U.S. Military Power

An Assessment of U.S. Military Power

Because America is a global power with global interests, its military is tasked first and foremost with defending the country from attack. Beyond that, it must be capable of protecting Americans abroad, America's allies, and the freedom to use international sea, air, space, and cyberspace while retaining the ability to engage in more than one major contingency at a time. America must be able not only to defend itself and its interests, but also to deter enemies and opportunists from taking action that would challenge U.S. interests, a capability that includes both preventing the destabilization of a region and guarding against threats to the peace and security of America's friends.

As noted in all preceding editions of the *Index*, however, the U.S. does not have the necessary force to meet a two–major regional contingency (two-MRC) requirement and is not ready to carry out its duties effectively. Consequently, as we have seen during the past few years, the U.S. finds itself increasingly challenged by major competitors such as China and Russia and the destabilizing effects of terrorist and insurgent elements operating in regions that are of substantial interest to the U.S.

For 2020, the extent to which SARS-CoV-2, the virus that causes the COVID-19 disease, will affect the broad, complex fabric of security issues—not only those of direct interest to the U.S., but also those that involve the societal, economic, political, and military pillars of allies, partners, and competitors—cannot be known. For the U.S. military, the COVID-19 pandemic has created challenges for recruiting and basic training, for standard individual and small unit training, and for large exercises, especially those that had been planned with allies and partners in 2020.[1]

Requirements to observe distancing (maintaining separation between individuals) have been the most direct factor affecting daily activities; instances of large-scale infection as occurred aboard the aircraft carrier USS *Theodore Roosevelt*, although rare, have captured the public's attention.[2] Of the roughly two million soldiers, sailors, airmen, and Marines serving in the Active and Reserve components, slightly more than 8,000 had contracted COVID-19 as of June 15, 2020, and slightly more than 4,800 were listed as recovered.[3] Aware of the need to maintain necessary levels of readiness, the services have balanced measures to protect the force with activities that are essential to keeping it trained and ready for action.

The service-specific sections that follow will address the impact that the COVID-19 pandemic has had on the respective services during 2020. Suffice it to say that, so far and in general, the public health crisis plaguing much of the world has not had a profound impact on the U.S. military.

How to Think About Sizing Military Power

For all of these reasons, military power consists of many things and is the result of how all of its constituent pieces are brought together to create an effective warfighting force. But it begins with the people and equipment used to conduct war: the weapons, tanks, ships, airplanes, and supporting tools such as communications systems that make it possible either for one group to impose its will on another or

to prevent such an outcome from happening, which is the point of deterrence.

However, simply counting the number of people, tanks, or combat aircraft that the U.S. possesses would be insufficient because it would lack context. For example, the U.S. Army might have 100 tanks, but to accomplish a specific military task, 1,000 or more might be needed or none at all. It might be that the terrain on which a battle is fought is especially ill-suited to tanks or that the tanks one has are inferior to the enemy's. The enemy could be quite adept at using tanks, or his tank operations might be integrated into a larger employment concept that leverages the supporting fires of infantry and airpower, whereas one's own tanks are poorly maintained, the crews are not well-prepared, or one's doctrine is irrelevant.

Success in war is partly a function of matching the tools of warfare to a specific task and employing those tools effectively in battle. Get these wrong—tools, objective, competence, or context—and you lose.

Another key element is the military's capacity to conduct operations: how many of the right tools—people, tanks, planes, or ships—it has. One might have the right tools and know how to use them effectively but not have enough to win. Because one cannot know with certainty beforehand just when, where, against whom, and for what reason a battle might be fought, determining how much capability is needed is an exercise that requires informed but not certain judgment.

Further, two different combatants can use the same set of tools in radically different ways to quite different effects. The concept of employment matters. Concepts are developed to account for numbers, capabilities, material readiness, and all sorts of other factors that enable or constrain one's actions, such as whether one fights alone or alongside allies, on familiar or strange terrain, or with a large, well-equipped force or a small, poorly equipped force. A thinking adversary will analyze his opponent for weaknesses or patterns of behavior and seek to develop techniques, approaches, and tools that exploit such shortfalls or predictable patterns—the asymmetries of war. One need not try to match an enemy tank for tank, and in many cases, not trying is more effective.

