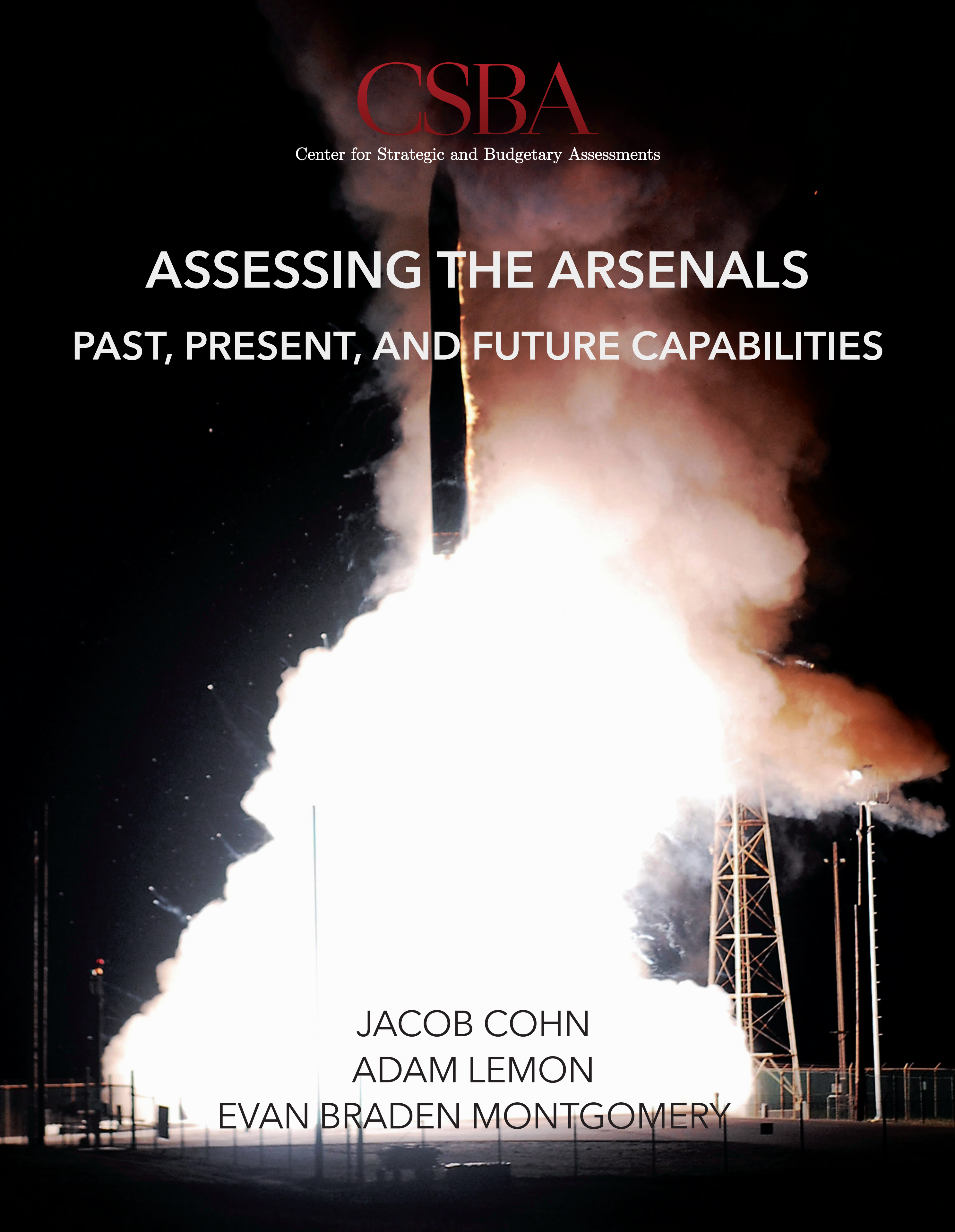

CSBA
Center for Strategic and Budgetary Assessments

# ASSESSING THE ARSENALS

## PAST, PRESENT, AND FUTURE CAPABILITIES

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## ABOUT THE CENTER FOR STRATEGIC AND BUDGETARY ASSESSMENTS (CSBA)

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

## ABOUT THE AUTHORS

**Jacob Cohn** is a Research Fellow at the Center for Strategic and Budgetary Assessments, where he conducts research on future warfare and long-term military competitions. He also manages CSBA's Strategic Choices Tool, which focuses on future challenges facing the United States and its allies as well as the linkages between the strategy and resources necessary to confront those challenges. Mr. Cohn has authored several publications on trends in the defense budget and defense acquisitions as well as ones exploring nuclear deterrence and the return of great power competition. He is also an adjunct lecturer at the Johns Hopkins School of Advanced International Studies.

**Adam Lemon** is a Research Assistant at the Center for Strategic and Budgetary Assessments. At CSBA, his research focuses on nuclear weapons, missiles and missile defense, naval warfare, and long-term geopolitical competitions. He has coauthored reports on the Second Nuclear Age, post-INF Treaty missile forces, the carrier air wing, and long-term competition with China. Prior to joining CSBA, Adam was a student at Duke University, graduating in 2017 and focusing on grand strategy, civil-military relations, and Eurasian geopolitics. He has also served as a research intern in the Center for National Defense at the Heritage Foundation and as an intern in the office of Congresswoman Cathy McMorris-Rodgers (WA-05).

**Evan Braden Montgomery** is a Senior Fellow and the Director of Research and Studies at the Center for Strategic and Budgetary Assessments. During more than a decade at CSBA, Dr. Montgomery has written dozens of monographs, reports, journal articles, and book chapters on a wide range of topics, including great power competition, alliance management, East Asia security challenges, and nuclear issues. In 2016–2017 he served as Special Advisor to the Vice Chairman of the Joint Chiefs of Staff, where he worked primarily on defense innovation and nuclear modernization. Dr. Montgomery is the author of numerous CSBA reports, including most recently *Reinforcing the Front Line: U.S. Defense Strategy and the Rise of China* and *Extended Deterrence in the Second Nuclear Age: Geopolitics, Proliferation, and the Future of U.S. Security Commitments*. His commentary and analysis have also appeared in *The Wall Street Journal*, *Foreign Affairs*, *International Security*, *Security Studies*, and the *Journal of Strategic Studies*, among other outlets. His book, *In the Hegemon's Shadow: Leading States and the Rise of Regional Powers*, was published by Cornell University Press. Dr. Montgomery graduated summa cum laude from Villanova University and received his M.A. and Ph.D. from the University of Virginia. He is a past recipient of the Smith Richardson Foundation Strategy and Policy Fellowship, the Council on Foreign Relations International Affairs Fellowship, and the Department of Defense Joint Civilian Service Commendation Award.

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**Cover:** A Minuteman III intercontinental ballistic missile successfully launches from Vandenberg Air Force Base, CA. The missile was configured with a National Nuclear Security Administration test assembly in which a single unarmed reentry vehicle traveled approximately 4,190 miles to their pre-determined targets near the Kwajalein Atoll in the Marshall Islands. U.S. Air Force photo by Joe Davila.

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CHAPTER 1

# Introduction

The nuclear balance is changing. Whereas the total inventory of nuclear warheads has been decreasing for decades, the number of nuclear powers is increasing. Whereas the nuclear balance throughout the Cold War was centered on the United States and the Soviet Union, today nuclear competition is multipolar. And although strategic interaction between the United States and the Soviet Union during the Cold War fell far short of the "action-reaction" model developed by international relations theorists, current and future patterns of interaction among nuclear powers will likely be more complex.[1] Whereas the nuclear arsenals of the United States and Russia have been constrained by bilateral nuclear arms control agreements, those of other nuclear powers have not. Moreover, the composition of nuclear forces is changing as new technologies, such as hypersonic delivery vehicles, enter service. Some states, such as the United States and Great Britain, appear to see decreasing utility in nuclear weapons, whereas others, notably Russia, Pakistan, and North Korea, appear to see nuclear weapons as having increasing utility.

Given the shifting nuclear landscape, the time is ripe for a net assessment of the nuclear balance.[2] This report is the first in a series of studies that collectively offer an unclassified net assessment of the nuclear balance in the Second Nuclear Age, a period that is arguably more complex and potentially more volatile than the bipolar U.S.-Soviet struggle that characterized

1 On U.S.-Soviet interaction during the Cold War, see Ernest R. May, John D. Steinbruner, and Thomas W. Wolfe, *History of the Strategic Arms Competition, 1945–1972*, Parts I and II (Washington, DC: Historical Office, Office of the Secretary of Defense, March 1981). On arms races in general, see Thomas G. Mahnken, Joseph A. Maiolo, and David Stevenson, eds., *Arms Races in International Politics from the Nineteenth to the Twenty-First Century* (Oxford: Oxford University Press, 2016).

2 For a previous such official effort, see Secretary of Defense and Director of Central Intelligence, *US and Soviet Strategic Forces: Joint Net Assessment*, NI 83-10002X (Washington, DC: Central Intelligence Agency, November 14, 1983).

the Cold War.[3] As the initial contribution to this effort, this study establishes a baseline by reviewing past, present, and planned arsenals for each of the world's declared nuclear powers and highlights some notable asymmetries in the composition of those arsenals that could impact strategic stability. Subsequent reports will assess strategic interaction between and among the United States, Russia, and China as well as key military balances, including system capabilities and emerging technologies.

## The Net Assessment Approach

As used in this report, the term "net assessment" is defined as "the comparative analysis of military, technological, political, economic, and other factors governing the relative military capability of nations. Its purpose is to identify problems and opportunities that deserve the attention of senior defense officials."[4]

As initially defined by the father of net assessment in the U.S. government, Andrew W. Marshall, net assessment is meant to be:

> A careful comparison of U.S. weapon systems, forces, and policies in relation to those of other countries. It is comprehensive, including description of the forces, operational doctrines and practices, training regime, logistics, known or conjectured effectiveness in various environments, design practices and their effect on equipment costs and performance, and procurement practices and their influence on cost and lead times. The use of net assessment is intended to be diagnostic.[5]

Two elements of this definition are worth noting. The first is the fact that net assessment is meant to be comprehensive and emphasizes a multidisciplinary approach to analysis. The second is that it is diagnostic, not prescriptive. It seeks to create an understanding of the character of a military balance rather than prescribing a particular course of action or policy recommendation. Specifically, it seeks to highlight emerging problems or opportunities in a given area of military competition in a timeframe that would allow a senior leader such as the Secretary of Defense to make meaningful policy decisions. This emphasis on emerging challenges and opportunities is a unique feature of the approach.

The net assessment approach includes a number of characteristic features. This series of reports seeks collectively to address all of them, though specific reports within the series lend

3 Evan Montgomery, *Extended Deterrence in the Second Nuclear Age: Geopolitics, Proliferation, and the Future of U.S. Security Commitments* (Washington, DC: Center for Strategic and Budgetary Assessments, 2016), p. 4. See also Colin S. Gray, *The Second Nuclear Age* (Boulder, CO: Lynne Rienner, 1999); Andrew F. Krepinevich, *Meeting the Challenge of a Proliferated World* (Washington, DC: Center for Strategic and Budgetary Assessments, 2010); and Paul Bracken, *The Second Nuclear Age: Strategy, Danger, and the New Power Politics* (New York: Times Books, 2012).

4 Deputy Secretary of Defense William J. Lynn III, "Director of Net Assessment," DOD Directive 5111.11, December 23, 2009, p. 1.

5 A.W. Marshall, "The Nature and Scope of Net Assessments," National Security Council Memorandum, August 16, 1972, p. 1.

themselves to emphasize different elements. The first—and most important to this specific report—is its emphasis on competitive interaction of national security organizations.[6] The net assessment approach assumes that the relationship between states and other actors is characterized neither by conflict nor cooperation, but rather competition between actors seeking to achieve different objectives. Moreover, it assumes that competitors do not develop strategy in a vacuum, but rather interact with one another, albeit imperfectly. Similarly, the net assessment approach assumes that competitors may perceive the world differently and act accordingly. In the military realm, this means that even though different countries may possess similar military hardware, they may choose to employ those systems in very different ways.

A second characteristic of the net assessment approach is the emphasis it places on bureaucratic, organizational, and cultural factors that often lead to sub-optimal behavior. These considerations are all the more important in an era of joint warfare. How states integrate different forms of combat power can heavily influence the overall effectiveness of their forces.

A third feature of net assessment is its acknowledgement of the fact that competitors possess limited resources and operate on the basis of imperfect information. Net assessment, like managerial economics and decision analysis, must deal with uncertainty. It also is comfortable using qualitative as well as quantitative data unlike, for example, much of systems analysis or cost-benefit analysis.[7]

A fourth characteristic of net assessment, which flows from the previous three, is an emphasis on asymmetry. One output of net assessment analyses is an understanding of asymmetries in doctrine, concepts of operations, and effectiveness of military systems and forces. Where are the key differences? What might be their impact on a conflict? Which ones could be useful for U.S. decision-makers? Which ones must they take into account and either counter or end-run? These asymmetries often create opportunities for one side or the other when actual strategies are developed.

Finally, net assessments evaluate how the competition is likely to evolve over time, often two to three decades. The net assessment approach attempts to reflect the time dimension of national military strengths and weaknesses relative to those of a potential foe. As a result, the net assessment approach puts a heavy emphasis on analyzing long-term trends, including, but not limited to, those in the military sphere.

6 Stephen Peter Rosen, "Net Assessment as an Analytical Concept," in A.W. Marshall, J.J. Martin, and Henry S. Rowan, eds., *On Not Confusing Ourselves* (Boulder, CO: Westview Press, 1991), pp. 283–301.

7 On this comparison, see Eliot A. Cohen, *Net Assessment: An American Approach*, JCSS memo #29 (Tel Aviv: JCSS, 1990).

## Report Structure

Chapter two provides a baseline on the global nuclear balance. It explores how the nuclear balance has evolved over time and describes key characteristics of the future balance. This includes examining the growing parity of all nuclear powers except the United States and Russia, as well as potential fragility in the nuclear design and production capacity of countries, proxied by the frequency of the development of new systems. The next chapter provides a baseline for all declared nuclear powers.[8] It traces the evolution of national arsenals from 1989 until today and highlights ongoing modernization plans. It presents this information through a series of tables, snapshots, and timelines including detailed notes on sources and assumptions. The fourth chapter focuses on asymmetries between nuclear powers and explores how that might affect nuclear competitions, the likelihood of nuclear crises, and the prospects for nuclear escalation. It concludes by pointing the way forward to future studies in this series that will explore the strategic interaction between key nuclear powers, the potential ramifications of the end of long-standing arms control agreements, and the possible effects of emerging technologies on the survivability of current and planned nuclear arsenals.

8 There is significant ambiguity over Israel's nuclear program. It is often assumed to be a nuclear power, but there is insufficient reliable open source data for CSBA to include Israel in this study.

CHAPTER 2

# Trends in the Nuclear Balance

Understanding the past can provide insight into the present and can point the way to the future. This chapter thus describes trends in the nuclear balance as a way of understanding both how it has shifted over the decades as well as how it may further change.

The first four and a half decades of the nuclear era corresponding to the Cold War, or the First Nuclear Age, was characterized by a bipolar international system and the U.S.-Soviet nuclear competition. Despite several nuclear crises, the Cold War ended without the use of nuclear weapons. In addition to deterring the use of nuclear weapons, the later years of the Cold War were characterized by growing efforts to limit their spread as well as reduce the size and constrain the capabilities of superpower nuclear arsenals.

With the end of the Cold War, concerns over nuclear deterrence and crisis stability seemed less relevant. Arms control and non-proliferation took center stage as policymakers sought a "peace dividend." Experts were far more concerned with the threat of revisionist states and terrorist groups acquiring nuclear weapons than with great power competition and conflict.[9]

Early in the post-Cold War era, there was a sense that great power competition and conflict was a relic of the past and some even hoped for the elimination of nuclear weapons world-wide. This nuclear optimism culminated in the 2010 Nuclear Posture Review, which placed the prevention of nuclear terrorism and non-proliferation efforts at the top of the U.S. policy agenda and described how the United States would reduce the size of the U.S. nuclear arsenal as well as the role of nuclear weapons in U.S. strategy.[10] The document aimed to strengthen nuclear non-proliferation efforts and continue arms reductions in concert with Russia. Nine

9 For more on arms control and non-proliferation efforts see Amy F. Woolf, Paul K. Kerr, and Mary Beth D. Nitkitin, *Arms Control and Nonproliferation: A Catalog of Treaties and Agreements*, RL33865 (Washington, DC: Congressional Research Service, May 8, 2018).

10 Office of the Secretary of Defense (OSD), *Nuclear Posture Review 2010* (Washington, DC: DoD, April 2010).

years later, the optimism of the post-Cold War era and the 2010 Nuclear Posture Review has disappeared.[11]

Recent Russian aggression in Eastern Europe and China's expansionist actions in the East and South China Seas have signaled the return of great power competition and the potential for great power conflict. Policymakers must adapt existing methods of thinking about strategic stability to a Second Nuclear Age characterized by multiple revisionist powers, the proliferation and modernization of nuclear weapons, and the rising importance of nuclear weapons in the warfighting doctrines of a number of states.[12] Moreover, policymakers and strategists must confront the complexities of both bipolar and multipolar competitions. The return of great power competition and the associated challenges to strategic stability are evident in the 2018 Nuclear Posture Review, which grapples with the modernizing Russian and Chinese nuclear arsenals, the consequences of North Korea's nascent nuclear capability, and growing challenges to extended deterrence.

The remainder of this chapter will outline key trends in the nuclear balance that will influence and shape competition in the Second Nuclear Age.

## Global Warhead Inventory

The global warhead inventory peaked in 1986 and has been declining ever since.[13] The United States had the largest nuclear arsenal through 1977, at which point it was surpassed by the Soviet Union. Although the 1972 Strategic Arms Limitation Treaty (SALT) limited the number of strategic launchers the United States and USSR could deploy, global inventories and nuclear capabilities continued to grow as the advent of multiple-independent reentry vehicle (MIRV) technology allowed a fixed number of launchers to carry increasing numbers of warheads.[14] This growth, however, was driven almost exclusively by the expansion of the Soviet arsenal.

11 OSD, *Nuclear Posture Review 2018* (Washington, DC: DoD, February 2018).

12 For more on the role of nuclear weapons in Russian doctrine, see "The Military Doctrine of the Russian Federation," Office of the President of the Russian Federation, February 5, 2010, available at http://carnegieendowment.org/files/2010russia_military_doctrine.pdf; "The Military Doctrine of the Russian Federation," Office of the President of the Russian Federation, December 25, 2014, available at https://rusemb.org.uk/press/2029; Nikolai N. Sokov, "The Evolving Role of Nuclear Weapons in Russia's Security Policy," in Cristinia Hansell and William C. Potter, eds., *Engaging China and Russia on Nuclear Disarmament* (Monterey, CA: Center for Nonproliferation Studies, April 2009), p. 78; Gunnar Arbman and Charles Thornton, *Russia's Tactical Nuclear Weapons Part I: Background and Policy Issues*, FOI-R—1057—SE (Stockholm: Swedish Defense Research Agency, November 2003), pp. 29–30; and Roger McDermott, "Reflections on Vostok 2010: Selling an Image," *Eurasia Daily Monitor* 7, no. 134, July 13, 2010. For more on the role of nuclear weapons in Pakistani doctrine, see Christopher Clary, "The Future of Pakistan's Nuclear Weapons Program," in Ashley J. Tellis, Abraham M. Denmark, and Travis Tanner, eds., *Asia in the Second Nuclear Age* (Washington, DC: National Bureau of Asian Research, 2013).

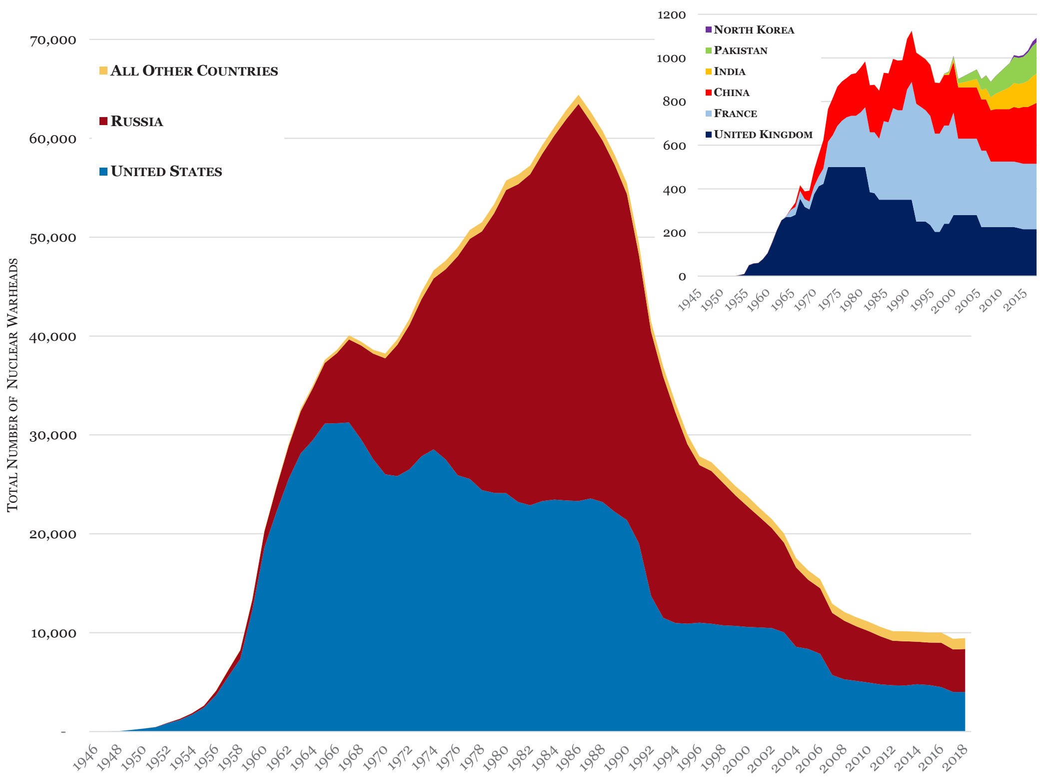
13 Warhead inventories count both deployed warheads and those in central storage.

