.

87. Article | Institute for Policy Studies | R. Brown and W. Huntley | Missile Defense & China | 6 October 2005 | https://ips-dc.org/missile_defense_china/ | The source is publicly available information and contains no classification markings | Posted on public website.
88. Article | *Inside Defense* | J. Sherman | NORTHCOM: U.S. to assume 'increased risk' against North Korean ICBMs in 202 | 29 January 2020 | https://insidedefense.com/daily-news/northcom-us-assume-increased-risk-against-north-korean-icbms-2025 | The source is publicly available information and contains no classification markings | Periodical posted on commercial website.
89. Book | DoD | *Fiscal Year (FY) 2021 Budget Estimates* | Missile Defense Agency Defense-Wide Justification Book Volume 2a of 5 | February 2020 | https://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2021/budget_justification/pdfs/03_RDT_and_E/RDTE_Vol2_MDA_RDTE_PB21_Justification_Book.pdf | The source is publicly available information and contains no classification markings | US government publication.
90. Article | *Breaking Defense* | P. McLeary | DoD Tries Again on Multi-Billion Missile Interceptor | 24 April 2020 | https://breakingdefense.com/2020/04/dod-tries-again-on-multi-billion-missile-interceptor/ | The source is publicly available information and contains no classification markings | Periodical posted on commercial website.
91. Article | *Breaking Defense* | T. Hitchens | MDA Can Accelerate Next-Gen Interceptor: NORTHCOM Nominee | 29 July 2020 | https://breakingdefense.com/2020/07/mda-moving-to-speed-ngi-says-northcom-nominee-vanherck/ | The source is publicly available information and contains no classification markings | Periodical posted on commercial website.
92. Article | *Defense News* | J. Judson | Missile Defense Agency director lays out hurdles in path to layered homeland missile defense | 18 August 2020 | https://www.defensenews.com/digital-show-dailies/2020/08/18/missile-defense-agency-director-lays-out-hurdles-in-path-to-layered-homeland-missile-defense/ | The source is publicly available information and contains no classification markings | US government website.
93. Article | *Defense News* | J. Judson | MDA's FY21 budget paves way for new homeland missile defense plan | 10 February 2020 | https://www.defensenews.com/smr/federal-budget/2020/02/11/mdas-fy21-budget-paves-way-for-new-homeland-missile-defense-plans/ | The source is publicly available information and contains no classification markings | US government website.
94. Report | DoD | *2019 Missile Defense Review* | 2019 | Executive Summary, p. V | https://media.defense.gov/2019/Jan/17/2002080666/-1/-1/1/2019-MISSILE-DEFENSE-REVIEW.pdf | The source is publicly available information and contains no classification markings | (U) US government report.
95. Recorded event | The Heritage Foundation | Virtual Event: Homeland Missile Defense: Plotting a Clear Path Forward | https://www.heritage.org/missile-defense/event/virtual-event-homeland-missile-defense-plotting-clear-path-forward | The source is publicly available information and contains no classification markings | Posted on public website.
96. Article | *Inside Defense* | J. Sherman | Northrop, Raytheon pitch NGI proposal that stresses incumbency backed by innovation | 11 September 2020 | https://insidedefense.com/daily-news/northrop-raytheon-pitch-ngi-proposal-stresses-incumbency-backed-innovation | The source is publicly available information and contains no classification markings | Periodical posted on commercial website.
97. Article | *Inside Defense* | J. Doubleday | Pentagon tech chief sets sights on ambitious developments, including space-based lasers | 17 April 2018 | https://insidedefense.com/daily-news/pentagon-tech-chief-sets-sights-ambitious-developments-including-space-based-lasers | The source is publicly available information and contains no classification markings | Periodical posted on commercial website.

98. Article | *Inside Defense* | J. Doubleday | Pentagon punts MDA's laser ambitions, shifts funding toward OSD-led 'laser scaling' | 19 February 2020 | https://insidedefense.com/daily-news/pentagon-punts-mdas-laser-ambitions-shifts-funding-toward-osd-led-laser-scaling | The source is publicly available information and contains no classification markings | Periodical posted on commercial website.
99. Article | *Inside Defense* | J. Sherman | MDA director: Boost-phase intercept, if technically possible, to be saved for retaliatory strike | 19 August 2020 | https://insidedefense.com/daily-news/mda-director-boost-phase-intercept-if-technically-possible-be-saved-retaliatory-strike | The source is publicly available information and contains no classification markings | Periodical posted on commercial website.
100. Article | *Inside Defense* | J. Sherman | NORTHCOM retooling homeland defense for Russian, Chinese threats with SHIELD modernization plan | 10 September 2020 | https://insidedefense.com/daily-news/northcom-retooling-homeland-defense-russian-chinese-threats-shield-modernization-plan | The source is publicly available information and contains no classification markings | Periodical posted on commercial website.
101. Article | *Defense News* | A. Mehta | Is the Pentagon moving quickly enough on hypersonic defense? | 21 March 2019 | https://www.defensenews.com/pentagon/2019/03/21/is-the-pentagon-moving-quickly-enough-on-hypersonic-defense/ | The source is publicly available information and contains no classification markings | Periodical posted on commercial website.
102. Article | *Inside Defense* | T. Bertuca | Hyten says he is pushing for new money to fund Space Sensor Layer | 12 August 2020 | https://insidedefense.com/daily-news/hyten-says-he-pushing-new-money-fund-space-sensor-layer | The source is publicly available information and contains no classification markings | Periodical posted on commercial website.
103. Report | DoD | Layered Homeland Missile Defense: A Strategy for Defending the United States | June 2020 | https://media.defense.gov/2020/Jun/22/2002319425/-1/-1/1/layered-homeland-missile-defense-final.pdf | The source is publicly available information and contains no classification markings | US government publication.
104. Article | CNN | US military uses warship to shoot down ICBM in test of missile defense system | 17 November 2020 | https://www.cnn.com/2020/11/17/politics/icbm-test-us-military/index.html | The source is publicly available information and contains no classification markings | Posted on public website.
105. Report | Center for Strategic and International Studies | T. Karako and W. Rumbaugh | Inflection Point: Missile Defense and Defeat in the 2021 Budget | 22 March 2020 | https://www.csis.org/analysis/inflection-point-missile-defense-and-defeat-2021-budget | The source is publicly available information and contains no classification markings | Posted on public website.
106. Hearing | Dr. Robert Soofer, Deputy Assistant Secretary of Defense for Nuclear and Missile Defense Policy | Statement to the Subcommittee on Strategic Forces, House Armed Services Committee, Hearing on FY 2021 Priorities for Missile Defense and Missile Defeat Programs | 12 March 2020 | https://armedservices.house.gov/hearings?ID=C193E2B7-C978-4EDF-AB7D-2FDA085A11B0 | The source is publicly available information and contains no classification markings | Congressional hearing.
107. Press release | Space Development Agency | SDA Awards Contracts for the First Generation of the Tracking Layer | 5 October 2020 | https://www.sda.mil/sda-awards-contracts-for-the-first-generation-of-the-tracking-layer/ | The source is publicly available information and contains no classification markings | Posted on SDA government website.
108. Website | Missile Defense Advocacy Alliance | https://missiledefenseadvocacy.org/defense-systems/hypersonic-and-ballistic-tracking-space-sensor-hbtss/ | Defense Systems: Hypersonic and Ballistic Tracking Space Sensor (HBTSS) | 2 July 2020 | Accessed November 2020 | The source is publicly available information and contains no classification markings | Posted on public website.

109. Hearing | General Terrence J. O'Shaughnessy, USAF, Commander United States Northern Command and North American Aerospace Defense Command | Statement to the Senate Armed Services Committee | 13 February 2020 | https://www.armed-services.senate.gov/hearings/20-02-13-united-states-northern-command-and-united-states-strategic-command | The source is publicly available information and contains no classification markings | Congressional hearing.
110. Hearing | Admiral Charles A. Richard, USN, Commander United States Strategic Command | Statement to the Senate Armed Services Committee | 13 February 2020 | https://www.armed-services.senate.gov/hearings/20-02-13-united-states-northern-command-and-united-states-strategic-command | The source is publicly available information and contains no classification markings | | Congressional hearing.
111. Hearing | Admiral Charles A. Richard, USN, Commander United States Strategic Command | Statement to the Senate Armed Services Committee | 13 February 2020 | https://www.armed-services.senate.gov/hearings/20-02-13-united-states-northern-command-and-united-states-strategic-command | The source is publicly available information and contains no classification markings | | Congressional hearing.
112. Report | DoD | *2019 Missile Defense Review* | 2019 | Executive Summary, p. V | https://media.defense.gov/2019/Jan/17/2002080666/-1/-1/1/2019-MISSILE-DEFENSE-REVIEW.pdf | The source is publicly available information and contains no classification markings | US government report.
113. Article | *The Hill* | R. Soofer | The case for a layered missile defense of the US homeland | 4 June 2020 | https://thehill.com/blogs/congress-blog/politics/501231-the-case-for-a-layered-missile-defense-of-the-us-homeland | The source is publicly available information and contains no classification markings | Periodical posted on commercial website.
114. Speech | President Ronald Reagan | Address to the Nation on Defense and National Security | 23 March 1983 | https://www.reaganlibrary.gov/research/speeches/32383d | The source is publicly available information and contains no classification markings | Transcript of speech.
115. Official statement | Lt. Gen. J.A. Abrahamson, Director, Strategic Defense Initiative Organization | Statement Before the Committee on Armed Services of the United States Senate | 21 February 1985 | https://www.thereaganfiles.com/gen-abrahamson-stmt-22185.pdf | The source is publicly available information and contains no classification markings | Given in Senate hearings.
116. Report | *Physics Today* | N. Bloembergen et al. | Vol. 40, No. 5 (S3) | Report to the APS of the Study Group on Science and Technology of Directed Energy Weapons | 1 May 1987 | https://physicstoday.scitation.org/doi/pdf/10.1063/1.2820011 | The source is publicly available information and contains no classification markings | Peer-reviewed journal.
117. Report | DoD Defense Science Board | *Defense Science Board Task Force on High Energy Laser Weapon Systems Applications* | June 2001 | The source is publicly available information and contains no classification markings | Federal Advisory Committee established to provide independent advice to the Secretary of Defense.
118. Report | DoD Defense Science Board | *Defense Science Board Task Force on Directed Energy Weapons* | December 2007 | The source is publicly available information and contains no classification markings | Federal Advisory Committee established to provide independent advice to the Secretary of Defense.
119. Report | Strategic Defense Initiative Organization | The Strategic Defense System Architecture | 17 December 1987 | The source is publicly available information and contains no classification markings | Report to Congress.
120. Report | Ballistic Missile Defense Organization | Conceptual and Burden Sharing Issues Related To Space-Based Ballistic Missile Defense Interceptors | 1 March 1992 | The source is publicly available information and contains no classification markings | Report to Congress.

121. Speech | President George H.W. Bush | State of the Union 1991 | 30 January 1991 | https://www.nytimes.com/1991/01/30/us/state-union-transcript-president-s-state-union-message-nation.html | The source is publicly available information and contains no classification markings | Transcript of speech.
122. Report | Ballistic Missile Defense Organization | Conceptual and Burden Sharing Issues Related To Space-Based Ballistic Missile Defense Interceptors | 1 March 1992 | The source is publicly available information and contains no classification markings | Report to Congress.