14 Improvements in warhead accuracy and the development of a missile bus capable of carrying and accurately deploying a large number of warheads increased the viability of a counterforce strategy. Prior to the advent of MIRVs, two ICBMs were allocated to destroy a single hardened silo. With accurate MIRVs, a single missile could destroy multiple silos. See Lawrence Freedman, *The Evolution of Nuclear Strategy*, 3rd edition (New York: Palgrave MacMillian, 2003), pp. 335–341.

Except for a brief increase from 1971–1974, the U.S. arsenal has been shrinking since 1967. In contrast, the Soviet arsenal grew through 1986.[15] It was not until 1987 that the global inventory began to shrink, in part due to arms control treaties like the Intermediate-range Nuclear Forces Treaty (INF) that banned entire classes of weapons, but also due to decreasing tensions between the two superpowers at the end of the Cold War. Both superpowers, however, have abandoned the INF Treaty, and the New Strategic Arms Reduction Treaty (New START) restricting U.S. and Russian arsenals is set to expire in 2021 with no indication that it will be extended. Essentially, the trend toward decreasing global nuclear weapons inventories could be reversing, particularly if tensions between the United States and Russia remain high.[16]

The composition of the global nuclear warhead inventory is also changing. While the arsenals of the Cold War-era nuclear powers continue to decrease, for the time being, newer nuclear powers, such as Indian, Pakistan, and North Korea are expanding their arsenals. Figure 1 highlights global nuclear warhead stockpiles from 1945–2018 in aggregate and by country.

## FIGURE 1: GLOBAL NUCLEAR WARHEAD INVENTORIES, 1945–2018

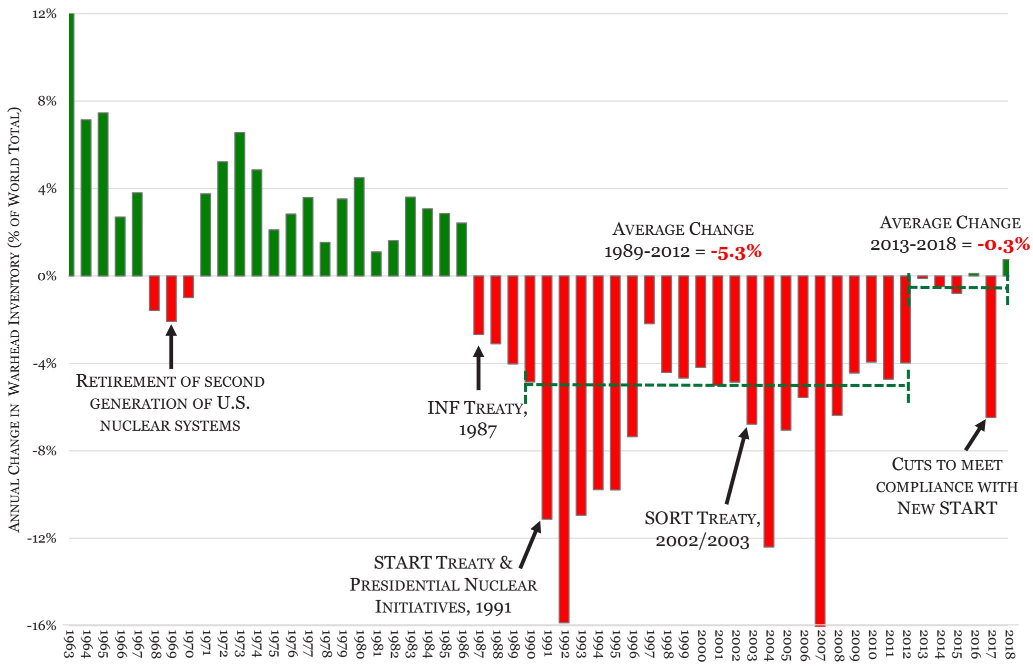



15 The U.S. arsenal grew at a faster rate than the Soviet arsenal, although over a shorter period of time (23 years of growth, starting in 1945, as compared to 38 years of growth, starting in 1949).

16 International Panel of Fissile Materials (IPFM), *Global Fissile Material Report 2015* (Princeton, NJ: Princeton University, 2015).

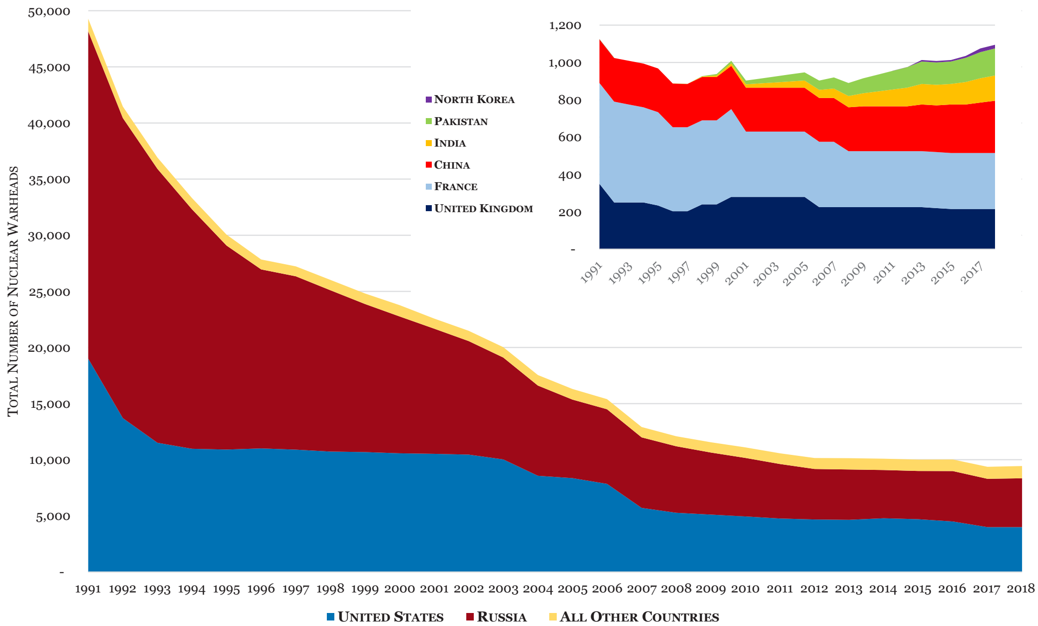
For much of the nuclear era, the size of the U.S. and Russian arsenals drove changes in the global stockpile of nuclear weapons. As figure 2 shows, it was not until 2018 that changes by other nuclear powers outweighed any changes by the United States and Russia. This figure also indicates how arms control treaties are linked to significant changes in nuclear arsenals and raises the question of what may happen if, after 2021, none of the declared nuclear powers are bound by arms control treaties regulating the size or shape of their arsenals.

## FIGURE 2: CHANGES IN GLOBAL NUCLEAR WEAPONS INVENTORY BY YEAR, 1963–2018




Despite post-Cold War nuclear reductions, U.S. and Russian arsenals still far overshadow those of all other nuclear powers combined. Yet, the growing parity among the smaller nuclear powers indicates that coalitions among them could destabilize other nuclear competitions. For example, both China and Pakistan represent nuclear threats to India; collaboration between Pakistan and China in the nuclear realm would pose an even greater challenge to Indian nuclear strategy. Figure 3 focuses on the post-Cold War years to highlight this trend and the current trajectory of each nuclear power.

## FIGURE 3: GLOBAL NUCLEAR WARHEAD INVENTORIES, 1991–2018




Sipri Annual Factbooks, United Kingdom Factsheet on Trident Program, and the Bulletin of Atomic Scientists Global Warhead Inventory 1945–2013.

## FIGURE 4: TIMELINE AND BASING MODE OF GLOBAL NUCLEAR CAPABILITIES ACTIVE AFTER 1989

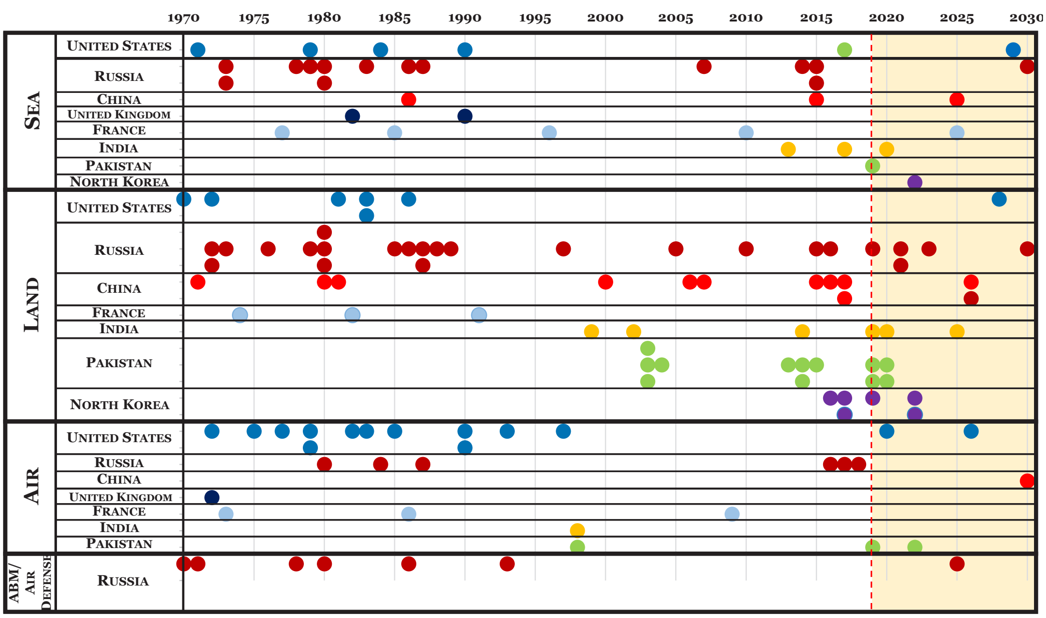
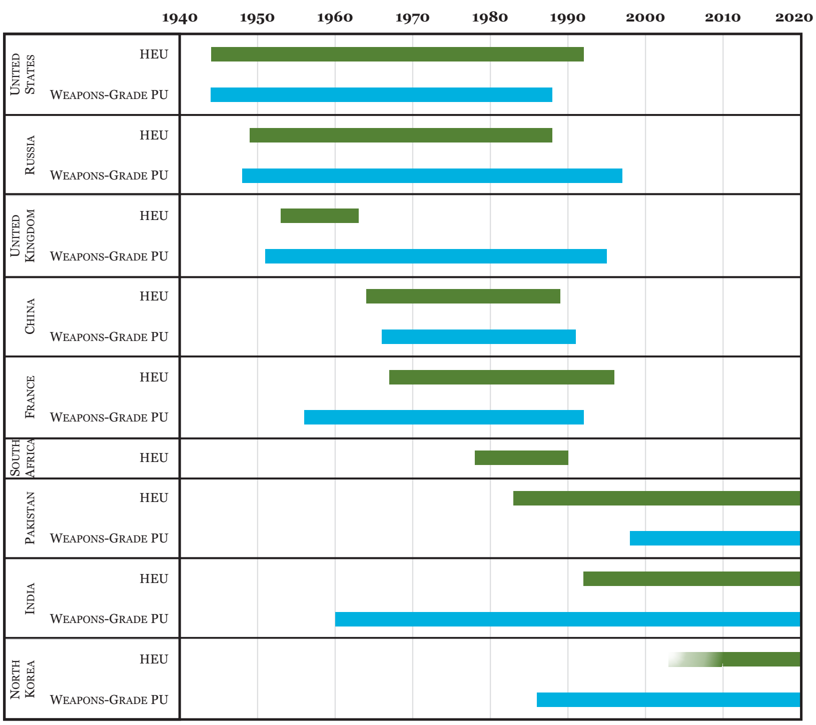



Figure 4 presents a different perspective on each nuclear power. It depicts a timeline from 1970–2030 highlighting when systems active after 1989 entered or will likely enter service and whether it is air-, sea-, or land-based (or, in Russia's case, are meant for air and ballistic missile defense). The frequency with which new systems are designed or existing ones are modernized can be viewed as a proxy for the strength of the intellectual and industrial base behind national nuclear arsenals. Russia develops and deploys the greatest number of new systems, suggesting that its nuclear infrastructure may be more robust than that of other nations. The same data, however, could also be used to suggest that a country frequently develops new capabilities because it is either replacing capabilities of low quality with improved systems or it has designed systems to have a relatively short lifespan for various strategic, technical, or bureaucratic reasons. Although this alternative explanation most likely does not apply to Russia, it could apply to a developing nuclear power such as North Korea.

## Special Nuclear Material Production and Stockpile

In addition to dramatic arms reductions, the final years of the Cold War into the 1990s saw most nuclear powers cease production of weapons grade fissile material. The start and end dates of weapons grade fissile material production are listed in the figure below. Although Russian production of highly enriched uranium (HEU) for military use ended in 1988, Russia began producing limited quantities of HEU for civilian reactor fuel in 2012.[17]

### FIGURE 5: SPECIAL NUCLEAR MATERIAL PRODUCTION




17 IPFM, *Global Fissile Material Report 2015.*

Although the global HEU stockpile available for weapons production is currently decreasing, it will level off and potentially increase slightly if the U.S. stops its HEU blend-down program and Pakistan, India, and North Korea continue producing HEU.[18] In contrast, global plutonium stores are increasing, but the overall increase in weapons grade plutonium is limited to production by India, Pakistan, and North Korea.

Much of the existing special nuclear material (SNM) is not actually in nuclear weapons. Under 30 percent of HEU stocks exist in warheads. The balance, equivalent to roughly 38,000 weapons, could eventually be turned into nuclear weapons if not downblended. There is sufficient military controlled plutonium to produce an additional 31,000 weapons, and a further 83,000 weapon equivalents of plutonium is either civilian controlled or declared as excess inventory.[19] Combined, roughly 9 percent of the SNM in existence has been manufactured into nuclear warheads, including those awaiting dismantlement.

### TABLE 1: SPECIAL NUCLEAR MATERIAL AND WARHEAD INVENTORIES AS OF 2017

| Country | HEU (tons) | Military Pu (tons) | Civilian Pu (tons) | SNM Warhead Equivalents | Total Warhead Inventory | Net Warhead Equivalents |
|---|---|---|---|---|---|---|
| Russia | 679 | 128 | 57.2 | 73,724 | 7,000 | 66,724 |
| United States | 574.5 | 80.8 | 7 | 46,551 | 6,800 | 39,751 |
| United Kingdom | 21.2 | 3.2 | 110.3 | 21,749 | 215 | 21,534 |
| France | 30.6 | 6 | 65.4 | 14,791 | 300 | 14,491 |
| China | 14 | 2.9 | 0.04 | 1,392 | 270 | 1,122 |
| India | 4 | 6.58 | 0.4 | 2,207 | 130 | 2,077 |
| Pakistan | 3.4 | 0.28 | 0 | 208 | 140 | 68 |

Warhead inventories include weapons deployed and in central storage and warheads awaiting dismantlement. Warhead equivalents assumed 25 kg HEU, 4 kg of military Pu, or 5 kg of civilian Pu per warhead equivalent. North Korea is not included due to the uncertainty regarding its nuclear program. For warhead conversion factors see *Global Fissile Material Report 2015*. Special nuclear material data was collected by the IPFM from IAEA declarations. Warhead inventories are from the 2017 Sipri Yearbook.

Current national inventories of SNM and weapons stockpiles are summarized in Table 1. These estimates are meant to be illustrative of potential warhead expansion and neither definitive nor predictive. They indicate, however, the relative scale of SNM controlled by the declared nuclear powers and the potential for arsenal expansion, if desired. Of note, Russia controls 43 percent of the warhead equivalents that could be converted to new warheads. This would provide a significant advantage for Russia if domestic and international limitations on the size and scope of its nuclear arsenal diminish over time and it chose to expand

18 For further information on the U.S. HEU blend-down program, see Department of Energy (DOE), *Tritium and Enriched Uranium Management Plan Through 2060* (Washington, DC: DOE, October 2015). Whereas North Korea started producing HEU in the early 2000s, the program is sufficiently obscure that there is no official start date. See Ankit Panda, "Exclusive: Revealing Kangson, North Korea's First Covert Enrichment Site," *The Diplomat*, July 13, 2018; and Defense Intelligence Agency (DIA), *Global Nuclear Landscape 2018* (Washington, DC: DIA, February 2018).

19 IPFM, *Global Fissile Material Report 2015*.

its arsenal. In addition, of all the countries in the preceding table, Pakistan is the only state that has converted the majority of its SNM into weapons. On average, just under 9 percent of SNM controlled by the other countries in table 1 has been manufactured into nuclear weapons, compared to 67 percent for Pakistan.

CHAPTER 3

# National Nuclear Programs in the Second Nuclear Age

The nuclear powers have approached nuclear weapons in very different ways in terms of the size of their arsenals, their doctrine and organizations, and delivery platforms. Because these choices tend to be long-lasting, they can provide clues as to how their arsenals may evolve into the future.

In the immediate aftermath of the Cold War, the United States and Russia enacted massive nuclear reductions and ended or delayed several modernization programs. For the United States, this was a means of achieving a peace dividend; for Russia, it was driven by economic circumstances.[20] This pause in nuclear competition, however, did not apply to powers such as India and Pakistan, and the United States and Russia have since resumed nuclear modernization efforts.

This chapter will provide a country-by-country overview of national nuclear programs since the end of the Cold War. It will also summarize the status and modernization plans of the declared nuclear powers and North Korea.

## United States

The United States maintains a triad of delivery systems operated by the Air Force and Navy. The Army once maintained non-strategic nuclear weapons but retired its last systems in the early 1990s.[21] The U.S. arsenal is heavily weighted toward the undersea leg of the triad, with submarine-launched ballistic missiles (SLBMs) carrying roughly 67 percent of deployed

20 "Russian Military Budget," Federation of American Scientists (FAS), updated September 7, 2000, available at https://fas.org/nuke/guide/russia/agency/mo-budget.htm.

21 Through the Presidential Nuclear Initiatives in 1991 and the Nuclear Posture Reviews in 1994 and in 2010, the United States denuclearized the Army and eliminated all sea-based non-strategic nuclear weapons.

warheads under New START restrictions and counting rules.[22] The United States is in the initial stages of a long-deferred modernization program aimed at upgrading each leg of the triad, nuclear command and control infrastructure, and the nuclear production complex. If fully funded and executed on time, these programs should be completed in the 2030s. The modernization program also includes a low-yield version of the Trident II D5 SLBM and an as-yet unfunded sea-launched cruise missile (SLCM).[23] Finally, the United States stopped producing weapons grade uranium in 1992 and plutonium in 1988. Eighty-five percent of its special nuclear material stockpile is not in existing weapons.