123. Report | Ballistic Missile Defense Organization | Conceptual and Burden Sharing Issues Related To Space-Based Ballistic Missile Defense Interceptors | 1 March 1992 | The source is publicly available information and contains no classification markings | Report to Congress.
124. US presidential directive | Presidential Review Directive/NSC-31 | U.S. Policy on Ballistic Missile Defenses and the Future of the ABM Treaty | 26 April 1993 | https://clinton.presidentiallibraries.us/items/show/36559 | The source is publicly available information and contains no classification markings | Issued by the US government; declassified 1 August 2008.
125. Report | CIA | OCA 96-1908 | Review of National Intelligence Estimate Report NIE 95-19, Emerging Missile Threats to North America During the Next Fifteen Years | 23 December 1996 | https://fas.org/irp/threat/missile/oca961908.htm | The source is publicly available information and contains no classification markings | As discussed in the Select Committee on Intelligence, United States Senate, 4 December 1996.
126. Senate hearing | U.S. Senate Select Committee on Intelligence | Intelligence Analysis of the Long-Range Missile Threat to the United States | S. Hrg. 104-854 | 104th Congress, second session, 4 December 1996 | https://www.intelligence.senate.gov/sites/default/files/hearings/intelligenceanaly00unit.pdf | The source is publicly available information and contains no classification markings | Transcript of Senate hearing.
127. Article | CNN | The 1996 Republican Party Platform | https://www.cnn.com/ALLPOLITICS/1996/conventions/san.diego/facts/gop.platform/platform.all.shtml | The source is publicly available information and contains no classification markings | Article posted on commercial website.
128. Report | Commission to Assess the Ballistic Missile Threat | Report of the Commission to Assess the Ballistic Missile Threat to the United States, Pursuant to Public Law 201 | 15 July 1998 | The source is publicly available information and contains no classification markings | The Commission was established by the National Defense Authorization Act for Fiscal Year 1997.
129. Report | Commission to Assess the Ballistic Missile Threat | Report of the Commission to Assess the Ballistic Missile Threat to the United States, Pursuant to Public Law 201 | 15 July 1998 | The source is publicly available information and contains no classification markings | The Commission was established by the National Defense Authorization Act for Fiscal Year 1997.
130. Report | Commission to Assess the Ballistic Missile Threat | Report of the Commission to Assess the Ballistic Missile Threat to the United States, Pursuant to Public Law 201 | 15 July 1998 | The source is publicly available information and contains no classification markings | The Commission was established by the National Defense Authorization Act for Fiscal Year 1997.
131. Article | *The New York Times* | T. Weiner | Iran said to test missile able to hit Israel and Saudis | 23 July 1998 | https://www.nytimes.com/1998/07/23/world/iran-said-to-test-missile-able-to-hit-israel-and-saudis.html | The source is publicly available information and contains no classification markings | Periodical posted on commercial website.
132. Article | *The Guardian* | J. Gittings | North Korea fires missile over Japan | 1 September 1998 | https://www.theguardian.com/world/1998/sep/01/northkorea | The source is publicly available information and contains no classification markings | Periodical posted on commercial website.

133. Article | *The New York Times* | D.E. Anger and J. Dao | A Nuclear North Korea: Intelligence; U.S. says Pakistan gave technology to North Korea | 18 October 2002 | https://www.nytimes.com/2002/10/18/world/nuclear-north-korea-intelligence-us-says-pakistan-gave-technology-north-korea.html | The source is publicly available information and contains no classification markings | Periodical posted on commercial website.
134. Speech | Secretary of Defense William J. Perry | Managing Danger: Prevent, Deter, Defeat | 4 March 1996 | https://archive.defense.gov/Speeches/Speech.aspx?SpeechID=893 | The source is publicly available information and contains no classification markings | Transcript.
135. Congressional hearing | Department of Defense Appropriations for 1999 | Hearings before the Committee on Appropriations, Subcommittee on National Security, 105th Congress | The source is publicly available information and contains no classification markings | Transcript.
136. Legislation | National Missile Defense Act of 1999 | Pub. L. No. 106-38 | 22 July 1999 | The source is publicly available information and contains no classification markings | Issued by the US government.
137. Press release | R. Lloyd, National Missile Defense – IEC Was There! | November 1999 | https://www2.l3t.com/iec/news/r_%20pr/110099.htm | The source is publicly available information and contains no classification markings | Posted on IEC INTERCOM website.
138. Website | CSIS Missile Defense Project | Ground-based Interceptor Development | https://missilethreat.csis.org/ground-based-interceptor-development/ | Accessed 30 September 2020 | The source is publicly available information and contains no classification markings | Appears as Chapter 4 in Missile Defense 2020: Next Steps for Defending the Homeland, 7 April 2017.
139. Fact sheet | MDA | Ballistic Missile Defense Intercept Flight Test Record (as of April 2020) | 20-MDA-10590 | 30 September 2020 | The source is publicly available information and contains no classification markings | US government publication.
140. Report | National Missile Defense Review Committee | Report of the National Missile Defense Review Committee, Panel on Reducing Risk in BMD Flight Test Programs | November 1999 | The source is publicly available information and contains no classification markings | US government publication.
141. Speech | President George W. Bush | Given at the National Defense University, Washington, D.C. | 1 May 2001 | https://fas.org/nuke/control/abmt/news/010501bush.html | The source is publicly available information and contains no classification markings | Transcript.
142. Speech | President George W. Bush | Given at the National Defense University, Washington, D.C. | 1 May 2001 | https://fas.org/nuke/control/abmt/news/010501bush.html | The source is publicly available information and contains no classification markings | Transcript.
143. Speech | President George W. Bush | Given at the National Defense University, Washington, D.C. | 1 May 2001 | https://fas.org/nuke/control/abmt/news/010501bush.html | The source is publicly available information and contains no classification markings | Transcript.
144. US presidential directive | National Security Presidential Directive-23 | National Policy on Ballistic Missile Defense | 16 December 2002 | https://georgewbushlibrary.smu.edu/~/media/GWBL/Files/Digitized%20Content/2014-0390-F/t030-021-012-nspd23-20140390f.ashx | The source is publicly available information and contains no classification markings | Issued by the US government; declassified 20 August 2014.
145. Report | Congressional Budget Office | Alternatives for Boost-Phase Missile Defense | July 2004 | The source is publicly available information and contains no classification markings | US government publication.
146. Report | Government Accountability Office | GAO-09-338 | Production and Fielding of Missile Defense Components Continue with Less Testing and Validation Than Planned | March 2009 | The source is publicly available information and contains no classification markings | US government publication.

147. Interview | Department of Defense News Briefing with Lt. Gen. Henry "Trey" Obering | 1 September 2006 | https://www.c-span.org/video/?194124-1/ground-based-missile-test | The source is publicly available information and contains no classification markings.
148. Report | DoD | Director, Operational Test and Evaluation FY 2007 Annual Report | https://www.dote.osd.mil/annualreport/ | The source is publicly available information and contains no classification markings | US government publication.
149. Private communication | Center for Strategic and International Studies | Email, December 2020 | July 2016 | Overall classification U | Updated graphic from 2016 article provided by CSIS.
150. Fact sheet | DoD | 2010 *Ballistic Missile Defense Review* Fact Sheet | 3 March 2010 | https://www.mda.mil/global/documents/pdf/bmdr_fs.pdf | The source is publicly available information and contains no classification markings | US government publication.
151. Speech | President Barack Obama | Remarks by the President on Strengthening Missile Defense in Europe | 17 September 2009 | https://obamawhitehouse.archives.gov/the-press-office/remarks-president-strengthening-missile-defense-europe | The source is publicly available information and contains no classification markings | Transcript.
152. Fact sheet | DoD | 2010 *Ballistic Missile Defense Review* Fact Sheet | 3 March 2010 | https://www.mda.mil/global/documents/pdf/bmdr_fs.pdf | The source is publicly available information and contains no classification markings | US government publication.
153. Report | DoD | Homeland Defense Hedging Policy and Strategy | June 2013 | The source is publicly available information and contains no classification markings | Report to Congress.
154. Article | Associated Press | N. Korea shows off new missile at military parade | 14 April 2012 | https://news.yahoo.com/nkorea-shows-off-missile-military-parade-054632037.html | The source is publicly available information and contains no classification markings | Periodical posted on commercial website.
155. Article | Space.com | North Korea Successfully Launches Satellite: Reports | 12 December 2012 | https://www.space.com/18867-north-korea-rocket-launch-satellite.html | The source is publicly available information and contains no classification markings | Article posted on commercial website.
156. Article | *The New York Times* | D.E. Sanger and C. Sang-Hun | North Korea Confirms It Conducted 3rd Nuclear Test | 11 February 2013 | https://www.nytimes.com/2013/02/12/world/asia/north-korea-nuclear-test.html | The source is publicly available information and contains no classification markings | Periodical posted on commercial website.
157. Article | *The Los Angeles Times* | D.S. Cloud | Pentagon plans to add missile interceptors in Alaska | 16 March 2013 | https://www.latimes.com/nation/la-xpm-2013-mar-16-la-na-anti-missile-20130316-story.html | The source is publicly available information and contains no classification markings | Periodical posted on commercial website.
158. Article | National Public Radio | E. Peralta | North Korea May Have a Nuclear Warhead To Put On A Missile, Says Pentagon | 11 April 2013 | https://www.npr.org/sections/thetwo-way/2013/04/11/176960362/north-korea-may-have-know-how-to-miniaturize-nuclear-warhead-says-pentagon | The source is publicly available information and contains no classification markings | Posted on public website.
159. Article | *The New York Times* | D.E. Sanger | U.S. Commander Sees Key Nuclear Step by North Korea | 24 October 2014 | https://www.nytimes.com/2014/10/25/world/asia/us-commander-sees-key-nuclear-step-by-north-korea.html | The source is publicly available information and contains no classification markings | Periodical posted on commercial website.
160. Presentation | VADM J.D. Syring, USD, Director, Missile Defense Agency | 14-MDA-7938 | 2014 Space and Missile Defense Conference | 13 August 2014 | The source is publicly available information and contains no classification markings | US government publication.

161. Article | *Mostly Missile Defense* | The Track Gate Anomaly: Does it also Affect CE-I Kill Vehicles? | 15 August (revised 18 August) 2014 | https://mostlymissiledefense.com/2014/08/15/the-track-gate-anomaly-does-it-also-affect-ce-i-kill-vehicles-august-15-2008/ | The source is publicly available information and contains no classification markings | Periodical posted on commercial website.
162. Report | United States Government Accountability Office | GAO-12-486 | Missile Defense: Opportunity Exists to Strengthen Acquisitions by Reducing Concurrency | 20 April 2012 | https://www.gao.gov/products/GAO-12-486 | The source is publicly available information and contains no classification markings | US government publication.
163. Presentation | VADM J.D. Syring, USD, Director, MDA | 14-MDA-7938 | 2014 Space and Missile Defense Conference | 13 August 2014 | The source is publicly available information and contains no classification markings | US government publication.
164. Presentation | VADM J.D. Syring, USD, Director, MDA | 14-MDA-7938 | 2014 Space and Missile Defense Conference | 13 August 2014 | The source is publicly available information and contains no classification markings | US government publication.
165. Article | CSIS Missile Threat | Missile Defense Agency Completes 44th GBI in Alaska | 14 November 2017 | https://missilethreat.csis.org/missile-defense-agency-completes-44th-gbi-alaska/ | The source is publicly available information and contains no classification markings | Posted on public website.