## TABLE 2: UNITED STATES NUCLEAR FORCES

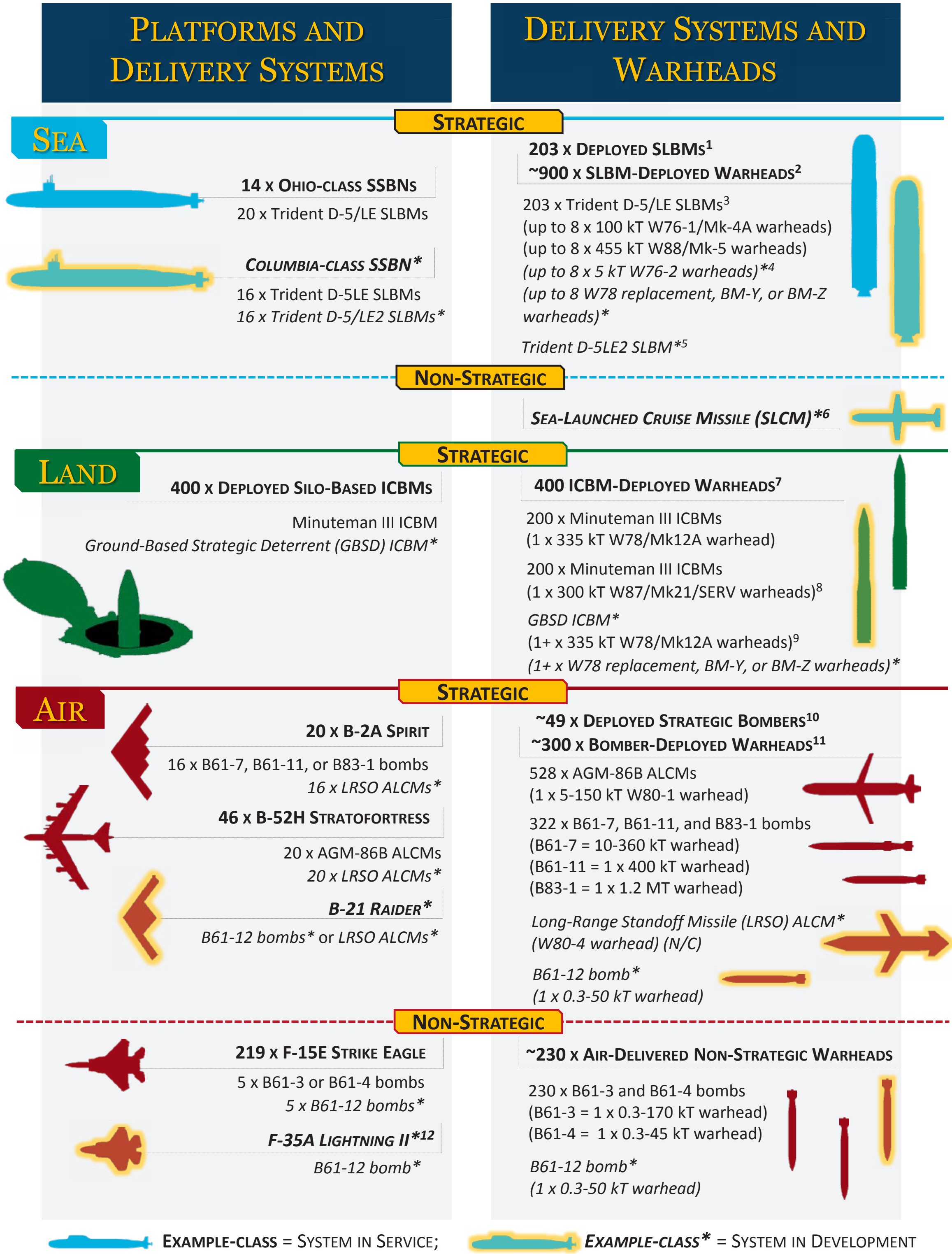
| Weapon Class | Number of Launchers[1] | Number of Warheads[2] |
|---|---|---|
| Intercontinental ballistic missiles | 400 | 800 |
| Submarine-launched ballistic missiles | 240 | 1,920 |
| Aircraft, Bombers | 60 | 850 |
| **Deployed, strategic** | **659** | **1,600** |
| **Deployed and non-deployed, strategic** | **800** | **3,570** |
| Aircraft, Fighters[3] | ? | 230 |
| **Total stockpile** | | **3,800** |

1. The strategic systems in the "Number of Launchers" column exceed the 659 launchers the United States declared under its most recent New START submission since it lists the total number of launchers assigned to the nuclear mission, even if some are not deployed. See Department of State, *New START Treaty Aggregate Numbers of Strategic Offensive Arms* (Washington, DC: Department of State, September 2018).
2. The "Number of Warheads" column reflects the total warheads available by category and not the number deployed. The number of deployed warheads will vary based on the availability and loadout of SSBNs, ICBM warhead upload decisions, and nuclear-capable bomber inventory. While the United States has 1,920 SLBM deliverable warheads, it can deploy a maximum of 1,090 SLBM warheads under New START restrictions unless it retires existing ICBMs or decreases its inventory of nuclear-capable bombers. It currently has roughly 400 warheads on ICBMs, approximately 300 warheads at bomber bases, 945 on SLBMs, and 150 non-strategic weapons in Europe. **3.** An unknown number of F-15s are tasked with delivering the B-61, the only non-strategic nuclear weapon the United States maintains. In regards to fighter aircraft, F-35As will eventually assume the non-strategic nuclear mission. The United States has an estimated 230 non-strategic nuclear weapons, but only roughly 150 are deployed and based in Europe. Table data is sourced from the Nuclear Notebook. See also Hans M. Kristensen and Robert S. Norris, "U.S. Nuclear Forces, 2018," *The Bulletin of the Atomic Scientists* 74, no. 2, March 2018.

22 New START limits the United States and Russia to 700 deployed launchers and 1,550 deployed warheads.

23 OSD, *Nuclear Posture Review 2018*.

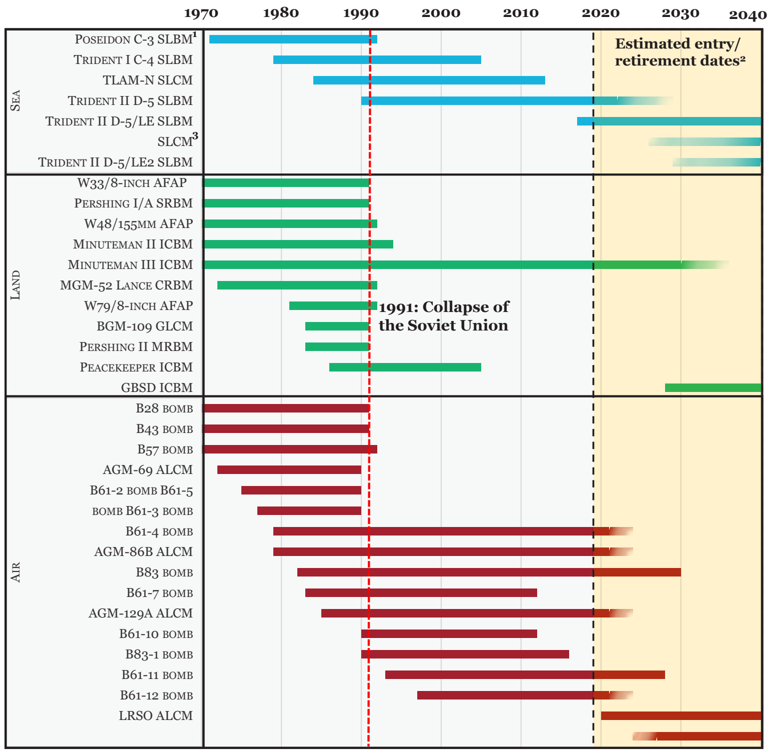
FIGURE 6: SNAPSHOT OF EXISTING AND FUTURE U.S. NUCLEAR CAPABILITIES



Explanatory Notes:

1. According to New START submissions, the U.S. deployed 203 SLBMs in February 2018 (the most recent submission available), with another 231 SLBMs in reserve. However, since *Ohio*-class SSBNs have a capacity of 20 x Trident II D-5/LE SLBMs, and only 12 out of the 14 SSBNs are normally available for use, the U.S. has 240 deployable SLBMs.
2. The most recent New START submission shows that the U.S. deployed 49 bombers, 400 ICBMs, and 1,350 total warheads in February 2018. Since each U.S. ICBM only deploys one warhead and each bomber only counts as one warhead under New START regulations, CSBA can estimate that the U.S. generally deploys about 900 warheads on its SLBMs. This means that U.S. SLBMs are equipped with an average of four or five warheads.
3. While the Trident D-5 is currently being phased out in favor of the upgraded Trident D-5/LE, the exact breakdown of base D-5 variants relative to the upgraded D-5/LE variants is unknown.
4. The W76-2 warhead is the low-yield SLBM option referred to in the 2018 Nuclear Posture Review.
5. The Trident D-5/LE2 is an additional life-extension and upgrade to the Trident D-5/LE. The DoD lists the D-5/LE2 in its April 2019 fact sheet "U.S. Nuclear Weapons: Claims and Responses" as currently being in the early stages of development. The 2018 NPR, stressing the "timely replacement" of the Trident D-5 system, had hinted that the new U.S. SLBM after the D-5/LE would be an entirely new system, but this seems to no longer be the case.
6. The 2018 Nuclear Posture Review announced that the U.S. would pursue an Analysis of Alternatives (AoA) for a new SLCM. The NPR did not, however, mention what naval platform(s) the new SLCM would be launched from.
7. Though the U.S. deploys only 400 land-based warheads—one on each of its 400 ICBMs—its ICBMs have a maximum capacity of 800 warheads.
8. The 200 Minuteman III Mk-12A/SERV ICBMs are usually deployed with only one warhead, despite being able to carry three and possessing an estimated 400 additional warheads in reserve.
9. The Air Force's 2015 Request for Information for the GBSD mentioned that the GBSD will use the Mk-12A and Mk-21 reentry vehicles, indicating that the GBSD will possess a MIRV capability, even if, like the Mk-21 Minuteman IIIs, it never deploys with more than one warhead.
10. While the U.S. possesses 66 nuclear-capable strategic bombers, only 49 (13 B-2s and 36 B-52Hs) were considered deployed in the most recent New START submission where the United States provided a breakdown of its deployed nuclear forces (February 2018).
11. The Bulletin of Atomic Scientists Nuclear Notebook estimates that the U.S. deploys only 300 bomber-delivered warheads (200 of which are ALCMs and 100 of which are gravity bombs). The total stockpile contains an estimated 850 warheads.
12. The F-35A is already in service in the United States Air Force, but the F-35A is not expected to be nuclear-certified until 2024.

## FIGURE 7: TIMELINE OF U.S. NUCLEAR-CAPABLE DELIVERY SYSTEMS ACTIVE AFTER 1989




Explanatory Notes:

1. In the event of conflicting retirement or entry into service dates, CSBA prioritized U.S. government sources. Non-government sources include the Bulletin of Atomic Scientists, SIPRI, and IHS Janes.
2. In the event that the retirement or entry into service dates for a particular system are not exact, then CSBA used a color gradient to show the rough period of time where CSBA believes the system left or entered service, or will likely leave or enter service, assuming the program continues at its current pace and priority.
3. Although the potential U.S. nuclear-capable SLCM is still in the AoA phase and may not become a program of record, the Nuclear National Security Administration (NNSA) stated in the FY 2019 Stockpile Stewardship and Management Plan that the goal was to pursue a new nuclear-capable SLCM "in the long term," but declined to outline a specific timeline.[24]

24 DOE/NNSA, *Fiscal Year 2019 Stockpile Stewardship and Management Plan—Biennial Plan Summary*, report to Congress (Washington, DC: DOE, October 2018).

## Russia

The Russian Federation maintains a triad of strategic delivery systems as well as the largest and most diverse non-strategic arsenal in the world. In contrast to the United States, Russian ICBMs are controlled by an independent service, the Strategic Rocket Force. Russian strategic bombers are controlled by the Long-Range Aviation Command, and Russian SSBNs are controlled by the Navy. Approximately 61 percent of deployed warheads under New START restrictions are ground-launched.[25] Russian ballistic missiles are designed to carry large numbers of MIRVs, but to accommodate treaty restrictions, many deploy with fewer than the maximum number of warheads. Russia is in the midst of a comprehensive modernization program that will be mostly complete by the 2020s. With it, Russia intends to recapitalize its existing arsenal of offensive and defensive systems as well as develop several new weapons such as the Long-Range Nuclear Powered (LRNP) cruise missile (Burevestnik or SSC-X-9 Skyfall), the Poseidon (Status-6) nuclear-powered torpedo, and the Avangard hypersonic glide vehicle. Weapons grade uranium production ended in 1988, and plutonium production ceased in 1997. Russia, however, restarted uranium production for civilian reactor fuel in 2012. Ninety-one percent of its SNM stockpile is not in existing weapons.

### TABLE 3: RUSSIAN NUCLEAR FORCES

| Weapon Class | Number of Launchers[1] | Number of Warheads[2] |
|---|---|---|
| Intercontinental ballistic missiles | 318 | 1,165 |
| Submarine-launched ballistic missiles | 160 | 720 |
| Aircraft, Bombers | 68 | 786 |
| **Deployed, strategic** | **527** | **1,600** |
| **Deployed and non-deployed, strategic** | **779** | **2,670** |
| Non-strategic or defensive weapons3 | ? | 1,820 |
| **Total stockpile** | | **4,490** |

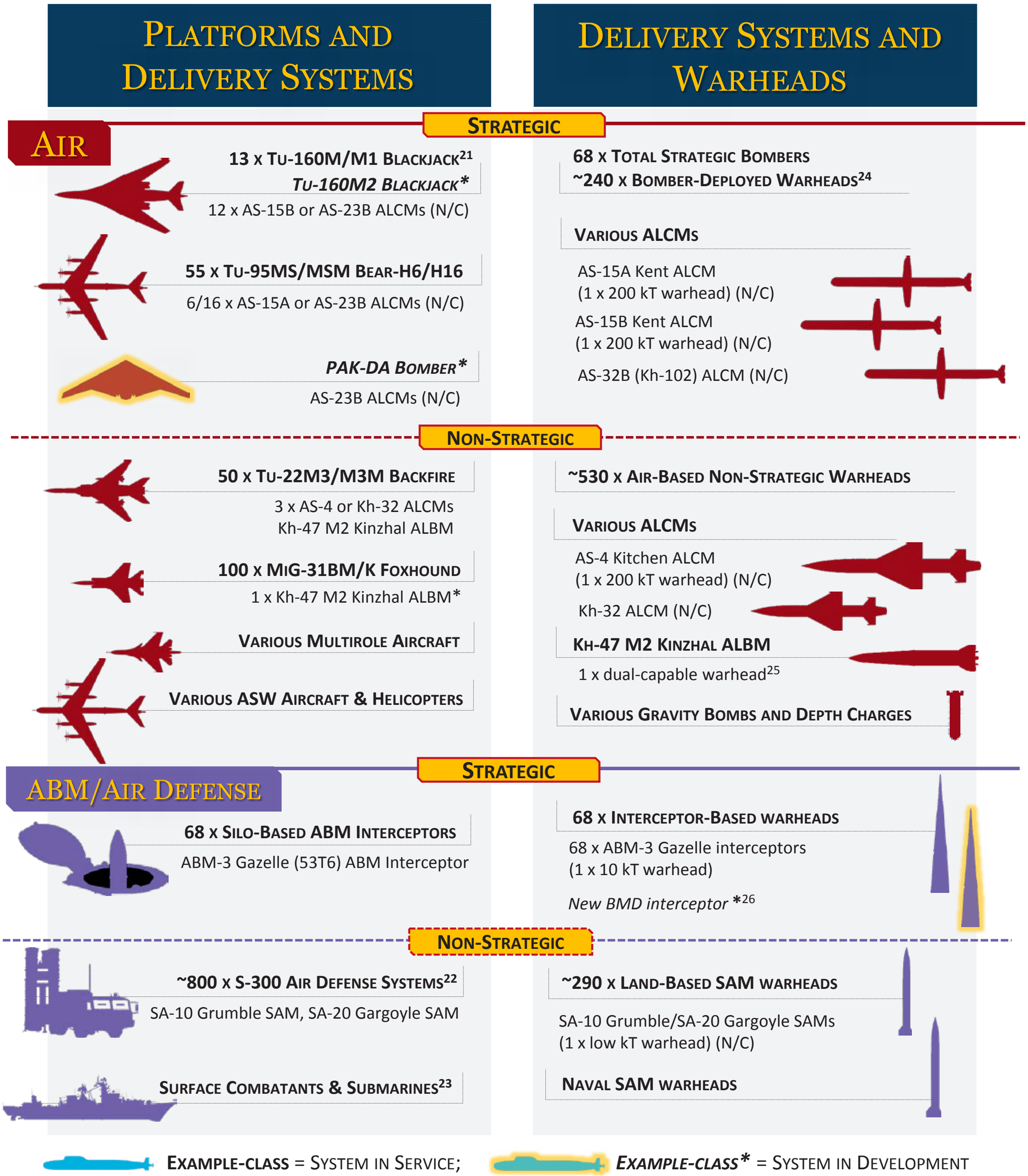
**1.** The "Number of Launchers" column exceeds the 517 launchers Russia declared in its most recent New START submission since it lists the total number of launchers assigned to the nuclear mission, even if some are not deployed. See Department of State, *New START Treaty Aggregate Numbers of Strategic Offensive Arms* (Washington, DC: Department of State, September 2018).
**2.** The "Number of Warheads" column reflects the total warheads available by category and not the number deployed. The number of deployed warheads will vary based on the availability and loadout of SSBNs, ICBM warhead upload decisions, and nuclear-capable bomber inventory. Based on Russia's most recent New START submission, it is estimated that roughly 860 warheads are deployed on ICBMs, 500 are deployed on SLBMs, and that Russia deploys approximately 50 nuclear-capable bombers.
**3.** All other nuclear weapons are assumed to be in central storage. Russia maintains a variety of non-strategic and defensive nuclear weapons; however, the exact quantity of launchers is unknown. Table data is sourced from the Nuclear Notebook. See also Hans M. Kristensen and Robert S. Norris, "Russian Nuclear Forces, 2019."

25 Estimates on deployed warheads are sourced from the Nuclear Notebook. See also Hans M. Kristensen and Robert S. Norris, "Russian Nuclear Forces, 2019," *The Bulletin of the Atomic Scientists* 75, no. 2, March 2019.

**FIGURE 8: SNAPSHOT OF EXISTING AND FUTURE RUSSIAN NUCLEAR CAPABILITIES**

| Platforms and Delivery Systems | Delivery Systems and Warheads |
|---|---|
| **SEA — STRATEGIC** | |
| **3 x Dolgorukiy-class SSBNs**<br>16 x SS-N-32 Bulava SLBMs<br>**6 x Delta-IV-class SSBNs**<br>16 x SS-N-23 M1 Sineva SLBMs<br>**1 x Delta-III-class SSBN**<br>16 x SS-N-18 Stingray SLBMs<br>**1 x Typhoon-class SSBN**[1]<br>*20 x SS-N-32 Bulava SLBMs**<br>***Belgorod & Khabarovsk SSNs****[2]<br>*Poseidon Torpedoes**<br>***Next-Generation SSBN**** | **160 x Total SLBMs**[11]<br>**~500 x SLBM-Deployed warheads**[12]<br>48 x SS-N-32 Bulava<br>(6 x 100 kT warheads)<br>96 x SS-N-23 M1 Sineva<br>(4 x 100 kT warheads)<br>16 x SS-N-18 Stingray<br>(3 x 50 kT warheads)<br>***Poseidon (Status-6)***<br>***Nuclear-Powered Torpedo****[13]<br>1 x 2 MT warhead |
| **SEA — NON-STRATEGIC** | |
| **8 x Oscar-II-class SSGNs**<br>24 x SS-N-19 Shipwreck ASCMs<br>*SS-N-30 Kalibr LACM**<br>**1 x Yasen-class SSGN**<br>32-40 x SS-N-30 Kalibr LACMs[3]<br>SS-N-16 Stallion ASROC<br>**Various SSNs and SSKs**<br>**Various Surface Combatants** | **~820 x Sea-Based Non-Strategic Warheads**[14]<br>**Various LACMs and ASCMs**<br>SS-N-30 Kalibr LACM (N/C)[15]<br>SS-N-21 Sampson LACM<br>(1 x 200 kT warhead)<br>SS-N-19 Shipwreck ASCM<br>(1 x 500 kT warhead) (N/C)<br>**Various Torpedoes and ASROCs** |
| **LAND — STRATEGIC** | |
| **180 x Road-Mobile ICBMs**<br>SS-25, SS-27 M1, and SS-27 M2<br>*SS-X-28 (RS-26) Rubezh**<br>**138 x Silo-Based ICBMs**<br>SS-18, SS-19, SS-27 M1, and SS-27 M2<br>*SS-X-29 Sarmat**<br>***Avangard Hypersonic***<br>***Boost-Glide Missile****[4]<br>*SS-19 M-X-4 w/ Yu-71 HGV** | **318 x Total ICBMs**<br>**~860 x ICBM-Deployed Warheads**[16]<br>111 x SS-27 M2 Yars<br>(4 x 100 kT warheads)<br>78 x SS-27 M1 Stalin<br>(1 x 800 kT warhead)<br>63 x SS-25 Sickle<br>(1 x 800 kT warhead)<br>46 x SS-18 M5 Satan<br>(10 x 800 kT warheads)<br>20 x SS-19 M3 Stiletto<br>(6 x 400 kT warheads)<br>*SS-X-29 Sarmat**<br>(10 x 500 kT warheads)<br>*SS-X-28 Rubezh**[17]<br>***Yu-71 Hypersonic Glide Vehicle****<br>***Long-Range Nuclear-Powered (LRNP)***<br>***(SSC-X-9 Skyfall) GLCM****[18] |
| **LAND — NON-STRATEGIC** | |
| **200+ Ground-Launched Cruise Missiles**[5]<br>SSC-8[6], SSC-5, SSC-1B, *Kalibr GLCM**[7]<br>**276+ Road-Mobile SRBMs**[8]<br>SS-21 Tochka-U, SS-26 Iskander-M<br>**Various Landmines and Artillery***[9]<br>***Theater-Range Hypersonic Weapon****[10] | **~87 Land-Based Non-Strategic Warheads**[19]<br>100 x SSC-8 Screwdriver LACM<br>(1 x 10-100 kT warhead) (N/C)<br>96 x SSC-5 Stooge ASCM<br>(1 x 10 kT warhead) (N/C)[20]<br>12 x SS-21 Tochka-U<br>(1 x 10-100 kT warhead) (N/C)<br>8 x SSC-1B Sepal ASCM<br>(1 x 350 kT warhead) (N/C)<br>264 x SS-26 Iskander-M<br>(1 x 10-100 kT warhead) (N/C)<br>*Kalibr GLCM**<br>*Theater-Range Hypersonic Weapon** |

**Example-class** = System in Service; ***Example-class**** = System in Development




Explanatory Notes:

1. In 2017, NASIC listed one Typhoon SSBN as being modified to carry 20 SS-N-32 Bulava SLBMs. According to the BAS, this Typhoon is a missile test platform only and not a submarine in active service.