166. Article | Space Based Infrared System (SBIRS) | 22 February 2016 | https://www.losangeles.af.mil/About-Us/Fact-Sheets/Article/734550/space-based-infrared-system-sbirs/ | The source is publicly available information and contains no classification markings | US government website.
167. Article | *The Washington Post* | A. Fifield | In latest test, North Korea detonates its most powerful nuclear device yet | 3 September 2017 | https://www.washingtonpost.com/world/north-korea-apparently-conducts-another-nuclear-test-south-korea-says/2017/09/03/7bce3ff6-905b-11e7-8df5-c2e5cf46c1e2_story.html | The source is publicly available information and contains no classification markings | Periodical posted on commercial website.
168. Article | *Daily News-Miner Fairbanks* | S. Friedman | Trump requests a 4th missile defense field at Fort Greely | 7 November 2017 | http://www.newsminer.com/news/local_news/trump-administration-asks-for-new-defense-silo-at-fort-greely/article_d16ad06a-c395-11e7-b4ac-cf358d5d0dd2.html | The source is publicly available information and contains no classification markings | Periodical posted on commercial website.
169. Hearing | United States Senate Committee on Armed Services | Hearing to consider the Nomination of General J.F. Dunford, Jr. USMC, for Reappointment to the Grade of General and Reappointment to be Chairman of the Joint Chiefs of Staff | 26 September 2017 | https://www.armed-services.senate.gov/imo/media/doc/17-80_09-26-17.pdf | The source is publicly available information and contains no classification markings | Senate hearing.
170. Article | DoD | K. Lange | Summary of the 2018 National Defense Strategy of the United States of America | 8 October 2018 | p. 3 | https://www.defense.gov/Explore/Features/story/Article/1656414/what-is-the-national-defense-strategy/ | The source is publicly available information and contains no classification markings | US government website.
171. Report | DoD | *2019 Missile Defense Review* | 2019 | Executive Summary, p. V | https://media.defense.gov/2019/Jan/17/2002080666/-1/-1/1/2019-MISSILE-DEFENSE-REVIEW.pdf | The source is publicly available information and contains no classification markings | US government report.
172. Report | DoD | Layered Homeland Missile Defense: A Strategy for Defending the United States | June 2020 | https://media.defense.gov/2020/Jun/22/2002319425/-1/-1/1/layered-homeland-missile-defense-final.pdf | The source is publicly available information and contains no classification markings | US government publication.

173. Report | DoD | Layered Homeland Missile Defense: A Strategy for Defending the United States | June 2020 | https://media.defense.gov/2020/Jun/22/2002319425/-1/-1/1/layered-homeland-missile-defense-final.pdf | The source is publicly available information and contains no classification markings | US government publication.
174. News release | MDA | 19-NEWS-0003 | Homeland Missile Defense System Successfully Intercepts ICBM Targe | 25 March 2019 | https://mda.mil/news/19news0003.html | The source is publicly available information and contains no classification markings | US government publication.
175. Hearing | Dr. Robert Soofer, Deputy Assistant Secretary of Defense for Nuclear and Missile Defense Policy | Statement to the Subcommittee on Strategic Forces, House Armed Services Committee, Hearing on FY 2021 Priorities for Missile Defense and Missile Defeat Programs | 12 March 2020 | https://armedservices.house.gov/hearings?ID=C193E2B7-C978-4EDF-AB7D-2FDA085A11B0 | The source is publicly available information and contains no classification markings | Congressional hearing.
176. Article | *Defense News* | J. Judson | Pentagon terminates program for redesigned kill vehicle, preps for new competition | 21 August 2019 | https://www.defensenews.com/pentagon/2019/08/21/dod-tanks-redesigned-kill-vehicle-program-for-homeland-defense-interceptor/ | The source is publicly available information and contains no classification markings | US government website.
177. Report | DoD | Layered Homeland Missile Defense: A Strategy for Defending the United States | June 2020 | https://media.defense.gov/2020/Jun/22/2002319425/-1/-1/1/layered-homeland-missile-defense-final.pdf | The source is publicly available information and contains no classification markings | US government publication.
178. Private communication | Center for Strategic and International Studies | Email, December 2020 | July 2016 | Overall classification U | Updated graphic from 2019 article provided by CSIS.
179. Report | DIA | DIA-05-1712-016 | Global Nuclear Landscape 2018 | February 2018 | The source is publicly available information and contains no classification markings | US government report.
180. Report | CRS | IF10472 | North Korea’s Nuclear and Ballistic Missile Programs | 6 June 2019 | The source is publicly available information and contains no classification markings | US government report.
181. Report | Director of National Intelligence D.R. Coats | Statement for the record: Worldwide threat assessment of the US Intelligence Community | 29 January 2019 | https://www.dni.gov/files/ODNI/documents/2019-ATA-SFR---SSCI.pdf | The source is publicly available information and contains no classification markings | Report to the Senate Select Committee on Intelligence.
182. Report | DIA | DIA-05-1712-016 | Global Nuclear Landscape 2018 | February 2018 | The source is publicly available information and contains no classification markings | US government report.
183. Article | *The New York Times* | Sang-Hun | North Korea Unveils What Appears to Be New ICBM During Military Parade | 10 October 2020 | https://www.nytimes.com/2020/10/10/world/asia/north-korea-icbm.html | The source is publicly available information and contains no classification markings | Periodical posted on commercial website.
184. Report | NASIC | NASIC-1031-0985-17 | Ballistic and Cruise Missile Threat 2017 | June 2017 | The source is publicly available information and contains no classification markings | US government report.
185. Report | NASIC | NASIC-1031-0985-17 | Ballistic and Cruise Missile Threat 2017 | June 2017 | The source is publicly available information and contains no classification markings | US government report.