2. The Belgorod and Khabarovsk are two distinct special mission submarines designed to carry the Poseidon nuclear-powered torpedo, among other unmanned underwater vehicles and surveillance systems. It is unclear what other platforms, if any, are expected to carry the Poseidon torpedo.
3. The first of the Yasen-class SSGNs has a capacity of up to 40 Kalibr LACMs, but other vessels of the class will only be able to carry 32 Kalibr missiles.
4. The Avangard hypersonic boost-glide missile uses the silo-based SS-19 M-X-4 ICBM as a booster to deliver the Yu-71 hypersonic glide vehicle (HGV), also referred to as Object 4202. Although this missile is not covered under New START, due to its intercontinental range, CSBA considers it a strategic system.
5. Russia possesses an estimated 100 SSC-8 GLCMs (both on launchers and spares), 96 SSC-5 missiles (with two missiles per launcher and an estimated 48 launchers according to BAS), and an estimated eight SSC-1B Sepals. It is likely that any spares for the SSC-5 would increase this number. This number may also be much larger if, as is rumored, the Iskander-K LACM and certain Russian multiple rocket launchers are also nuclear-capable.
6. The Novator 9M729, designated as SSC-8, is a nuclear-capable ground-launched cruise missile (GLCM), which the United States and many NATO governments believe violates the 1987 INF Treaty. The SSC-8's deployment in 2017 was the primary cause for the United States' suspension of its obligations under the INF Treaty on February 1, 2019.
7. The Russian government declared on February 5, 2019 that it intended to pursue a ground-launched variant of the Kalibr SLCM and field it by 2021. Considering many reports that the SSC-8 GLCM is a Kalibr variant, it is unclear if the announced weapon would be a new system or whether this is an attempt by the Russian government to obscure the origins of the SSC-8.
8. This total includes the 132 Iskander-M launchers (each with a two-missile capacity) and 12 Tochka-U launchers (each with a single missile capacity) the BAS estimates are in service.
9. In the April 2019 DoD fact sheet "Enhancing Deterrence with Supplemental Nuclear Capabilities," the DoD confirms that, in addition to those nonstrategic nuclear weapons capabilities listed in the 2018 NPR, Russia also possesses nonstrategic nuclear weapons set aside for landmines and nuclear artillery shells.
10. In the same announcement about its desire to pursue a Kalibr GLCM, the Russian government also claimed that it intended to develop a ground-launched hypersonic weapon of medium and shorter range that might be nuclear-capable by 2021.
11. In 2017, NASIC claimed that there are 96 SS-N-18 M1 launchers, enough for six Delta-III SSBNs, while the BAS estimates that there are at most 16 launchers on one submarine, totaling 96 warheads. Since there is only one Delta-III SSBN in service, CSBA assumes NASIC's claim refers to the total number of launchers active and in reserve.
12. While Russia has an estimated 720 deployed and non-deployed SLBM warheads, CSBA estimates that approximately 500 are deployed on SLBMs at any moment based on Russia's warhead declarations under New START and the BAS estimate of actively-deployed land-based warheads and

strategic bombers. For a more detailed explanation of how CSBA arrived at these estimates, see the explanatory notes for Figure 21 on upload capacity.

13. The developmental Poseidon nuclear-powered torpedo, commonly referred to as the Status-6 or Kanyon, is not covered by New START as a strategic weapon, but CSBA considers it a strategic system due to its apparent intercontinental range.

14. The BAS estimates that the Russian Navy possesses 820 non-strategic nuclear warheads in reserve with an unknown breakdown among the various delivery systems. These warheads include surface- and submarine-launched ASCMs and LACMs, torpedoes, anti-submarine rockets (ASROCs), and naval SAMs, as well as air-delivered depth charges and anti-ship missiles.

15. An intermediate-range (4,500 km) Kalibr variant, the Kalibr-M, is reported to be in development by The Diplomat and TASS. However, this has not yet been confirmed by a U.S. government source.

16. While approximately 860 warheads are deployed on Russian ICBMs according to the BAS, the number of deployed and reserve warheads for those ICBMs totals around 1,165.

17. Development of the SS-X-28 (RS-26) Rubezh has been halted and will likely remain so throughout the 2027 State Armaments Plan (SAP). The new SAP also stopped development on the rail-mobile Barguzin ICBM, a variant of the SS-27 M2.

18. In the April 2019 DoD fact sheet "U.S. Nuclear Weapons: Claims and Responses," the DoD officially confirmed the existence of the Russian developmental nuclear-powered ground-launched cruise missile, often referred to as Burevestnik, which the DoD designated "Long-Range Nuclear-Powered" (LRNP). The Diplomat claims that this missile's NATO designation is SSC-X-9 Skyfall.

19. The BAS estimated in March 2019 that Russia has approximately 87 ground-based non-strategic nuclear warheads for delivery by its various SRBMs and GLCMs. This number does not include an estimate of how many warheads Russia has set aside for its nuclear landmines and artillery shells, as the most recent BAS assessment of Russian nuclear forces precedes the April 2019 DoD fact sheets.

20. The SSC-5 Stooge ASCM (also known as the SS-N-26 or 3M-55) is considered a "nuclear-possible" system by NASIC and comes in ground-, submarine-, and surface-launched variants.

21. While Russian strategic bombers once carried gravity bombs, it is unclear if they still do so today. Non-strategic nuclear-capable Russian aircraft, however, still maintain the capability.

22. While the 2018 Nuclear Posture Review confirmed that Russia has nuclear weapons meant for its air defense systems, there is no clear evidence as to which air defense systems are nuclear-capable. According to the BAS, the SA-10 and SA-20 interceptors, used by the S-300, and potentially the SA-21 interceptor, used by the S-400 system, are likely nuclear-capable.

23. The 2018 Nuclear Posture Review also confirmed that Russia possesses nuclear weapons for SAMs on surface ships and submarines, though it provided no details as to which ships and submarines employ such weapons.

24. Although Russian strategic bombers have a maximum capacity of 786 warheads, the BAS credits them with "a couple hundred" actively deployed air-delivered warheads. Based on Russia's declarations under New START, CSBA estimates this to be about 240 warheads. For a more detailed

explanation of how CSBA arrived at these estimates, see the explanatory notes for Figure 21 on upload capacity.

25. Though no U.S. government publications have yet credited the Kinzhal with any nuclear capability, the BAS considers it to be dual-capable.

26. The 2018 Nuclear Posture Review confirmed, but provided no real details on, a new Russian ballistic missile defense (BMD) interceptor in development.

## FIGURE 9: TIMELINE OF RUSSIAN NUCLEAR-CAPABLE DELIVERY SYSTEMS ACTIVE AFTER 1989

Explanatory Notes:

1. In the event of conflicting retirement or entry into service dates, CSBA prioritized U.S. government sources. Non-government sources include the Bulletin of Atomic Scientists, SIPRI, and IHS Janes.
2. In the event that the retirement or entry into service dates for a particular system are not exact, CSBA used a color gradient to show the rough period of time where CSBA believes the system left or entered service, or will likely leave or enter service, assuming the program continues at its current pace and priority.

## China

Although the majority of China's nuclear weapons are land-based and controlled by the People's Liberation Army Rocket Force (PLARF), China is expanding its undersea capability and might maintain a limited air-delivered capability. Even if China does not currently have an active triad of delivery systems, its modernization programs are designed to field one. China's ongoing modernization program is focused on developing next-generation, secure second-strike capabilities such as a new SSBN, a stealth bomber, and a road mobile ICBM. Like Russia, China also deploys a wide variety of nuclear systems, some of which are dual-capable, that can be employed either at the battlefield level or at a broader strategic level. Weapons grade uranium production stopped in 1989, and plutonium production ended in 1991. Eighty-one percent of its special nuclear material stockpile is not in existing weapons. China has never been constrained by nuclear arms control treaties, which has contributed to the overall opacity surrounding its nuclear weapons programs.

### TABLE 4: CHINESE NUCLEAR FORCES

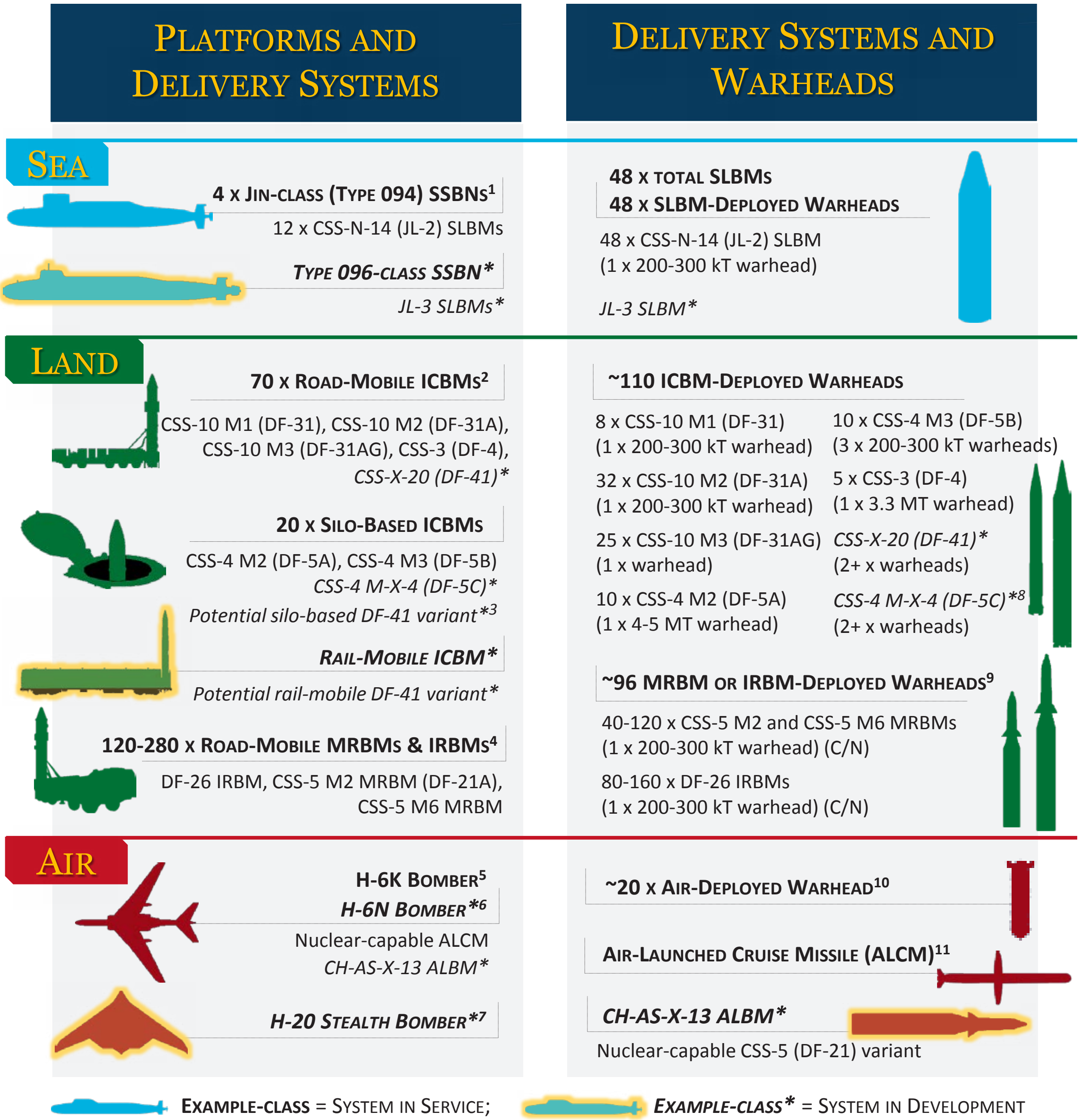
| Weapon Class | Number of Launchers | Number of Warheads |
|---|---|---|
| Intercontinental ballistic missiles | 90 | 110 |
| Intermediate & Medium-range ballistic missiles | 120 | 96 |
| Submarine-launched ballistic missiles | 48 | 48 |
| Aircraft, Bombers | ?[1] | 20 |
| **Total stockpile** | | **280+[2]** |

This summary table does not distinguish between deployed and non-deployed warheads. Many Chinese systems are dual-capable. China, however, has been opaque as to exactly which systems are dual-capable and the breakdown between conventional and nuclear variants of a given system. Some sources suggest the DF-15 is dual-capable, and others suggest that China has nuclear-capable air- and sea-launched cruise missiles, but there is no definitive evidence. A 2013 U.S. Air Force Global Strike Command briefing listed the CJ-20 as a nuclear-capable air-launched cruise missile. This has not been reflected in subsequent NASIC reports, but has been reflected in the 2018 Nuclear Posture Review. If, however, China had large numbers of dual-capable systems and equipped only a fraction of those weapons with nuclear warheads, it could significantly reshape the nuclear balance. For instance, deploying nuclear-capable cruise missiles near the Sino-Indian border could dramatically affect the regional competition.

**1.** While China likely has at least 20 air-delivered nuclear weapons, it is unclear which aircraft and how many are nuclear-capable. DoD's 2018 annual report on Chinese military power refers to the H-6 and the future stealth bomber as platforms which could "both be nuclear-capable," though it does not designate which variant of H-6 it was referring to.

**2.** DoD's 2019 annual report on Chinese military power outlines a significant expansion in China's 1,000+ km missile force. It is unclear how many of these new missiles are nuclear-capable; ergo, the true extent of China's nuclear stockpile is unknown. In 2018, the BAS estimated that China had roughly an additional 30 warheads split between the DF-26 and DF-41, but it was unclear how many warheads were associated with each missile. Nine of those are assumed to be allocated to the new road-mobile ICBMs, while the rest are included as unallocated, reserve warheads. Based on the missile inventory growth in DoD's 2019 report, it is plausible that China has expanded its arsenal beyond 280 warheads, but it is unclear by how much. The data is sourced from OSD, *Military and Security Developments Involving the People's Republic of China 2019*, annual report to Congress (Washington, DC: DoD, 2019); and the Nuclear Notebook. See also Hans M. Kristensen and Robert S. Norris, "Chinese Nuclear Forces, 2018," *The Bulletin of the Atomic Scientists* 74, no. 4, June 2018.

**FIGURE 10: SNAPSHOT OF EXISTING AND FUTURE CHINESE NUCLEAR CAPABILITIES**




Explanatory Notes:

1. OSD's 2019 annual report on Chinese military power notes that China has constructed six Jin-class SSBNs, but only four are operational. The other two SSBNs are outfitting for service.

2. OSD's 2019 annual report on Chinese military power assesses that China possesses 90 ICBM missiles and 90 ICBM launchers, though it did not comment on the breakdown between fixed and road-mobile ICBMs. The most recent BAS assessment of Chinese nuclear forces in June 2018 estimated that China had 20 silo-based ICBMs and between 45–61 road-mobile ICBMs, depending on

whether or not the DF-31AG was a new missile or simply the DF-31A on a new launcher. The April 2019 DoD fact sheet “U.S. Nuclear Weapons: Claims and Responses” showed the DF-31AG as a distinct system from the DF-31A, so CSBA assumed that China, in 2018, possessed 61 road-mobile ICBMs. Since the 2019 OSD report on China’s military power stated that “the PLARF continues to enhance its fixed ICBMs” while “adding more survivable, mobile delivery systems,” it is likely, though by no means certain, that the nine Chinese ICBMs added in the past year are road-mobile missiles. Additionally, CSBA assumed that the new ICBMs would be the most recent DF-31AG variant. This would bring the PLARF total to 70 road-mobile ICBMs and 20 silo-based ICBMs.

3. OSD’s 2018 and 2019 annual reports on Chinese military power note that China is actively considering silo-based and rail-mobile variants of the CSS-X-20 (DF-41). The April 2019 DoD fact sheet “U.S. Nuclear Weapons: Claims and Responses,” however, lists the DF-41 only as road-mobile.

4. PLARF inventory estimates from the 2019 OSD report on China’s military power show that there are one to two IRBM missiles per IRBM launcher and one to three MRBM missiles per MRBM launcher. As such, with 80 nuclear-capable IRBM launchers and an estimated 40 nuclear-capable MRBM launchers, China likely possesses 80–160 nuclear-capable IRBMs and 40–120 nuclear-capable MRBMs.

5. OSD’s 2018 annual report on Chinese military power claims that the H-6 and the “future stealth bomber”—presumably referring to the H-20—“could both be nuclear-capable.” It is, however, unclear what nuclear weapons it could employ. It is possible that the H-6 could employ the potentially nuclear-capable CH-AS-X-13 ALBM designed for the H-6N, an unidentified nuclear-capable ALCM (see note 7), or a different unidentified nuclear weapon.

6. The H-6N is currently in development and will be a variant of the H-6K designed to launch the CH-AS-X-13 ALBM.

7. The DIA 2019 report on China’s military power confirmed that China is developing two stealth bombers, one strategic and the other tactical. While it confirmed the dual-capable nature of the strategic bomber—widely referred to as the H-20—it did not specify whether the tactical stealth bomber—commonly referred to as the JH-XX—would be nuclear-capable.

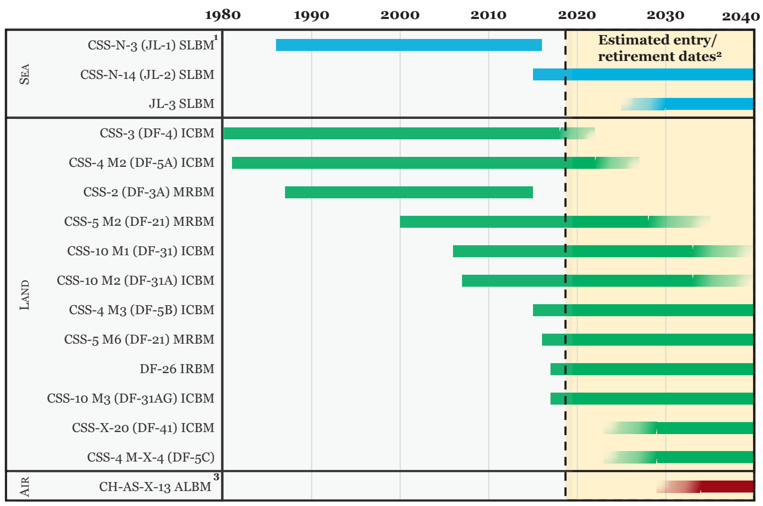
8. The April 2019 DoD fact sheet “U.S. Nuclear Weapons: Claims and Responses” confirmed the existence of the DF-5C as a silo-based delivery system in development. Though the fact sheets provide no details on the DF-5C’s payload, reports suggest that the DF-5C, like the DF-5B, is MIRVed and has been tested with up to ten warheads. Due to the uncertainty of these reports, however, this assessment only credits the DF-5C with a general MIRV capability.

9. CSBA estimated that China has roughly 96 MRBM/IRBM nuclear warheads. This assumes that each of the 40 nuclear-capable DF-21 MRBM launchers the BAS estimated China possessed in their 2018 report have two assigned nuclear weapons per launcher. This is in addition to the 16 warheads the BAS estimated were assigned to China’s DF-26 IRBM force.

10. It is unclear how many air-delivered nuclear weapons China possesses. The PLAAF’s new nuclear mission suggests that there are some air-delivered warheads in the Chinese arsenal. The BAS has long credited the PLAAF with approximately 20 air-delivered warheads.

11. A fact sheet released alongside the 2018 Nuclear Posture Review noted that China had a nuclear-capable ALCM. This nuclear-capable ALCM is possibly the CJ-20, as STRATCOM designated in 2013, though this has not since been confirmed or noted as nuclear-capable. In 2007, NASIC designated the CJ-20 as conventional only. Accordingly, this assessment indicates that China has a general nuclear-capable ALCM without identifying a specific weapon.

## FIGURE 11: TIMELINE OF CHINESE NUCLEAR-CAPABLE DELIVERY SYSTEMS ACTIVE AFTER 1989




Explanatory Notes:

1. In the event of conflicting retirement or entry into service dates, CSBA prioritized U.S. government sources. Non-government sources include the Bulletin of Atomic Scientists, SIPRI, and IHS Janes.
2. In the event that the retirement or entry into service dates for a particular system are not exact, CSBA used a color gradient to show the rough period of time where CSBA believes the system left or entered service, or will likely leave or enter service, assuming the program continues at its current pace and priority.
3. Although the DoD credits China with a nuclear-capable air-launched cruise missile (ALCM), it does not specify which ALCM it is referring to. As such, it is not included in this timeline.