186. Report | DIA | DIA-05-1712-016 | Global Nuclear Landscape 2018 | February 2018 | The source is publicly available information and contains no classification markings | US government report.
187. Report | DIA | DIA-05-1712-016 | Global Nuclear Landscape 2018 | February 2018 | The source is publicly available information and contains no classification markings | US government report.

188. Report | NASIC | NASIC-1031-0985-17 | Ballistic and Cruise Missile Threat 2017 | June 2017 | The source is publicly available information and contains no classification markings | US government report.
189. Report | DIA | DIA-05-1712-016 | Global Nuclear Landscape 2018 | February 2018 | The source is publicly available information and contains no classification markings | US government report.
190. Report | NASIC | NASIC-1031-0985-17 | Ballistic and Cruise Missile Threat 2017 | June 2017 | The source is publicly available information and contains no classification markings | US government report.
191. Report | DIA | DIA-05-1712-016 | Global Nuclear Landscape 2018 | February 2018 | The source is publicly available information and contains no classification markings | US government report.
192. Report | NIC | Foreign Missile Developments and the Ballistic Missile Threat Through 2015 | December 2001 | https://www.dni.gov/files/documents/missilethreat_2001.pdf | The source is publicly available information and contains no classification markings | Unclassified summary of a National Intelligence Estimate.
193. Report | DIA | DIA_Q_00055_A | ISBN 978-0-16-095157-2 | Iran Military Power: Ensuring Regime Survival and Securing Regional Dominance | August 2019 | https://www.dia.mil/Portals/27/Documents/News/Military%20Power%20Publications/Iran_Military_Power_LR.pdf | The source is publicly available information and contains no classification markings | US government report.
194. Report | DIA | DIA_Q_00055_A | ISBN 978-0-16-095157-2 | Iran Military Power: Ensuring Regime Survival and Securing Regional Dominance | August 2019 | https://www.dia.mil/Portals/27/Documents/News/Military%20Power%20Publications/Iran_Military_Power_LR.pdf | The source is publicly available information and contains no classification markings | US government report.
195. Report | CRS | IF10938 | Iran's Ballistic Missile and Space Launch Programs | 9 January 2020 | https://crsreports.congress.gov | The source is publicly available information and contains no classification markings | US government report.
196. Report | CRS | RS20871 | Iran Sanctions | 23 July 2020 | https://crsreports.congress.gov | The source is publicly available information and contains no classification markings | US government report.
197. Article | *Pulse*, *The New York Times* | Putin Shows Off New Weapons, and Warns U.S. and Europe, Too | 1 March 2018 | https://www.pulse.ng/the-new-york-times/world/world-putin-shows-off-new-weapons-and-warns-us-and-europe-too/wrzgnmv | The source is publicly available information and contains no classification markings | Periodical posted on commercial website.
198. Report | NASIC | NASIC-1031-0985-17 | Ballistic and Cruise Missile Threat 2017 | June 2017 | The source is publicly available information and contains no classification markings | US government report.
199. Report | NIC | Foreign Missile Developments and the Ballistic Missile Threat Through 2015 | December 2001 | https://www.dni.gov/files/documents/missilethreat_2001.pdf | The source is publicly available information and contains no classification markings | Unclassified summary of a National Intelligence Estimate.
200. Report | NASIC | NAIC-1031-0985-00 | Ballistic and Cruise Missile Threat 2000 | September 2000 | The source is publicly available information and contains no classification markings | US government report.
201. Report | NASIC | NASIC-1031-0985-17 | Ballistic and Cruise Missile Threat 2017 | June 2017 | The source is publicly available information and contains no classification markings | US government report.
202. Report | DIA | DIA-05-1712-016 | Global Nuclear Landscape 2018 | February 2018 | The source is publicly available information and contains no classification markings | US government report.

203. Report | NASIC | NASIC-1031-0985-17 | Ballistic and Cruise Missile Threat 2017 | June 2017 | The source is publicly available information and contains no classification markings | US government report.
204. Report | DIA | DIA-05-1712-016 | Global Nuclear Landscape 2018 | February 2018 | The source is publicly available information and contains no classification markings | US government report.
205. Report | NASIC | NASIC-1031-0985-13 | Ballistic and Cruise Missile Threat 2013 | 2013 | The source is publicly available information and contains no classification markings | US government report.
206. Report | DoD | Nuclear Posture Review | February 2018 | The source is publicly available information and contains no classification markings | US government report.
207. Report | DIA | DIA-05-1712-016 | Global Nuclear Landscape 2018 | February 2018 | The source is publicly available information and contains no classification markings | US government report.
208. Report | CRS | Russia’s Nuclear Weapons: Doctrine, Forces, and Modernization | 2 January 2020 | https://crsreports.congress.gov | The source is publicly available information and contains no classification markings | US government report.
209. Article | TASS | First regiment of Avangard hypersonic missile systems goes on combat duty in Russia | 27 December 2019 | https://tass.com/defense/1104297 | The source is publicly available information and contains no classification markings | Russian news agency.
210. Report | NASIC | NASIC-1031-0985-06 | Ballistic and Cruise Missile Threat 2006 | March 2006 | The source is publicly available information and contains no classification markings | US government report.
211. Report | NASIC | NASIC-1031-0985-17 | Ballistic and Cruise Missile Threat 2017 | June 2017 | The source is publicly available information and contains no classification markings | US government report.
212. Report | CRS | Russia’s Nuclear Weapons: Doctrine, Forces, and Modernization | 2 January 2020 | https://crsreports.congress.gov | The source is publicly available information and contains no classification markings | US government report.
213. Article | TASS | Work on Russia’s Avangard hypersonic missile continued for over 30 years — designer | 6 October 2020 | https://tass.com/defense/1209209 | The source is publicly available information and contains no classification markings | Russian news agency.
214. Article | TASS | First serial-produced Sarmat ICBMs to assume combat duty in Russia in 2021 | 3 February 2020 | https://tass.com/defense/1115697 | The source is publicly available information and contains no classification markings | Russian news agency.
215. Article | TASS | Preparations for flight trials of Sarmat missiles proceed as scheduled | 19 April 2020 | https://tass.com/science/1146889 | The source is publicly available information and contains no classification markings | Russian news agency.
216. Report | CRS | Russia’s Nuclear Weapons: Doctrine, Forces, and Modernization | 2 January 2020 | https://crsreports.congress.gov | The source is publicly available information and contains no classification markings | US government report.
217. Report | NASIC | NASIC-1031-0985-17 | Ballistic and Cruise Missile Threat 2017 | June 2017 | The source is publicly available information and contains no classification markings | US government report.
218. Report | DIA | DIA-05-1712-016 | Global Nuclear Landscape 2018 | February 2018 | The source is publicly available information and contains no classification markings | US government report.
219. Report | NASIC | NASIC-1031-0985-17 | Ballistic and Cruise Missile Threat 2017 | June 2017 | The source is publicly available information and contains no classification markings | US government report.

220. Article | TASS | Avangard hypersonic missiles replace Rubezh ICBMs in Russia's armament plan through 2027 | 22 March 2018 | https://tass.com/defense/995628 | The source is publicly available information and contains no classification markings | Russian news agency.
221. Article | TASS | Shipbuilders deliver latest Borei-A nuclear-powered sub to Russian Navy | 28 May 2020 | https://tass.com/defense/1161565 | The source is publicly available information and contains no classification markings | Russian news agency.
222. Report | DIA | DIA-11-1704-161 | Russia Military Power: Building a Military to Support Great Power Aspirations | 2017 | The source is publicly available information and contains no classification markings | US government report.
223. Report | DoD | Nuclear Posture Review | February 2018 | The source is publicly available information and contains no classification markings | US government report.
224. Report | NASIC | NASIC-1031-0985-17 | Ballistic and Cruise Missile Threat 2017 | June 2017 | The source is publicly available information and contains no classification markings | US government report.
225. Report | DoD | Nuclear Posture Review | February 2018 | The source is publicly available information and contains no classification markings | US government report.
226. Report | CRS | R43832 | Russian Compliance with the Intermediate Range Nuclear Forces (INF) Treaty: Background and Issues for Congress | 7 December 2018 | https://crsreports.congress.gov | The source is publicly available information and contains no classification markings | US government report.
227. Speech | Lt. Gen. R.P. Ashley, Jr., Director, DIA | Russian and Chinese Nuclear Modernization Trends: Remarks at the Hudson Institute | 29 May 2019 | https://www.dia.mil/DesktopModules/ArticleCS/Print.aspx?PortalId=27&ModuleId=24601&Article=1859890 | The source is publicly available information and contains no classification markings | Transcript, as prepared for delivery.
228. Report | Department of State | Adherence to and Compliance with Arms Control, Nonproliferation, and Disarmament Agreements and Commitments | August 2019 | https://www.state.gov/wp-content/uploads/2019/08/Compliance-Report-2019-August-19-Unclassified-Final.pdf | The source is publicly available information and contains no classification markings | US government report.
229. Article | TASS | New trials of Kinzhal hypersonic complex to show bomber's ability to boost missiles | 2 July 2018 | https://tass.com/defense/1011683 | The source is publicly available information and contains no classification markings | Russian news agency.
230. Article | Radio Free Europe | U.S. Concludes White Sea Radiation Explosion Came During Russian Nuclear-Missile Recovery | 12 October 2019 | https://www.rferl.org/a/u-s-concludes-white-sea-radiation-explosion-came-during-russian-nuclear-missile-recovery/30213494.html | The source is publicly available information and contains no classification markings | Posted on public website.
231. Report | CRS | Russia's Nuclear Weapons: Doctrine, Forces, and Modernization | 2 January 2020 | https://crsreports.congress.gov | The source is publicly available information and contains no classification markings | US government report.
232. Article | TASS | Russia to float out new sub to carry Poseidon nuke drone in late June — source | 6 May 2020 | https://tass.com/defense/1153699 | The source is publicly available information and contains no classification markings | Russian news agency.
233. Report | DIA | DIA-05-1712-016 | Global Nuclear Landscape 2018 | February 2018 | The source is publicly available information and contains no classification markings | US government report.
234. Report | DIA | DIA-11-1704-161 | Russia Military Power: Building a Military to Support Great Power Aspirations | 2017 | The source is publicly available information and contains no classification markings | US government report.

235. Report | DIA | DIA-11-1704-161 | Russia Military Power: Building a Military to Support Great Power Aspirations | 2017 | The source is publicly available information and contains no classification markings | US government report.
236. Article | *DoD News* | J. Garamone | Missile Defense Becomes Part of Great Power Competition | 28 July 2020 | https://www.defense.gov/Explore/News/Article/Article/2291331/missile-defense-becomes-part-of-great-power-competition/ | The source is publicly available information and contains no classification markings | US government website.
237. Article | *DoD News* | J. Garamone | Missile Defense Becomes Part of Great Power Competition | 28 July 2020 | https://www.defense.gov/Explore/News/Article/Article/2291331/missile-defense-becomes-part-of-great-power-competition/ | The source is publicly available information and contains no classification markings | US government website.
238. Report | DIA | DIA-02-1706-085 | China Military Power: Modernizing a Force to Fight and Win | 2019 | The source is publicly available information and contains no classification markings | US government report.
239. Report | DoD | 2020 | *Military and Security Developments Involving the People's Republic of China 2020* | https://media.defense.gov/2020/Sep/01/2002488689/-1/-1/1/2020-DoD-CHINA-MILITARY-POWER-REPORT-FINAL.PDF | The source is publicly available information and contains no classification markings | Annual report to Congress.