## United Kingdom

The United Kingdom maintains only one type of nuclear delivery system: Trident II D-5 SLBMs deployed aboard Royal Navy SSBNs. The nuclear program leverages shared sustainment capabilities and development costs for the common missile compartment (used on the planned *Columbia*- and *Dreadnought*-class SSBNs) and the Trident II D-5 missile.[26] UK nuclear targeting is integrated into U.S. planning, and UK nuclear forces are "formally assigned to the defense of NATO except in an extreme national emergency."[27] The UK has also imposed artificial limitations on its SSBN capacity. The current SSBN, the *Vanguard*-class, could carry sixteen SLBMs apiece but only deploys with eight missiles. The replacement SSBN, the *Dreadnought*-class, will be capable of carrying twelve SLBMs, but will only deploy with eight.[28] Finally, the UK stopped producing weapons grade uranium in 1963 and plutonium in 1995. Ninety-nine percent of its special nuclear material stockpile is not in existing weapons.

### TABLE 5: UNITED KINGDOM NUCLEAR FORCES

| Weapon Class | Number of Launchers[1] | Number of Warheads |
|---|---|---|
| Submarine-launched ballistic missiles | 48 | 120 |
| **Non-deployed, reserve** | | **105** |
| **Total stockpile** | | **225** |

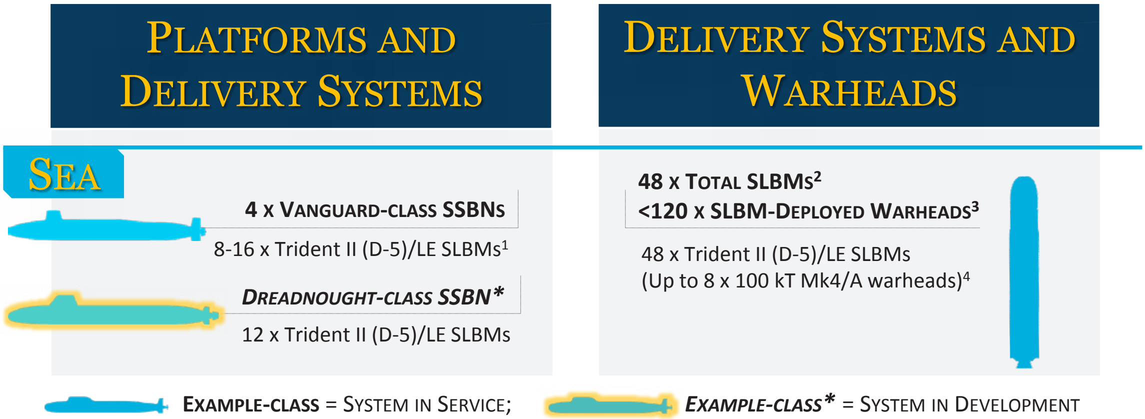
**1.** The "Number of Launchers" column reflects the total number of launchers the United Kingdom maintains even though one of its four SSBNs is generally undergoing maintenance and thus unavailable for operational use.The data is sourced from Hans M. Kristensen and Robert S. Norris, "British Nuclear Forces, 2011," *The Bulletin of the Atomic Scientists* 67, no. 5, November 2015; Shannon N. Kile and Hans M. Kristensen, "World Nuclear Forces," *SIPRI Yearbook* 2017 (Oxford, UK: Oxford University Press, 2016); and Mills, *Replacing the UK's "Trident" Nuclear Deterrent*.

26 Claire Mills, *Replacing the UK's "Trident" Nuclear Deterrent* (London: House of Commons Library, February 2018), no. 7353; George Allison, "UK Funds $2.1m in Development for New Submarine Common Missile Compartment," *UK Defence Journal*, November 3, 2017; and "Exchange of Notes between the Government of the United Kingdom of Great Britain and Northern Ireland and the Government of the United States concerning the Acquisition by the United Kingdom of the Trident II Weapon System under the Polaris Sales Agreement," Washington, DC, October 19, 1982.

27 Extreme national emergency is loosely defined as a point where "H.M.G. may decide that supreme national interests are at stake." John F. Kennedy, "Joint Statement Following Discussions with Prime Minister Macmillan—The Nassau Agreement," December 21, 1962, available at https://www.jfklibrary.org/asset-viewer/archives/JFKPOF/042/JFKPOF-042-013. See also Foreign Affairs Committee, *Global Security: UK-US Relations*, sixth report (London: House of Commons, March 18, 2010).

28 Mills, *Replacing the UK's "Trident" Nuclear Deterrent*.

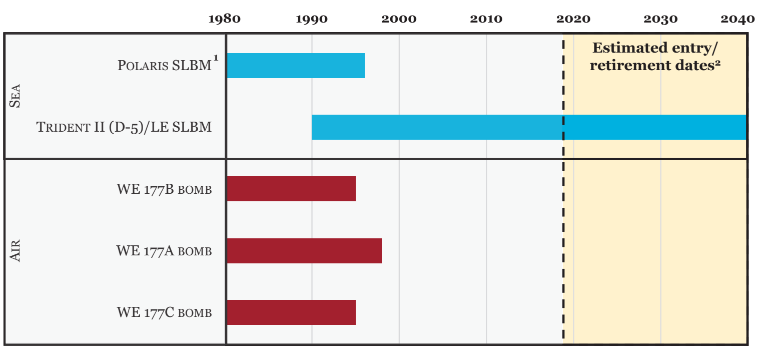
### FIGURE 12: SNAPSHOT OF EXISTING AND FUTURE UK NUCLEAR CAPABILITIES




Explanatory Notes:

1. While the *Vanguard*-class SSBNs have a capacity of 16 Trident II SLBMs, the British government has reduced the number of operational missiles on each submarine to no more than eight.
2. The UK possesses 48 Trident II SLBMs for operational use and another ten for testing and spares.
3. The UK reduced its requirement for operationally available warheads to "no more than 120" since 2010. While the UK government's goal is to only possess 180 total warheads by the mid-2020s, its current stockpile is estimated by BAS to be 215.
4. The UK has reduced the number of warheads on each deployed SSBN to 40. As such, Trident II SLBMs deploy with an average of five warheads each.

### FIGURE 13: TIMELINE OF UK NUCLEAR DELIVERY SYSTEMS ACTIVE AFTER 1989




Explanatory Notes:

1. In the event of conflicting retirement or entry into service dates, CSBA prioritized U.S. government sources. Non-U.S. government sources include the UK Parliament, the Bulletin of Atomic Scientists, SIPRI, and IHS Janes.

2. In the event that the retirement or entry into service dates for a particular system are not exact, CSBA used a color gradient to show the rough period of time where CSBA believes the system left or entered service, or will likely leave or enter service, assuming the program continues at its current pace and priority.

## France

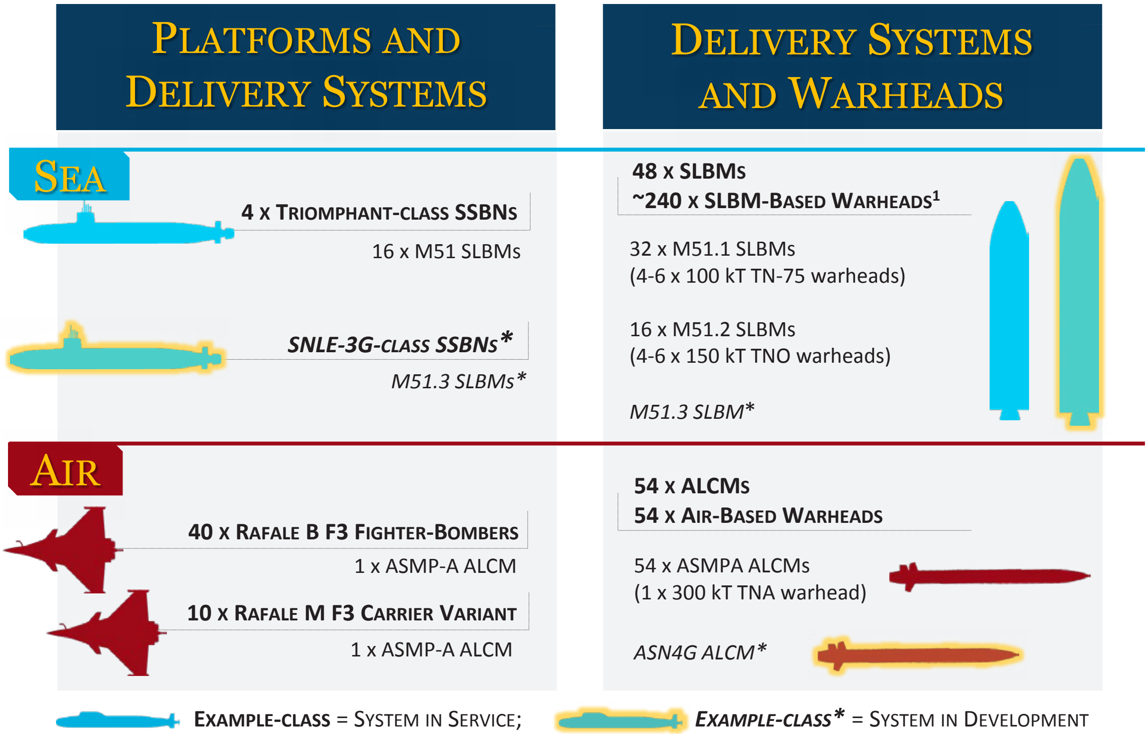
France has always maintained an independent nuclear force and is not part of NATO nuclear planning. It eliminated the land-based missile leg of its triad in 1996 but maintains indigenously developed sea-based and air-delivered weapons. The Navy deploys SLBMs, and both the Navy and Air Force maintain fighter-launched cruise missiles. An ongoing modernization plan is set to replace all weapons and launch platforms by the mid-2030s. France stopped producing weapons grade uranium in 1996 and plutonium in 1992. Ninety-eight percent of its special nuclear material stockpile is not in existing weapons.

### TABLE 6: FRANCE NUCLEAR FORCES

| Weapon Class | Number of Launchers[1] | Number of Warheads |
|---|---|---|
| Aircraft, Fighters (land-based) | 40 | 54 |
| Aircraft, Fighters (carrier-based) | 10 | |
| Submarine-launched ballistic missiles | 48 | 240 |
| **Non-deployed, reserve** | | **6** |
| **Total stockpile** | | **300** |

**1.** The "Number of Launchers" column reflects the total number of deployed launchers France maintains. One of its four SSBNs is generally undergoing maintenance and thus unavailable for operational use. The data in this table is sourced from François Hollande, "Discours sur la dissuasion nucléaire–Déplacement auprès des forces aériennes stratégiques," speech, Istres, February 25, 2015; and Hans M. Kristensen and Matt Korda, "French Nuclear Forces, 2019," *The Bulletin of the Atomic Scientists* 75, no. 1, January 2019.

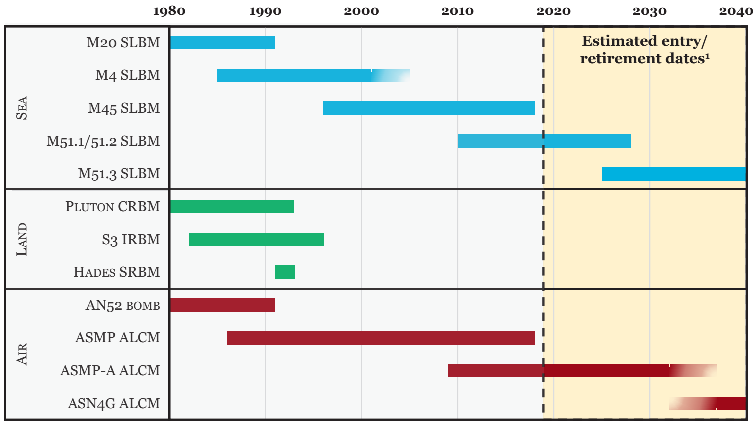
FIGURE 14: SNAPSHOT OF EXISTING AND FUTURE FRENCH NUCLEAR CAPABILITIES




Explanatory Notes:

1. The theoretical capacity of France's 48 SLBMs with six warheads each is 288 warheads. However, France has a total of 300 warheads, with 54 warheads going to the ASMP-A ALCMs, leaving France's SLBM force with approximately 240 SLBM-based warheads and the remaining six estimated to be in reserve.

## FIGURE 15: TIMELINE OF NUCLEAR-CAPABLE FRENCH DELIVERY SYSTEMS ACTIVE AFTER 1989




Explanatory Notes:

1. In the event of conflicting retirement or entry into service dates, CSBA prioritized U.S. government sources. Non-government sources include speeches by French government officials, the Bulletin of Atomic Scientists, SIPRI, and IHS Janes.
2. In the event that the retirement or entry into service dates for a particular system are not exact, CSBA used a color gradient to show the rough period of time where CSBA believes the system left or entered service, or will likely leave or enter service, assuming the program continues at its current pace and priority.

## Pakistan

Pakistan's nuclear forces are oriented entirely toward counterbalancing Indian strategic depth and conventional superiority. The arsenal is predominantly land-based, and most active missiles have a range at or below 1,250 km. The land and air legs are divided between the Army and Air Force respectively. Current production is focused on medium-range ballistic missiles to hold all Indian territory, including potential facilities at the Nicobar and Andaman Islands, at risk.[29] Pakistan started producing weapons grade uranium in 1983 and weapons grade plutonium in 1998. In contrast to most other declared nuclear powers, the majority of Pakistan's special nuclear material has already been manufactured into warheads. Only 33 percent of its special nuclear material is not in existing weapons.

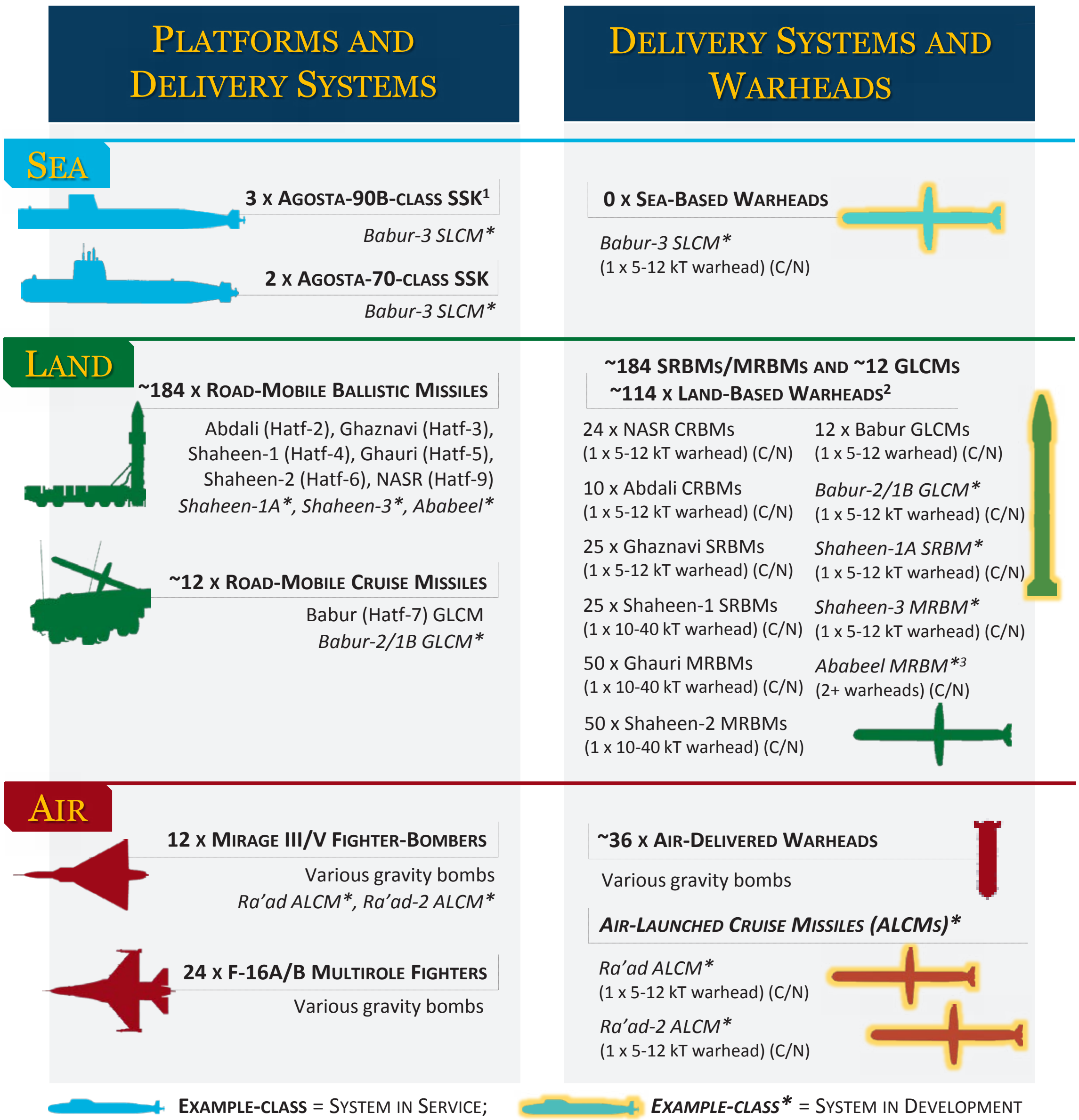
29 Hans M. Kristensen and Robert S. Norris, "Pakistani Nuclear Forces, 2018," *The Bulletin of the Atomic Scientists* 74, no. 5, August 2018.

### TABLE 7: PAKISTAN NUCLEAR FORCES

| Weapon Class | Number of Launchers | Number of Warheads |
|---|---|---|
| Intermediate/Medium-range ballistic missiles | 36 | 36 |
| Close- and Short-range ballistic missiles | 66 | 66 |
| Ground-launched cruise missiles[1] | 12 | 12 |
| Aircraft, Fighters | 36 | 36 |
| **Total stockpile** | | **15** |

1. Pakistan is also developing a sea-based cruise missile. If deployed, Pakistan would possess a triad of delivery systems. The data in this table is source from Hans M. Kristensen, Robert S. Norris, and Julia Diamond "Pakistani Nuclear Forces, 2018," *The Bulletin of the Atomic Scientists* 74, no. 5, August 2018.

### FIGURE 16: SNAPSHOT OF EXISTING AND FUTURE PAKISTANI NUCLEAR CAPABILITIES



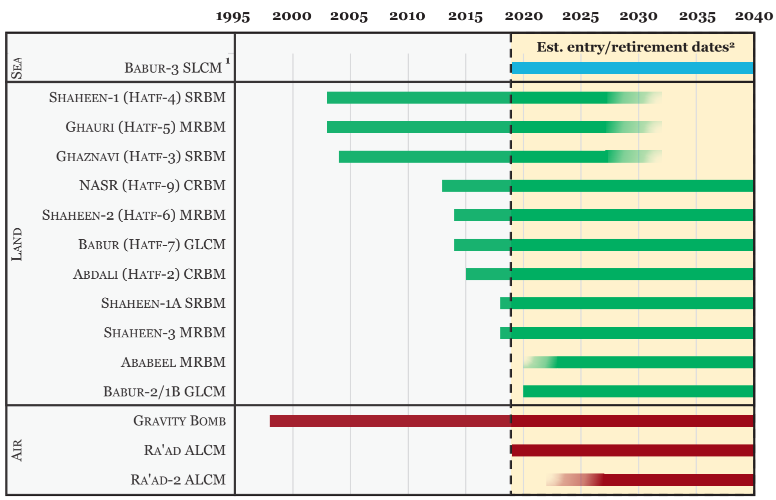
Explanatory Notes:

1. The U.S. government has not yet stated which platforms the Babur-3 SLCM will launch from. However, according to the BAS, they will likely be launched from either Pakistan's *Agosta*-70 or *Agosta*-90B SSKs, which are also believed to be the submarines the Babur-3 has been tested on.

2. The Bulletin of Atomic Scientists estimates that Pakistan has roughly 102 warheads on their land-based ballistic missiles and 12 on their ground-launched cruise missiles.

3. NASIC claims that the Ababeel MRBM will have a MIRV capability, but the exact number of warheads on the future Ababeel is unknown.

## FIGURE 17: TIMELINE OF PAKISTANI NUCLEAR-CAPABLE DELIVERY SYSTEMS




Explanatory Notes:

1. In the event of conflicting retirement or entry into service dates, CSBA prioritized U.S. government sources. Non-government sources include the Bulletin of Atomic Scientists, SIPRI, and IHS Janes.

2. In the event that the retirement or entry into service dates for a particular system are not exact, CSBA used a color gradient to show the rough period of time where CSBA believes the system left or entered service, or will likely leave or enter service, assuming the program continues at its current pace and priority.

3. While CSBA is unsure of the exact type of gravity bombs Pakistan possesses, Pakistan has had a general gravity bomb capability since at least 1998.