240. Report | DIA | DIA-02-1706-085 | China Military Power: Modernizing a Force to Fight and Win | 2019 | The source is publicly available information and contains no classification markings | US government report.
241. Report | NASIC | NASIC-1031-0985-09 | Ballistic and Cruise Missile Threat 2009 | April 2009 | The source is publicly available information and contains no classification markings | US government report.
242. Report | NASIC | NASIC-1031-0985-17 | Ballistic and Cruise Missile Threat 2017 | June 2017 | The source is publicly available information and contains no classification markings | US government report.
243. Report | DoD | 2020 | *Military and Security Developments Involving the People's Republic of China 2020* | https://media.defense.gov/2020/Sep/01/2002488689/-1/-1/1/2020-DoD-CHINA-MILITARY-POWER-REPORT-FINAL.PDF | The source is publicly available information and contains no classification markings | Annual report to Congress.
244. Report | NASIC | NASIC-1031-0985-17 | Ballistic and Cruise Missile Threat 2017 | June 2017 | The source is publicly available information and contains no classification markings | US government report.
245. Report | DoD | 2020 | *Military and Security Developments Involving the People's Republic of China 2020* | https://media.defense.gov/2020/Sep/01/2002488689/-1/-1/1/2020-DoD-CHINA-MILITARY-POWER-REPORT-FINAL.PDF | The source is publicly available information and contains no classification markings | Annual report to Congress.
246. Report | DIA | DIA-02-1706-085 | China Military Power: Modernizing a Force to Fight and Win | 2019 | The source is publicly available information and contains no classification markings | US government report.
247. Report | NASIC | NASIC-1031-0985-17 | Ballistic and Cruise Missile Threat 2017 | June 2017 | The source is publicly available information and contains no classification markings | US government report.
248. Report | NASIC | NASIC-1031-0985-17 | Ballistic and Cruise Missile Threat 2017 | June 2017 | The source is publicly available information and contains no classification markings | US government report.
249. Report | DIA | DIA-05-1712-016 | Global Nuclear Landscape 2018 | February 2018 | The source is publicly available information and contains no classification markings | US government report.

250. Report | DoD | 2020 | *Military and Security Developments Involving the People's Republic of China 2020* | https://media.defense.gov/2020/Sep/01/2002488689/-1/-1/1/2020-DoD-CHINA-MILITARY-POWER-REPORT-FINAL.PDF | The source is publicly available information and contains no classification markings | Annual report to Congress.
251. Report | DoD | 2020 | *Military and Security Developments Involving the People's Republic of China 2020* | https://media.defense.gov/2020/Sep/01/2002488689/-1/-1/1/2020-DoD-CHINA-MILITARY-POWER-REPORT-FINAL.PDF | The source is publicly available information and contains no classification markings | Annual report to Congress.
252. Report | NASIC | NASIC-1031-0985-17 | Ballistic and Cruise Missile Threat 2017 | June 2017 | The source is publicly available information and contains no classification markings | US government report.
253. Report | DoD | 2020 | *Military and Security Developments Involving the People's Republic of China 2020* | https://media.defense.gov/2020/Sep/01/2002488689/-1/-1/1/2020-DoD-CHINA-MILITARY-POWER-REPORT-FINAL.PDF | The source is publicly available information and contains no classification markings | Annual report to Congress.
254. Report | DoD | 2020 | *Military and Security Developments Involving the People's Republic of China 2020* | https://media.defense.gov/2020/Sep/01/2002488689/-1/-1/1/2020-DoD-CHINA-MILITARY-POWER-REPORT-FINAL.PDF | The source is publicly available information and contains no classification markings | Annual report to Congress.
255. Report | DIA | DIA-05-1712-016 | Global Nuclear Landscape 2018 | February 2018 | The source is publicly available information and contains no classification markings | US government report.
256. Report | DoD | 2020 | *Military and Security Developments Involving the People's Republic of China 2020* | https://media.defense.gov/2020/Sep/01/2002488689/-1/-1/1/2020-DoD-CHINA-MILITARY-POWER-REPORT-FINAL.PDF | The source is publicly available information and contains no classification markings | Annual report to Congress.
257. Report | DIA | DIA-02-1706-085 | China Military Power: Modernizing a Force to Fight and Win | 2019 | The source is publicly available information and contains no classification markings | US government report.
258. Report | DoD | 2020 | *Military and Security Developments Involving the People's Republic of China 2020* | https://media.defense.gov/2020/Sep/01/2002488689/-1/-1/1/2020-DoD-CHINA-MILITARY-POWER-REPORT-FINAL.PDF | The source is publicly available information and contains no classification markings | Annual report to Congress.
259. Report | DoD | 2020 | *Military and Security Developments Involving the People's Republic of China 2020* | https://media.defense.gov/2020/Sep/01/2002488689/-1/-1/1/2020-DoD-CHINA-MILITARY-POWER-REPORT-FINAL.PDF | The source is publicly available information and contains no classification markings | Annual report to Congress.
260. Report | DoD | 2020 | *Military and Security Developments Involving the People's Republic of China 2020* | https://media.defense.gov/2020/Sep/01/2002488689/-1/-1/1/2020-DoD-CHINA-MILITARY-POWER-REPORT-FINAL.PDF | The source is publicly available information and contains no classification markings | Annual report to Congress.
261. Report | DoD | 2020 | *Military and Security Developments Involving the People's Republic of China 2020* | https://media.defense.gov/2020/Sep/01/2002488689/-1/-1/1/2020-DoD-CHINA-MILITARY-POWER-REPORT-FINAL.PDF | The source is publicly available information and contains no classification markings | Annual report to Congress.