## India

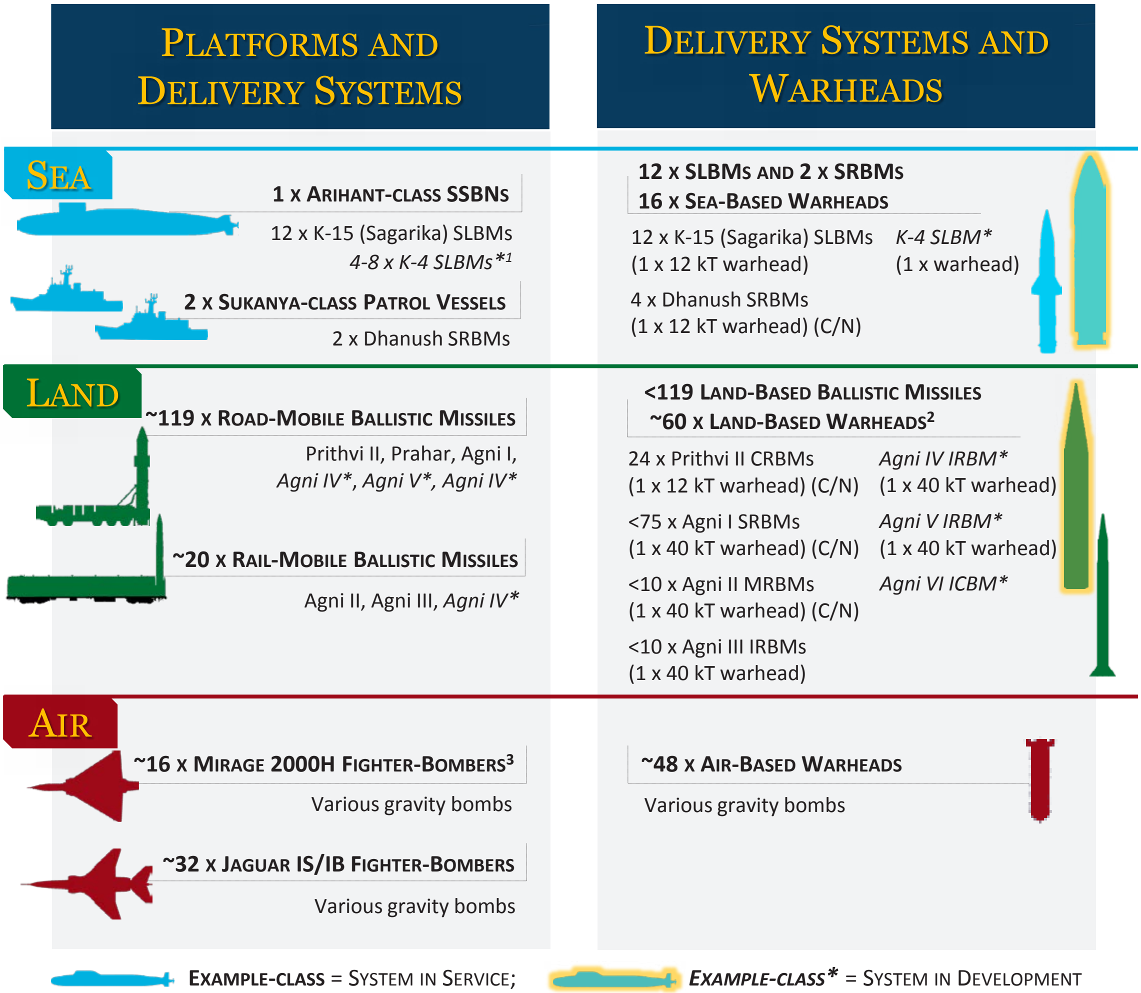
Although India's first nuclear test occurred in 1974, it wasn't until 1998 that it declared itself a nuclear weapon state. The majority of India's arsenal is land based and comprised of short- and medium-range ballistic missiles that are designed and postured to provide an assured retaliation capability in response to Pakistani nuclear use. India's ongoing modernization plans, however, seem intended to develop capabilities to deter and confront China. India is developing missiles—the Agni-IV and Agni-V—that can range major Chinese countervalue targets. Additionally, India is moving from nascent sea-based capabilities, in the form of a small numbers of sea-launched SRBMs and short-range SLBMs, toward a more mature sea-based leg of triad, although progress is slow. Finally, India started producing weapons grade uranium in 1992 and weapons grade plutonium in 1960. Ninety-four percent of its special nuclear material is not in existing weapons.

### TABLE 8: INDIA NUCLEAR FORCES

| Weapon Class | Number of Launchers | Number of Warheads |
|---|---|---|
| Intermediate/Medium-range ballistic missiles | 16 | 16 |
| Short-range ballistic missiles (land) | 44 | 44 |
| Short-range ballistic missiles (sea) | 4 | 4 |
| Submarine-launched ballistic missiles[1] | 12/4 | 12/4 |
| Aircraft, Fighters | 48 | 48 |
| **Awaiting assignment to launchers[2]** | | **6–16** |
| **Total stockpile** | | **130–140** |

**1.** India's existing submarine-launched weapon, the K-15, has a range of only 700 kilometers. This could target southern Pakistan but could not threaten China unless Indian submarines sailed far into the South China Sea. It is likely functioning as a development platform until a longer-range missile, the K-4, is deployed.
**2.** Indian SSBNs can carry twelve K-15 SLBMs or four K-4 SLBMs. According to the Bulletin of Atomic Scientists, additional warheads for use on K-4 SLBMs, Agni-III MRBMs, and future Agni-IV IRBMs may already exist but not be fieldable on their respective delivery systems yet. The data in this table is source from Hans M. Kristensen and Matt Korda, "Indian Nuclear Forces, 2018," *The Bulletin of the Atomic Scientists* 74, no. 6, November 2018.

**FIGURE 18: SNAPSHOT OF EXISTING AND FUTURE INDIAN NUCLEAR CAPABILITIES**



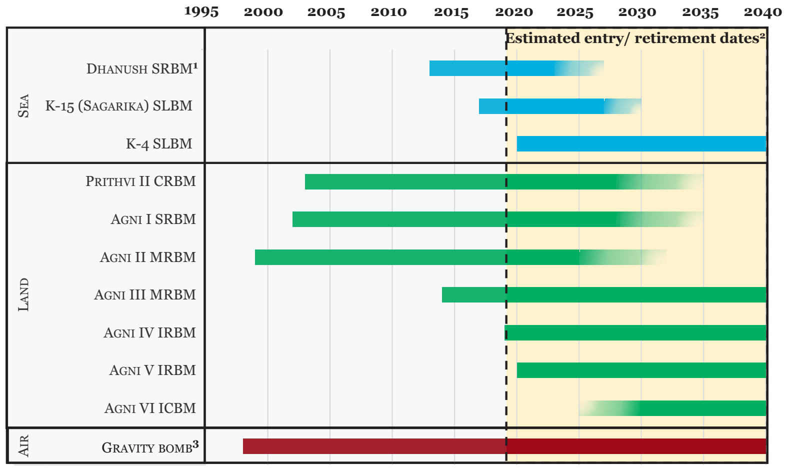

Explanatory Notes:

1. While the *Arihant* will only carry four K-4 SLBMs, the BAS 2018 Indian Nuclear Forces report states that the next two or three SSBNs in the *Arihant*-class will likely carry eight K-4 SLBMs.

2. Combining estimates from NASIC's 2017 Ballistic and Cruise Missile Threat report and the BAS, India has less than 119 land-based nuclear-capable launchers, and the BAS estimates that of those, roughly 60 have assigned nuclear warheads.

3. The exact number of Indian aircraft assigned a nuclear delivery mission is unknown, though the BAS estimates that three to four Indian Air Force squadrons are nuclear-capable. This snapshot asumes only three squadrons are nuclear-capable.

### FIGURE 19: TIMELINE OF NUCLEAR-CAPABLE INDIAN DELIVERY SYSTEMS




Explanatory Notes:

1. In the event of conflicting retirement or entry into service dates, CSBA prioritized U.S. government sources. Non-government sources include the Bulletin of Atomic Scientists, SIPRI, and IHS Janes.
2. In the event that the retirement or entry into service dates for a particular system are not exact, CSBA used a color gradient to show the rough period of time where CSBA believes the system left or entered service, or will likely leave or enter service, assuming the program continues at its current pace and priority.
3. While CSBA is uncertain as to the exact type(s) of gravity bombs India possesses, India has had a general gravity bomb capability since at least 1998.

## North Korea

North Korea's nuclear program is opaque, but seems to have three goals: first, deter any external attempt at regime change through the development of a credible deterrent; second, provide a more affordable defense capability than a large conventional military; third, serve as a source for economic assistance and foreign exchange either by offering "concessions" for foreign assistance or selling nuclear technology to rogue actors.[30]

In recent years, North Korea has demonstrated it can produce nuclear devices (six nuclear tests from October 2006–September 2017) and that it can produce ballistic missiles that can range the continental United States. It is unclear, however, if North Korea could use any of its missiles to deliver a nuclear weapon. To do so, North Korea would also have to possess guidance and control systems to ensure the missile arrives at the desired target, a reentry vehicle

30 John S. Park, "Nuclear Ambition and Tension on the Korean Peninsula," in Tellis, Denmark, and Tanner, *Asia in the Second Nuclear Age*.

so the warhead will survive the stresses of a long-range missile shot, and a warhead small enough to be carried by a missile and sturdy enough to survive the journey.[31]

The potential North Korean arsenal is entirely land-based, although it is developing a submarine-launched capability. It has a substantial number of SRBMs and MRBMs that could conceivably be paired with nuclear warheads, but it is unclear how many will ultimately fulfill that role. North Korea started producing weapons grade uranium in 1983 and weapons grade plutonium in 1998.

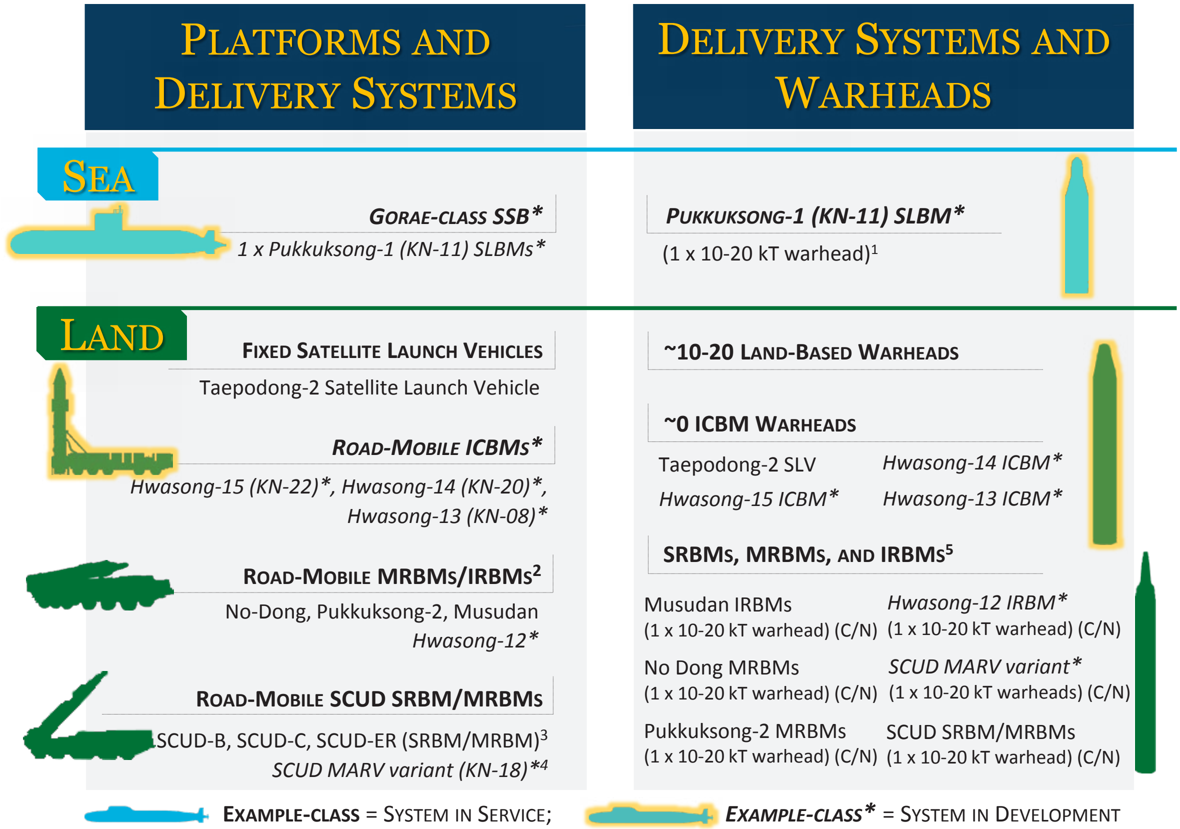
### TABLE 9: NORTH KOREA NUCLEAR FORCES

| Weapon Class | Number of Launchers | Number of Warheads[1] |
|---|---|---|
| Intercontinental ballistic missiles | Unknown | |
| Intermediate/Medium-range ballistic missiles | < 150 | 20 |
| Short-range ballistic missiles | < 100 | |

**1.** It is unknown if any of North Korea's warheads are deliverable by cruise or ballistic missiles. North Korea likely has the fissile material for up to 60 warheads, but most assessments assume North Korea only has 20. The data in this table is sourced from National Air and Space Intelligence Center (NASIC), *2017 Ballistic and Cruise Missile Threat Report* (Dayton, OH: U.S. Air Force, 2018).

31 Hans M. Kristensen and Robert S. Norris, "North Korean Nuclear Capabilities, 2018," *The Bulletin of the Atomic Scientists* 71, no. 1, January 2018.

## FIGURE 20: SNAPSHOT OF EXISTING AND FUTURE NORTH KOREAN NUCLEAR CAPABILITIES




Explanatory Notes:

1. The BAS assesses that North Korea has produced enough material for 30–60 warheads, but has probably only assembled 10–20 warheads with yields of approximately 10–20 kT. As such, CSBA assumes that all North Korean delivery systems, assuming they could be paired with warheads in the first place, would be paired with warheads of a roughly 10–20 kT yield.

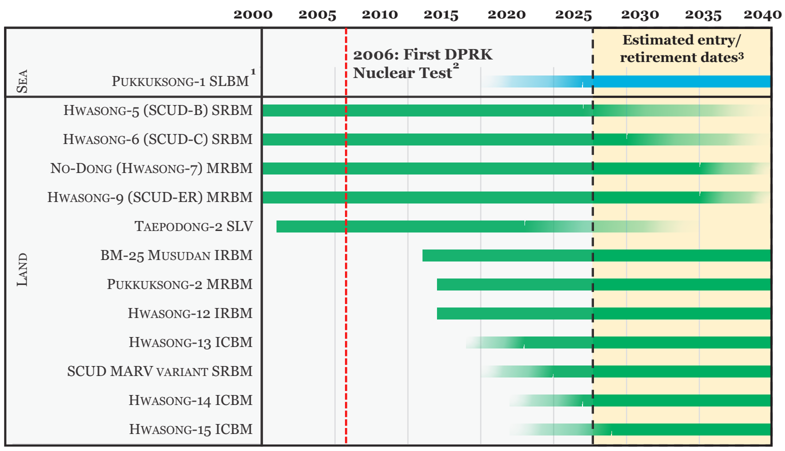
2. The SCUD-ER (SCUD Extended Range), with a maximum range of up to 1000 km, is occasionally classified as an MRBM. For this snapshot, CSBA grouped it with other SRBMs in the SCUD family.

3. According to NASIC's *2017 Ballistic and Cruise Missile Threat Report*, North Korea possesses approximately 150 road-mobile MRBMs and IRBMS and about 100 road-mobile SCUD launchers; however, it is unclear which missiles, if any, are nuclear-capable. As such, CSBA elected not to include estimated missile inventories or estimates on the number of warheads assigned to nuclear-capable missiles.

4. The DIA claims that North Korea is working on a modified SCUD SRBM with a maneuverable reentry vehicle (MaRV) capability, the KN-18.

5. The total of 250 SRBMs, MRBMs, and IRBMs only counts launchers. North Korea may have multiple missiles for different types of launchers, as well as spares or reloads.

### FIGURE 21: TIMELINE OF NUCLEAR-CAPABLE NORTH KOREAN DELIVERY SYSTEMS




Explanatory Notes:

1. In the event of conflicting retirement or entry into service dates, CSBA prioritized U.S. government sources. Non-U.S. government sources include the Bulletin of Atomic Scientists, 38North, Arms Control Wonk, and IHS Janes.

2. North Korea possessed nuclear-capable or nuclear-possible delivery systems before it possessed a confirmed nuclear capability after its first nuclear test in 2006.

3. In the event that the retirement or entry into service dates for a particular system are not exact, CSBA used a color gradient to show the rough period of time where CSBA believes the system left or entered service, or will likely leave or enter service, assuming the program continues at its current pace and priority.

## Summary

Almost thirty-years into the Second Nuclear Age, nuclear weapons are still critical components of national defense and global competition. All nuclear powers are developing modern arsenals, although only a few, such as Pakistan, India, and North Korea, are expanding. The differences between nuclear powers are diminishing. Additionally, the United States, the United Kingdom, and France have modest modernization programs compared to other nuclear powers, leading some analysts to fear that the intellectual and industrial capital to develop new weapons is atrophying.[32]

32 DoD, *National Security and Nuclear Weapons in the 21st Century* (Washington, DC: DoD, September 2008).

CHAPTER 4

# Key Asymmetries Among Nuclear Powers

This chapter highlights key asymmetries in national nuclear arsenals and describes how these asymmetries could affect competition, crisis escalation, and the likelihood of conflict, to include the possible use of nuclear weapons. Specifically, it focuses on three potential sources of instability: fear of a disarming first strike, leading to competition over arsenal size and survivability; vertical escalation and miscalculation in the context of crisis management, leading to concerns over warhead/weapon system discrimination and the role of nuclear weapons in warfighting doctrine; and horizontal escalation in nuclear competitions, to include new extended deterrent guarantees.[33]

## Arsenal Size and Nuclear Competition in the Second Nuclear Age

For a variety of reasons, including geography, political objectives, doctrine, technology, and alliance relationships, national nuclear programs do not look alike, particularly when it comes to the size of nuclear arsenals. Tables 10 and 11 summarize the launcher and warhead stockpiles of each nuclear power. Based on size alone, it suggests grouping nuclear powers into three tiers (major, middle, and minor). Absent significant decreases on the part of a major power, it would take extensive effort for a middle power to jump to the top tier. It would not, however, take as much effort to establish a noticeable quantitative advantage within the middle tier. Similarly, it would not take much for North Korea to develop an arsenal comparable in size to the lower end of the middle tier.

33 The dynamics in this chapter are therefore somewhat broader than those captured by the concept of strategic stability, which typically refers to the intensity of arms racing and looks at the incentives for nuclear use during a crisis. It also remains controversial and subject to differing interpretations. See, for example, the discussions in Elbridge A. Colby and Michael S. Gerson, eds., *Strategic Stability: Contending Interpretations* (Carlisle, PA: U.S. Army War College Press, 2013) and Lawrence Rubin and Adam N. Stulberg, eds., *The End of Strategic Stability* (Washington, DC: Georgetown University Press, 2018).

## TABLE 10: GLOBAL NUCLEAR-CAPABLE LAUNCHER INVENTORIES

| | Country | ICBMs | IRBMs/ MRBMs | SRBMs | GLCMs | Aircraft[1] | SLBMs (available tubes) |
|---|---|---|---|---|---|---|---|
| Major Powers | U.S. | 400 | | | | 60 | 240 |
| | Russia | 318 | | | | 68 | 160 |
| Middle Powers | China | 90 | 120 | | | 20 | 48[2] |
| | UK | | | | | | 48 |
| | France | | | | | 50 | 48 |
| | Pakistan | | 36 | 66 | 12 | 36 | |
| | India | | 24 | 48[3] | | 48 | 12 |
| Minor Power | DPRK | It is unclear how many of North Korea's potential launchers are functional and could be mated with a nuclear warhead[4] | | | | | |

This table includes all nuclear-capable launchers even if not deployed.
**1.** United States and Russian aircraft include only strategic bombers. Data for other countries includes all nuclear-capable aircraft.
**2.** While China has constructed two additional Jin-class SSBNs, which each hold 12 SLBM tubes, these SSBNs have not yet entered active service and thus are not considered part of the available launcher pool.
**3.** The number of India's SRBMs includes two Sukanya-class patrol vessels, each capable of launching two Dhanush SRBMs.
**4.** North Korea maintains a variety of missile programs. It is unclear which missiles are nuclear-capable. The data is sourced from the previously cited Nuclear Notebook articles published by the Bulletin of Atomic Scientists and SIPRI's 2017 Annual Yearbook.

## TABLE 11: GLOBAL WARHEAD STOCKPILES

| | Country | Total | ICBMs | IRBMs/ MRBMs | SRBMs | GLCMs | Air-launched[1] | SLBMs | NSNWs & Defensive weapons | Reserve |
|---|---|---|---|---|---|---|---|---|---|---|
| Major Powers | U.S. | **3800** | 800 | | | | 850 | 1920 | 230 (NSNW only) | 2050 |
| | Russia | **4490** | 1165 | | | | 786 | 720 | 1820 | 2890 |
| Middle Powers | China | **280+** | 110 | 96 | | | 20 | 48 | | 21+[2] |
| | UK | **225** | | | | | | 120 | | 105 |
| | France | **300** | | | | | 54 | 240 | | 6 |
| | Pakistan | **140-150** | | 36 | 66 | 12 | 36 | | | |
| | India | **130-140** | | 24 | 46[3] | | 48 | 12 | | |
| Minor Power | DPRK | **20[4]** | | | | | | | | |

This table includes all nuclear-capable launchers even if not deployed.
**1.** The "Air-launched" category includes air-launched cruise missiles, gravity bombs, and any potential air-launched ballistic missiles.
**2.** In the BAS 2018 report, 30 warheads are estimated to be split between the DF-26 and DF-41, but it is unclear how many are allocated to each missile. Nine have been allocated to China's new ICBMs, but the rest remain counted as reserve warheads. Additionally, it is unclear how many of the new missiles noted in OSD's 2019 annual report on Chinese military power are assigned nuclear warheads, which raises the possibility that China's true inventory is greater than 280.
**3.** The number of India's SRBMs includes four launched by the two Sukanya-class patrol vessels.
**4.** North Korea is believed to have enough special nuclear material for 30–60 warheads, but likely has fewer than 20 in inventory. The data is sourced from the previously cited Nuclear Notebook articles published by the Bulletin of Atomic Scientists, SIPRI's 2017 Annual Yearbook, and Hollande, "Discours sur la dissuasion nucléaire."

During the Cold War, the nuclear landscape was dominated by the United States and Soviet Union. As a result, assessing the nuclear balance was a matter of focusing on the U.S.-USSR bipolar competition. Given the increasingly multipolar nuclear competition that characterizes the current security environment, at least among middle and minor powers, the nuclear balance is becoming harder to measure. For instance, a nuclear competition between India and Pakistan or India and China could tip decisively against India if security cooperation between its two longtime rivals increased to the point that New Delhi faced a more serious two-front nuclear threat—one that would increase the number of warheads it faced in a regional contingency by over 190 percent.

There are also linkages between tiers that could affect decisions on the shape and size of a country's arsenal. Confronting a long-term competition with the United States and the potential of future tension with Russia, China could decide to expand the size of its strategic arsenal, either to close the existing gap under current New START limits or avoid an even bigger gap in a post-New START world. Such a decision would have second-order consequences for the India/Pakistan/China nuclear balance. It might, for instance, encourage India to move away from its minimal deterrent so that it does not fall further behind, which could in turn provide an added incentive for Pakistan to continue expanding its nuclear force structure.

In short, it is increasingly difficult to view the nuclear balance as the product of a bipolar competition. This could upend traditional notions of "how much is enough" and drive countries to alter strategies, postures, and capabilities for a range of potential adversaries.[34]

For any country to assure rough parity, say of strategic launchers, within a multipolar nuclear competition, it would need superiority over any single adversary to overcome potential alliances among other rival powers. Since any one state cannot be certain that another state will not threaten it, advances in offensive power in one state, such as the quest for nuclear superiority, could drive competing advances in another.[35] A potential security dilemma could manifest itself as the rapid development in both the size and lethality of nuclear arsenals, similar to the buildup of the U.S. and Soviet nuclear arsenals during the first few decades of the Cold War.[36]

This dilemma could come about in two ways. First, nuclear powers could simply expand their nuclear arsenals. Pakistan, India, and North Korea are all pursuing this path. Alternatively, nuclear powers could upload more warheads onto MIRVed missiles or load more air-delivered weapons on nuclear-capable aircraft. China appears to be pursuing both paths. The United States and Russia are currently constrained by arms control treaties so cannot legally expand

34 Matthew Kroenig, *Approaching Critical Mass: Asia's Multipolar Nuclear Future*, NBR Special Report #58 (Washington, DC: The National Bureau of Asian Research, June 2016).

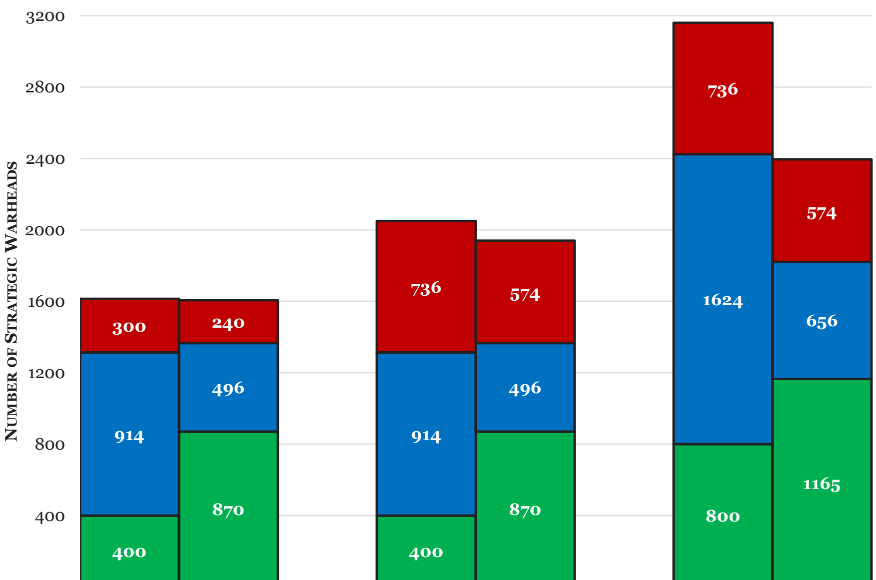
35 While the distinction between strategic and non-strategic launchers is generally only applied to the United States and Russia based on definitions in arms control treaties, in this particular case, CSBA assumes that strategic launchers refer to launchers not intended for battlefield use. Though theoretically appealing, security dilemmas have practical limitations. For instance, given the close alliance relationships between the United States, the United Kingdom, and France, advances by any one of those nations should not generate a sense of insecurity in the other two. In contrast, advances by Pakistan might threaten India. Indian nuclear development in reaction could also challenge China's sense of security.

36 Robert Jervis, "Cooperation Under the Security Dilemma," *World Politics* 30, no. 3; and Thomas G. Mahnken, Joseph Maiolo, and David Stevenson, eds., *Arms Races in International Politics from the Nineteenth to the Twenty-First Century* (Oxford: Oxford University Press, 2016).

their deployed arsenals—except by exploiting New START rules that count nuclear-capable aircraft as one warhead even if they can carry multiple weapons (although at some point this would require reductions to other types of deployed warheads to remain under the treaty limit). Alternatively, or in addition, they could deploy strategic delivery systems not covered by arms control treaties, such as hypersonic boost-glide weapons.

The following two figures show the upload capacity of both the United States and Russia assuming neither country produces additional weapons but deploys weapons in reserve status. The first column presents the current allocation of warheads for the United States and Russia. The second column assumes both countries remain compliant with New START but maximize the number of ALCMs deployed with their strategic bombers, taking advantage of the rules that count strategic bombers as one warhead and not the total number of warheads carried by the bomber. The final column builds on the second and assumes that the New START restrictions have lapsed, but neither country has produced or deployed additional launchers (essentially, this reflects the number of additional warheads that could be uploaded on MIRV-capable missiles). Finally, the figures assume that the right types of warheads are available in reserve stockpiles. Of note, with current inventories of launchers, the U.S. has a greater immediate upload capacity than Russia. As Russia deploys its newest generation of ICBMs with large warhead capacities, however, this may quickly change.

## FIGURE 22: UNITED STATES AND RUSSIAN UPLOAD CAPACITY, WITH AND WITHOUT NEW START CONSTRAINTS




| | US | Russia | US | Russia | US | Russia |
|---|---|---|---|---|---|---|
| | Current | | Compliant with Max ALCMs | | Upload Capacity | |
| Air | 300 | 240 | 736 | 574 | 736 | 574 |
| Sea | 914 | 496 | 914 | 496 | 1624 | 656 |
| Land | 400 | 870 | 400 | 870 | 800 | 1165 |

Explanatory Notes for United States Upload Capacity:

1. These calculations are attempts to predict the composition and loadouts of U.S. nuclear forces in the face of constantly changing numbers of deployed bombers and SSBNs and unclear loadouts of warheads on U.S. SLBMs. Estimates will not exactly match either U.S. New START data or the Bulletin of Atomic Scientists data used elsewhere.
2. Current:
   - The number of current U.S. air-delivered warheads is based on an estimate of 300 deployed air-delivered warheads by the Bulletin of Atomic Scientists.
   - The U.S. declared 203 deployed SLBMs under New START in February 2018 that carry an average of four and five warheads each (CSBA uses 4.5). This brings CSBA to approximately 914 SLBM-deployed warheads.
   - The U.S. declared 400 deployed ICBMs under New START in February 2018, and all current U.S. Minuteman III ICBMs deploy with only one warhead, though half possess a MIRV capability.
3. Compliant with Max Possible ALCMs
   - The U.S. declared 13 B-2 and 36 B-52 strategic bombers under New START in February 2018. With the B-2 possessing the capacity for 16 nuclear bombs and the B-52 possessing the capacity for 20 AGM-86B ALCMs, currently-deployed U.S. bombers could theoretically hold a maximum of 208 nuclear bombs and 720 nuclear ALCMs (928 warheads). However, this is limited by the U.S. stockpile of only 528 AGM-86B ALCMs.
   - The U.S. could deploy a maximum of 736 air-delivered warheads on its currently active bombers (436 more than it does today) without violating New START or deploying any additional strategic bombers.
4. Upload Capacity
   - According to the Bulletin of Atomic Scientists, roughly 200 of the 400 U.S. Minuteman III ICBMs have the capacity for three MIRV warheads. As such, currently-deployed U.S. ICBMs could theoretically hold 800 warheads.
   - The U.S. declared 203 deployed SLBMs under New START in February 2018, and each U.S. Trident II D-5 SLBM has the capacity for eight warheads. As such, currently-deployed U.S. SLBMs could theoretically hold 1,624 warheads.
   - This would represent an increase of 1,546 warheads over what CSBA estimates the United States currently deploys.

Explanatory Notes for Russian Upload Capacity:

1. These calculations are attempts to predict the composition and loadouts of Russian nuclear forces in the face of Russian opacity about its nuclear forces, constantly changing numbers of deployed bombers and SSBNs, and uncertainty about which ICBMs and SLBMs Russia downloaded to meet

its New START obligations. Estimates will not exactly match either Russian New START data or the Bulletin of Atomic Scientists data used elsewhere.

2. Current:

- Total Launcher and Warhead Estimates. Based on Russia's February 2018 declaration of 1,444 warheads under New START, the retirement of one Delta-III SSBN (30 fewer warheads and 16 fewer launchers), and the replacement of nine SS-25 ICBMs with nine SS-27 M2's (18-27 additional warheads), CBSA estimates that Russia deploys approximately 1,415 warheads (according to New START counting rules) on 511 launchers as of early 2019.

- Launcher Breakdown. BAS estimates that Russia deploys 318 ICBMs as of early 2019. Russia's sea-based leg of the triad is more difficult to estimate. Russia possesses a maximum of 160 SLBM launch tubes on its ten SSBNs, but some of these are in overhaul and not deployable. In order to total Russia's expected 511 launchers (with 318 ICBMs and roughly 50 strategic bombers), Russia must have about 143 SLBM tubes deployed. As 144 SLBM tubes would be equal to nine full deployed SSBNs, with one Delta IV SSBN in overhaul, CSBA assumes 144 SLBM tubes deployed. By process of elimination, this leaves 49 deployed Russian strategic bombers.

- ICBM-Deployed Warheads. Assuming that, as BAS suggests, Russia has downloaded its SS-18 M5 and SS-27 M2 ICBMs from ten and four warheads apiece to six and three, this leaves Russia with 870 deployed land-based warheads, close to their estimation of 860.

- SLBM-Deployed Warheads. With an expected 1,414 warheads, 870 deployed ICBM-based warheads, and 49 bombers (each counting as one warhead), then Russia possesses approximately 500 SLBM-based warheads. BAS suggests Russia has downloaded its SS-N-32 Bulava SLBMs from six warheads per missile to four, but that is still insufficient to reduce Russia's New START warhead count down to 1,414. This suggests that the SS-N-32's are loaded with only two to three warheads, or that some SS-N-23 M1 Sineva SLBMs (where the bulk of Russia's sea-based warheads reside) have been downloaded alongside the SS-N-32's. CSBA estimates that Russia has downloaded its SS-N-32 and SS-N-23 SLBMs to an operational loadout of approximately 3.5 (sometimes three warheads, sometimes four). This results in 496 SLBM-based warheads.

- Bomber-Deployed Warheads. Assuming Russia's land-based arsenal is approximately 870 warheads, its sea-based arsenal is approximately 496 warheads, and its total deployed arsenal is about 1,600 warheads as BAS suggests, the current number of deployed Russian air-delivered warheads is approximately 240.

3. Compliant with Max Possible ALCMs

- Since the breakdown of Russia's 68 deployable bombers into 49 deployed bombers is unknown among its three bomber types, the Tu-95 Bear-H6 (with a capacity of six ALCMs), Tu-95 Bear-H16 (16 ALCMs), and Tu-160 Blackjacks (12 ALCMs), CSBA assumes that a consistent ratio of each type is deployed, totaling 17 Bear-H6s, 22 Bear-H16s, and ten Blackjacks.

- As such, CSBA estimates Russia could deploy 574 air-delivered warheads (about 340 more than it does today) without violating New START or deploying any additional strategic bombers.

4. Upload Capacity

- If CSBA's assumptions about which Russian ICBMs have been downloaded hold (SS-18s from ten warheads to six and SS-27 M2s from four to three), then Russian ICBMs could carry up to 1,165 warheads.
- Assuming SS-N-32 and SS-N-23 SLBMs were downloaded from six and four to about 3.5 each, then Russian SLBMs could hold up to 656 warheads.
- This represents an increase of 789 warheads over what CSBA estimates Russia currently deploys.

## Seeking a Survivable Second-Strike Capability

National nuclear arsenals developed asymmetrically based on differing assessments of how to maximize arsenal survivability. For instance, the U.S. emphasis on submarine-launched weapons developed due to its strategic geography and long-running advantage in undersea warfare, and thus supported the perceived survivability of those platforms. In contrast, Russia and China have placed greater weight on land-based missiles, to include mobile missiles, due to their concern over ensuring control over their nuclear forces. Because these preferences, and the asymmetries they produce, are deep-seated, they tend to be enduring. The following series of charts depict the percentage of warheads by leg of triad and then by basing mode, suggesting differing perspectives on how to assure a retaliatory capability. A subsequent study in this series will explore the changing balance in key conventional military competitions that could affect the survivability of the different legs of the triad. To the extent one leg is becoming increasingly vulnerable, it could have a deleterious effect on crisis stability and thus nuclear deterrence overall.

## FIGURE 23: U.S. DEPLOYED AND NON-DEPLOYED STRATEGIC WEAPONS BY BASING TYPE


* Includes both deployed and non-deployed strategic warheads

## FIGURE 24: RUSSIAN DEPLOYED AND NON-DEPLOYED STRATEGIC WEAPONS BY BASING TYPE


*Includes both deployed and non-deployed strategic warheads

FIGURE 25: CHINESE DEPLOYED AND NON-DEPLOYED WEAPONS BY BASING TYPE


*An estimated 20 warheads exist for air delivery, but the composition of these warheads among gravity bombs and/or ALCMs is unknown.

## Vertical Escalation and Potential Miscalculation

With the return of great power competition and the increasing possibility of great power conflict, it is worth considering how asymmetries of arsenal composition, size, and design could affect escalation management in times of crisis and nuclear-use scenarios. Consider the following three cases.

### Case 1: Nuclear Weapons as a Warfighting Tool

In general, the United States enjoys conventional superiority over Russia, and India is conventionally superior to Pakistan.[37] In both cases, however, the conventionally inferior country has some advantages at the nuclear level. Both Russia and Pakistan appear to have designed, postured, and exercised their forces in ways that provide a comparative advantage, vis-à-vis their potential adversaries, in the ability to conduct limited nuclear strikes.[38]

37 While the U.S. may have conventional superiority in a global context, the conventional balance in Eastern Europe has shifted in Russia's favor. The role of nuclear weapons in modern Russian military doctrine, however, grew out of a period of conventional inferiority in the 1990s and early 2000s. For more on the conventional balance in Eastern Europe and potential means of countering Russian conventional advantages, see Billy Fabian, Mark Gunzinger, Jan van Tol, Jacob Cohn, and Gillian Evans, *Strengthening the Defense of NATO's Eastern Frontier* (Washington, DC: Center for Strategic and Budgetary Assessments, March 13, 2019).

38 "The Military Doctrine of the Russian Federation" (2010); "Military Doctrine of the Russian Federation" (2014); Sokov, "The Evolving Role of Nuclear Weapons in Russia's Security Policy"; Arbman and Thornton, *Russia's Tactical Nuclear Weapons Part I*; McDermott, "Reflections on Vostok 2010"; and Evan Braden Montgomery and Eric S. Edelman, "Rethinking Stability in South Asia: India, Pakistan, and the Competition for Escalation Dominance," *Journal of Strategic Studies* 38, no. 1–2, 2015.

Russia, for instance, has a substantially larger non-strategic nuclear arsenal than the United States. Russia has roughly 1,820 non-strategic warheads (or 41 percent of its stockpile of warheads) compared to only 230 non-strategic warheads (or 6 percent) in the U.S. stockpile.[39] Additionally, Russia has a greater variety and quantity of non-strategic weapons than the United States. For instance, Russia is planning on having roughly 14 non-strategic nuclear weapon systems active in the 2020s compared to the United States, which will have one type of non-strategic gravity bomb and potentially a low-yield SLBM and a new sea/submarine-launched cruise missile.

Consider a scenario where Russia uses nuclear threats to deter a NATO reaction to Russian aggression along NATO's eastern frontier. Inaction on NATO's part would undermine the integrity of the Alliance. Alternatively, consider a scenario where Russia is engaged in a conventional conflict with little hope of victory. In both cases, Russia might attempt to leverage its non-strategic superiority to achieve its objectives, either undermining NATO's integrity or salvaging victory in an actual conflict. NATO has a limited ability to respond in kind to the limited use of nuclear weapons. NATO could rely on its small inventory of non-strategic weapons deliverable by legacy fighters or B-2s. The concern here is that Russia's advanced integrated air defenses would prevent legacy fighters entering contested airspace, and, depending on how effectively Russia's air defenses are networked together, they may also substantially decrease the likelihood that a B-2 could successfully penetrate contested airspace and employ the only non-strategic weapon the United States has—the B-61 gravity bomb. Alternatively, NATO could threaten limited retaliation with a strategic weapon, but that may not be a credible response, due in part to the greater yield of such weapons.[40] In either scenario, the asymmetry in arsenal composition between Russia and NATO leaves Russia with a greater set of options in a nuclear crisis. It is precisely this problem that spurred the 2018 Nuclear Posture Review to recommend the development of new low-yield nuclear weapons.[41]

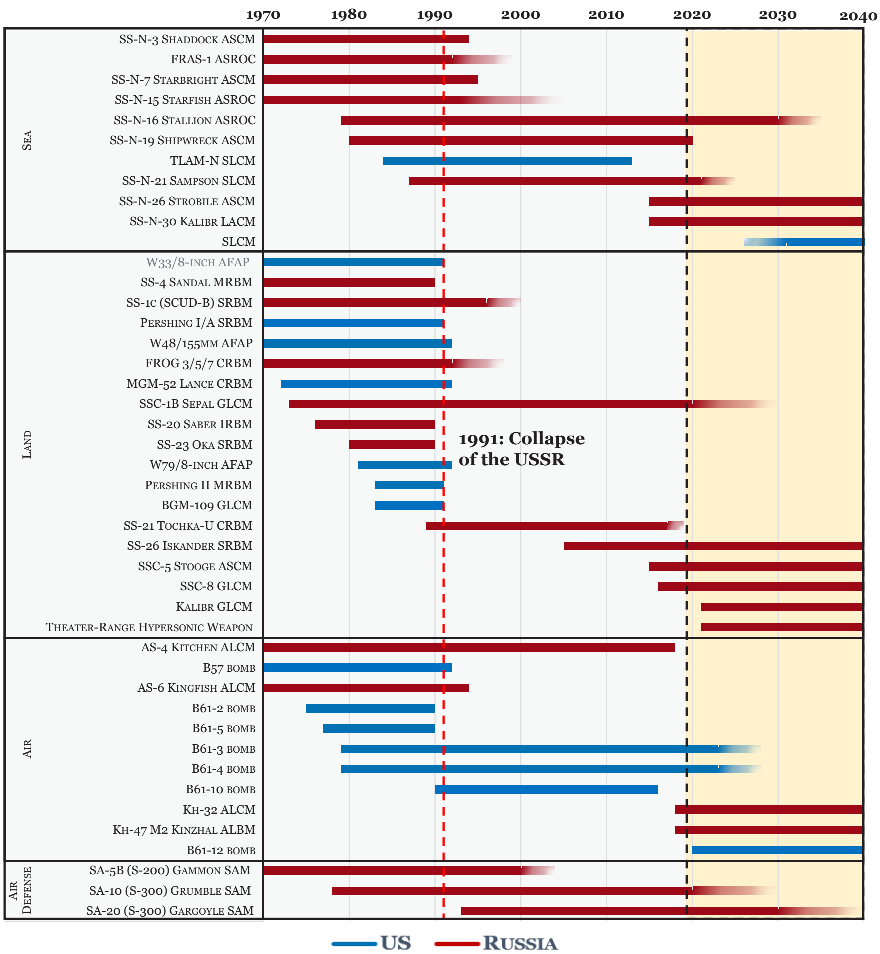
The following figure highlights the disparity in non-strategic nuclear weapons between the United States and Russia. Note that, while the United States and Russia had similar types of non-strategic weapons at the end of the Cold War, the United States has divested almost all of its non-strategic weapons since then, and Russia, in contrast, is recapitalizing them.

39 See Hans M. Kristensen and Robert S. Norris, "U.S. Nuclear Forces, 2018," *The Bulletin of the Atomic Scientists* 74, no. 2, March 2018; and Kristensen and Norris, "Russian Nuclear Forces, 2019."

40 For examples of how non-strategic weapons could play a role in future nuclear crises, see Andrew F. Krepinevich and Jacob Cohn, *Rethinking Armageddon: Scenario Planning in the Second Nuclear Age* (Washington, DC: Center for Strategic and Budgetary Assessments, 2016); and Thomas G. Mahnken, "Fighting a Nuclear War in the 21st Century: Future Scenarios of Limited Nuclear Conflict," in Jeffrey A. Larsen and Kerry M. Kartchner, eds., *On Limited Nuclear Warfare in the 21st Century* (Palo Alto, CA: Stanford University Press, 2014).

41 OSD, *Nuclear Posture Review 2018*.

## FIGURE 26: NON-STRATEGIC DELIVERY SYSTEMS ACTIVE AFTER 1989




## Case 2: Arsenal Size and Targeting Options

Some countries are limited to countervalue strikes against potential adversaries simply as a function of the size of their arsenals. For example, the United Kingdom and France do not have a sufficient inventory of nuclear weapons to attempt counterforce strikes against Russia. Given Russia's arsenal size, there would always be warheads left over for a retaliatory strike. In contrast, powers of comparable size, such as India and Pakistan or the United States and Russia, could consider counterforce targeting if their weapons were sufficiently accurate.[42] Put another way, countries within the same "tier" or countries from a "superior tier" could conceivably implement a counterforce targeting policy, but countries from an "inferior tier" could not implement counterforce targeting against a larger nuclear power. For example, given the asymmetry in arsenal sizes, France must rely on a counter-value strategy to deter Russia, while China must rely on a counter-value strategy to deter the United States.

42 For more on the potential of counterforce targeting see Keir A. Lieber and Daryl G. Press, "The New Era of Counterforce," *International Security* 41, no. 4, Spring 2017.

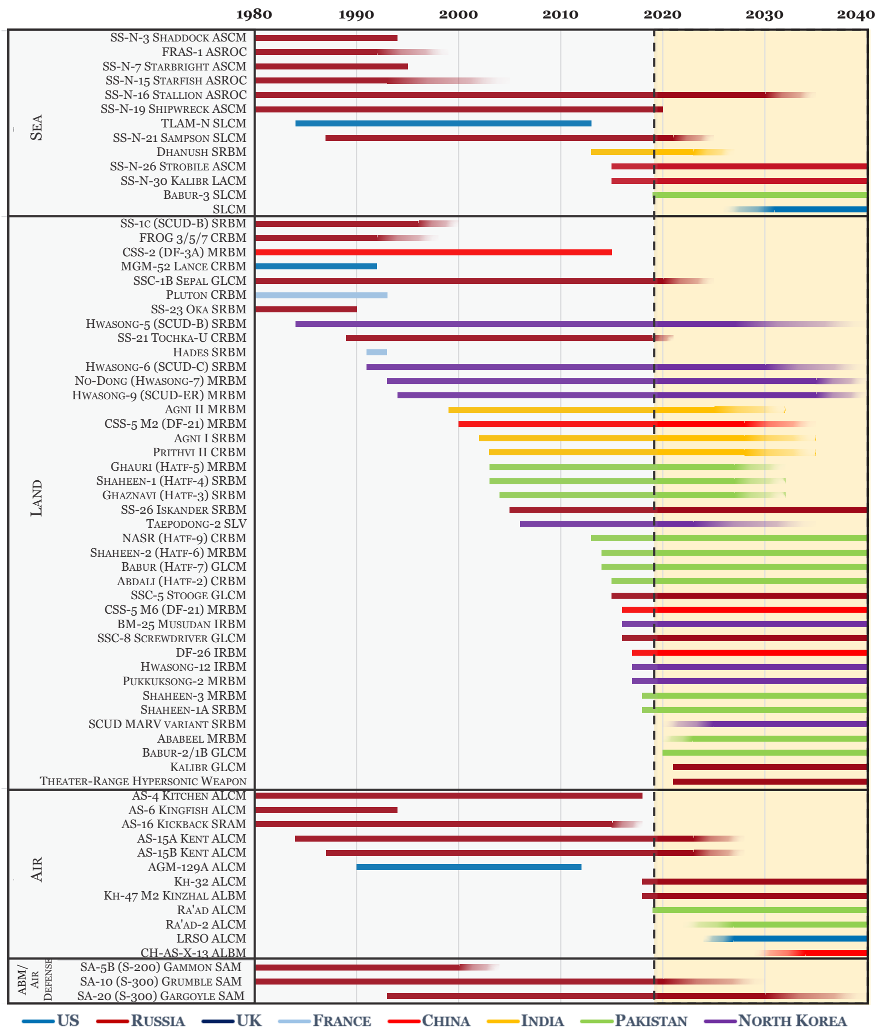
As middle-tier countries expand their arsenals and the distinctions between the tiers blend, however, it could incentivize nuclear growth by both the major and middle nuclear powers. Middle powers might be incentivized to expand their arsenals to increase their targeting and doctrinal flexibility, while major powers might expand their arsenals to maintain the distinction between tiers and limit the options available to smaller powers. Asymmetries in arsenal size will foreclose or open certain options to a country in times of crisis.

### Case 3: Nuclear/Conventional Ambiguity

China, in particular, has been consistently ambiguous about how much of its missile force is dual-capable as well as the level of geographic integration between nuclear and conventional systems. It is likely that at least some PLA Rocket Force bases support both nuclear and conventional units.[43] This ambiguity presents China with two advantages. First, it increases the difficulty of disarming China's comparatively small arsenal by increasing the number of targets an adversary would have to strike to be confident it eliminated all of China's weapons. Some strikes would end up targeting conventional systems, but since the split between nuclear and conventional systems is unclear, both would have to be targeted. Second, it may deter an adversary from acting for fear of how China might react if strikes ostensibly aimed at conventional forces took out nuclear capabilities. This asymmetry of arsenal design enhances the deterrent value of China's arsenal beyond that normally associated with an arsenal of its size. Similar ambiguous postures by other countries, such as North Korea and Pakistan, also have an enhanced deterrent effect. The following figure highlights the extent to which each nuclear power employs dual-capable systems.

43 Lora Saalman, "China: Lines Blur between Nuclear and Conventional Warfighting," *The Interpreter,* December 19, 2014.

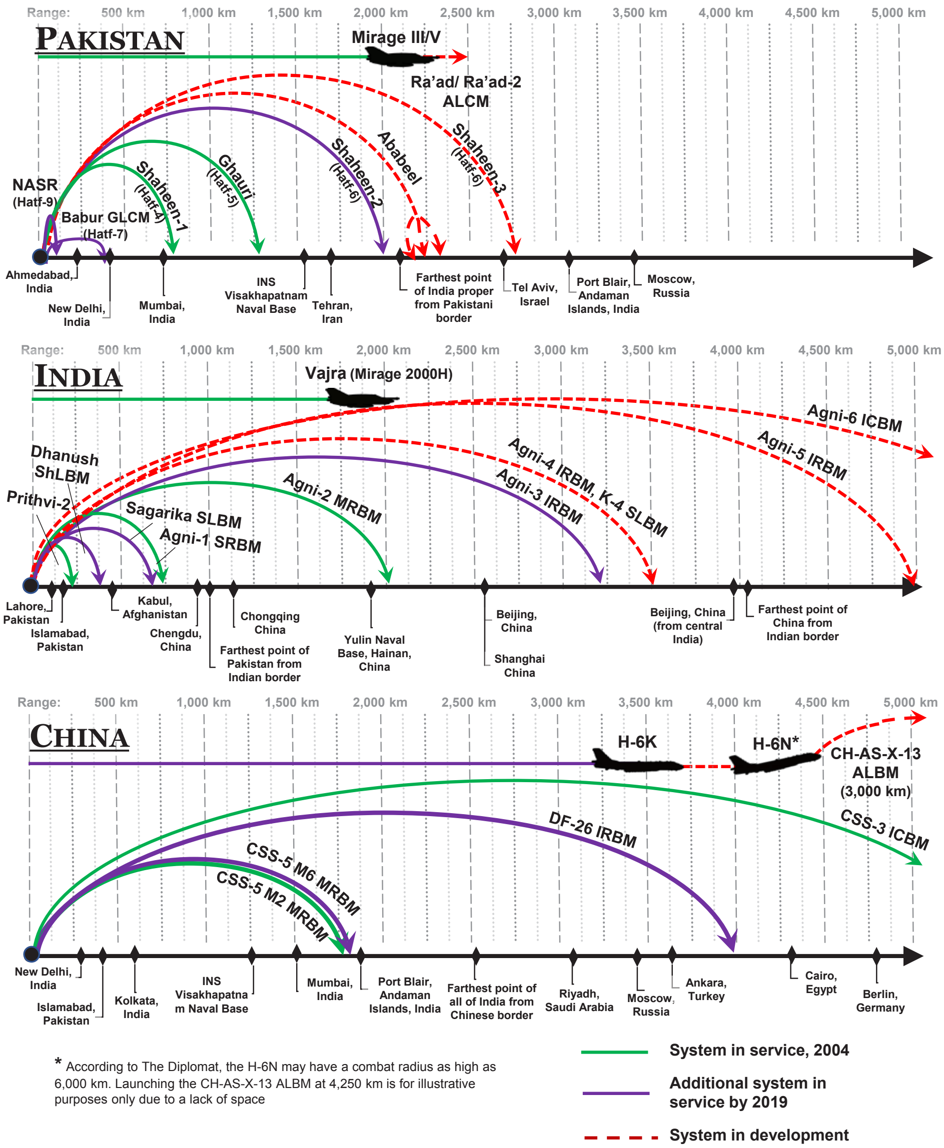
FIGURE 27: DUAL-CAPABLE SYSTEMS ACTIVE AFTER 1989




## Horizontal Escalation and New Extended Deterrent Guarantees

Multipolar nuclear competitions may introduce new sources of instability into strategic competition through two pathways: further proliferation and the extension of extended deterrent guarantees by new providers. Depending on the progress of North Korea's nuclear program, the potential development of an Iranian nuclear weapon, and the credibility and reliability of a U.S. security guarantee, other East Asian or Middle Eastern countries may either develop their own independent nuclear force or seek an alternative extended deterrent guarantor.[44] Figure 28 visualizes how increases in the range covered by nuclear-capable ballistic missiles could enable other countries to provide plausible extended deterrent guarantees.

## FIGURE 28: RANGE ENABLES EXTENDED DETERRENT GUARANTEES

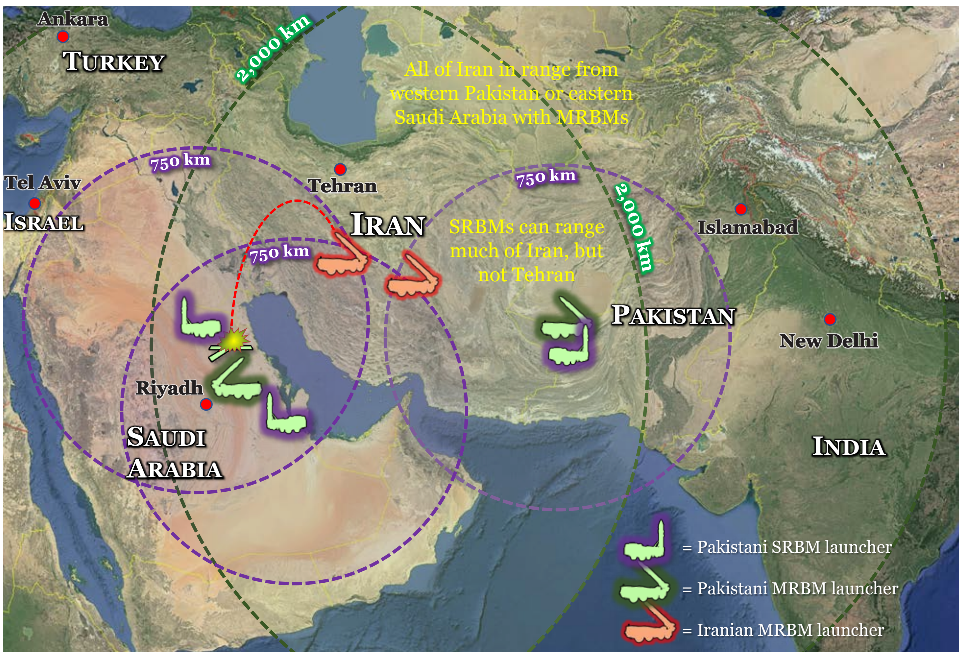



For space considerations, not all nuclear-capable systems by China, India, and Pakistan are shown in this graphic. Ranges in this graphic are approximate and are measured as the nearest distance between a nation's borders and major cities or potential military targets. For aircraft, ranges are measured in combat radius. The heights of missile arcs in this graphic are not indicative of the actual altitudes of these missiles' flight paths.

44 The potential of further proliferation, or nuclear "cascade," as a consequence of an Iranian nuclear program has been discussed in depth elsewhere. See, e.g., Andrew F. Krepinevich, *Critical Mass: Nuclear Proliferation in the Middle East* (Washington, DC: Center for Strategic and Budgetary Assessments, 2013). For a similar discussion regarding a cascade in East Asia, see Montgomery, *Extended Deterrence in the Second Nuclear Age.*

The possible end of the U.S. near-monopoly on extended deterrence is an underappreciated implication of the Second Nuclear Age.[45] Assuming that the agreement constraining Iran's nuclear program collapses, Iran develops a nuclear weapon, and American partners are not reassured by the explicit or implicit guarantees the United States is willing to offer, partners such as Saudi Arabia might seek alternative guarantors.[46] For instance, Saudi Arabia has been rumored to believe it has "the semblance of a nuclear umbrella provided by Pakistan."[47] While it could be stabilizing in some contexts, the expansion of extended deterrent guarantors could also create linkages and potential spillover effects between conflicts in different regions. If Pakistan provided extended deterrence to Saudi Arabia by placing Pakistani weapons and soldiers in Saudi Arabia, similar to NATO's nuclear sharing, those weapons and that region could be drawn into a conflict between India and Pakistan. Consider the reverse: Pakistan could get drawn into a conflict in the Middle East, which might also have spillover effects on the relationship between India and Pakistan. Regardless of the specific example, the existence of new extended deterrence guarantors increases the risk that nuclear crises might spillover into additional regions and draw other nations into the crisis.

## FIGURE 29: VISUALIZING A PAKISTANI EXTENDED DETERRENT GUARANTEE HOSTED EITHER IN SAUDI ARABIA OR BASED IN PAKISTAN




45 While Russia has implied extended deterrent commitments, they are not as widespread or formalized as those of the United States. See "The Military Doctrine of the Russian Federation," Office of the President of the Russian Federation, June 26, 2015.

46 For more on this prospect see Evan Braden Montgomery, "Sources of Instability in the Second Nuclear Age: An American Perspective," in Lawrence Rubin and Adam N. Stulberg, eds., *The End of Strategic Stability* (Washington, DC: Georgetown University Press, 2018).

47 Yaroslav Trofimov, "Saudi Arabia Considers Nuclear Weapons to Offset Iran," *Wall Street Journal*, May 7, 2015.

## Key Implications

As the United States prepares for an era of great power competition, there are three key implications from the assessment of trends and asymmetries that should underpin further study of the Second Nuclear Age: all nuclear powers are modernizing and several are expanding the size and capability of their nuclear arsenal; multipolar nuclear competitions pose new challenge to strategic stability and require nations to base their policies, doctrine, and force structure on multiple adversaries and potentially shifting coalitions; and, finally, nuclear warfighting is regaining prominence in the warfighting doctrines of several nations, often those that are conventionally weaker than potential adversaries.

CHAPTER 5

# Conclusion

The United States is entering a dynamic period when it comes to the existing and emerging nuclear balance. After a period of continuously declining U.S. and Russian arsenals, as well as deferred modernization on the U.S. side, the future of bilateral great power arms control looks bleak, as both sides are now replacing their legacy nuclear forces. China, long known for having a minimal deterrent posture and having a "lean and effective force," is engaging in a modest expansion of its force structure as well as investing in notable qualitative improvements such as the development of MIRV-capable missiles, road-mobile systems, and a potential strategic bomber. Regional rivals like India and especially Pakistan are improving their arsenals, and North Korea no longer has just a few bombs in the basement, but dozens of weapons—and potentially the ability to deliver them at intercontinental ranges.

At this inflection point, the time is right to reassess the shifting nuclear balance, especially among the major powers. The first step in that effort is a clear understanding of what capabilities states have, what capabilities they intend to procure, and the key asymmetries in national nuclear force structures.

With that baseline in place, future studies in this series will explore the strategic interactions between nuclear powers who have very different strategies, doctrines, and strategic cultures; the potential ramifications of the end of long-standing arms control agreements; and the possible effects of emerging technologies on the survivability of current and planned nuclear arsenals, which goes to the very heart of strategic stability as it is commonly understood.

# APPENDIX A

## Methodology and Sources

In its attempt to document the changes in the global nuclear balance since the end of the Cold War, CSBA has compiled open source data on all confirmed and potentially nuclear-capable platforms, delivery systems, and warheads that have existed from 1990 onward, as well as all nuclear-capable systems currently in development. This data covers all the declared nuclear weapons states.

There is substantial uncertainty in the open source world regarding nuclear weapons programs. To sift through and categorize the available information, CSBA used the following methodology.

Whenever possible, CSBA used U.S. government sources for official data and prioritized it over other sources of information. Such key U.S. government sources include the 2018 Nuclear Posture Review, regular New START verification data, annual Department of Defense (DoD) or Defense Intelligence Agency (DIA) reports and fact sheets, National Nuclear Security Administration (NNSA) stockpile management reports, and National Air and Space Intelligence Center (NASIC) Ballistic and Cruise Missile Threat reports. Key non-government sources of information include the Bulletin of the Atomic Scientists' (BAS) regular Nuclear Notebook reports on national nuclear arsenals, as well as the Stockholm International Peace Research Institute (SIPRI) and IHS Janes. Other sources of information include the UK Parliament, foreign government speeches and publications, CSIS Missile Threat, Arms Control Wonk, International Institute for Strategic Studies (IISS), U.S. journal articles, and U.S. and foreign news reports. All information on special nuclear materials is from the International Panel on Fissile Materials (IPFM). A full list of CSBA's sources may be made available upon request.

There were invariably differences between sources. When there were discrepancies, CSBA weighted government sources higher than all other sources. If there were disagreements between government sources, CSBA weighted the more recent source higher. If government sources did not discuss an issue, CSBA considered non-governmental sources as outlined above.

## LIST OF ACRONYMS

| | |
|---|---|
| **ABM** | anti-ballistic missile |
| **AFAP** | artillery-fired atomic projectile |
| **ALBM** | air-launched ballistic missile |
| **ALCM** | air-launched cruise missile |
| **AOA** | Analysis of Alternatives |
| **ASCM** | anti-ship cruise missile |
| **ASROC** | anti-submarine rocket |
| **BAS** | Bulletin of Atomic Scientists |
| **BMD** | ballistic missile defense |
| **CRBM** | close-range ballistic missile |
| **DIA** | Defense Intelligence Agency |
| **DoD** | Department of Defense |
| **GBSD** | Ground-Based Strategic Deterrent |
| **GLCM** | ground-launched cruise missile |
| **HEU** | highly enriched uranium |
| **HGV** | hypersonic glide vehicle |
| **ICBM** | intercontinental ballistic missile |
| **INF** | Intermediate Nuclear Forces Treaty |
| **IRBM** | intermediate-range ballistic missile |
| **LACM** | land-attack cruise missile |
| **LRSO** | Long-Range Standoff Missile |
| **MaRV** | maneuverable reentry vehicle |
| **MIRV** | multiple independently targeted reentry vehicle |
| **MRBM** | medium-range ballistic missile |
| **NASIC** | National Air and Space Intelligence Center |
| **NATO** | North Atlantic Treaty Organization |
| **New START** | New Strategic Arms Reduction Treaty |
| **NNSA** | National Nuclear Security Administration |
| **NPR** | 2018 Nuclear Posture Review |
| **NSNW** | non-strategic nuclear weapons |
| **PLAAF** | People's Liberation Army Air Force |
| **PLARF** | People's Liberation Army Rocket Force |
| **SALT** | Strategic Arms Limitation Treaty |
| **SAM** | surface-to-air missile |
| **SAP** | State Armaments Program |
| **SCUD-ER** | SCUD Extended Range |
| **SIPRI** | Stockholm International Peace Research Institute |
| **SLBM** | submarine-launched ballistic missile |
| **SLCM** | sea-launched cruise missile |

| | |
|---|---|
| **SLV** | satellite launch vehicle |
| **SNM** | special nuclear material |
| **SRBM** | short-range ballistic missile |
| **SSB** | ballistic missile submarine |
| **SSBN** | nuclear-powered ballistic missile submarine |
| **SSGN** | nuclear-powered guided-missile submarine |
| **SSK** | diesel-electric submarine |
| **SSN** | nuclear-powered attack submarine |
| **STRATCOM** | U.S. Strategic Command |

CSBA
Center for Strategic and Budgetary Assessments

1667 K Street, NW, Suite 900
Washington, DC 20006
Tel. 202.331.7990 • Fax 202.331.8019
www.csbaonline.org