All of these factors and a multitude of others affect the outcome of any military contest. Military planners attempt to account for them when devising requirements, developing training and exercise plans, formulating war plans, and providing advice to the President in his role as Commander in Chief of U.S. military forces.

Measuring hard combat power in terms of its capability, capacity, and readiness to defend U.S. vital interests is difficult, especially in such a limited space as this *Index*, but it is not impossible. However difficult determining the adequacy of one's military forces may be, the Secretary of Defense and the military services have to make such decisions every year when the annual defense budget request is submitted to Congress.

The adequacy of hard power is affected most directly by the resources the nation is willing to apply. Although that decision is informed to a significant degree by an appreciation of threats to U.S. interests and the ability of a given defense portfolio to protect U.S. interests against such threats, it is not informed solely by such considerations; hence the importance of clarity and honesty in determining just what is needed in terms of hard power and the status of such power from year to year.

Administrations take various approaches in determining the type and amount of military power needed and, by extension, the amount of money and other resources that will be necessary to support that power. After defining the national interests to be protected, the Department of Defense (DOD) can use worst-case scenarios to determine the maximum challenges the U.S. military might have to overcome. Another way is to redefine what constitutes a threat. By taking a different view of whether major actors pose a meaningful threat and of the extent to which friends and allies have the ability to assist the U.S. in

meeting security objectives, one can arrive at different conclusions about the necessary level of military strength.

For example, one Administration might view China as a rising belligerent power bent on dominating the Asia–Pacific region. Another Administration might view China as an inherently peaceful rising economic power and the expansion of its military capabilities a natural occurrence commensurate with its strengthening status. The difference between these views can have a dramatic impact on how one thinks about U.S. defense requirements. So, too, can policymakers amplify or downplay risk to justify defense budget decisions.

There also can be strongly differing views on requirements for operational capacity.

- Does the country need enough for two major combat operations (MCOs) at roughly the same time or just enough for a single major operation and some number of lesser cases?

- To what extent should "presence" tasks—the use of forces for routine engagement with partner countries or simply to be on hand in a region for crisis response—be in addition to or a subset of a military force sized to handle two major regional conflicts?

- How much value should be assigned to advanced technologies as they are incorporated into the force?

- What is the likelihood of war and, if one thinks it unlikely, what is the risk one is willing to accept that sufficient warning will allow for rearming?

Where to Start

There are two major references that one can use to help sort through the variables and arrive at a starting point for assessing the adequacy of today's military posture: government studies and historical experience. The government occasionally conducts formal reviews that are meant to inform decisions on capabilities and capacities across the Joint Force relative to the threat environment (current and projected) and evolutions in operating conditions, the advancement of technologies, and aspects of U.S. interests that may call for one type of military response over another.

The 1993 Bottom-Up Review (BUR) conducted by then-Secretary of Defense Les Aspin has been one such frequently cited example. Secretary Aspin recognized that "the dramatic changes that [had] occurred in the world as a result of the end of the Cold War and the dissolution of the Soviet Union" had "fundamentally altered America's security needs" and were driving an imperative "to reassess all of our defense concepts, plans, and programs from the ground up."[4]

The BUR formally established the requirement that U.S. forces should be able "to achieve decisive victory in two nearly simultaneous major regional conflicts and to conduct combat operations characterized by rapid response and a high probability of success, while minimizing the risk of significant American casualties."[5] Thus was formalized the two-MRC standard.

Since that study, the government has undertaken others as Administrations, national conditions, and world events have changed the context of national security. Quadrennial Defense Reviews (QDRs) were conducted in 1997, 2010, and 2014, accompanied by independent National Defense Panel (NDP) reports that reviewed and commented on them. Both sets of documents purported to serve as key assessments, but analysts came to minimize their value, regarding them as justifications for executive branch policy preferences (the QDR reports) or overly broad generalized commentaries (the NDP reports) that lack substantive discussion about threats to U.S. interests, a credible strategy for dealing with them, and the actual ability of the U.S. military to meet national security requirements.

The QDR was replaced by the National Defense Strategy (NDS), released in 2018, and the independent perspectives of the formal DOD

review by the National Defense Strategy Commission, which released its view of the NDS in November 2018. Departing from their predecessors, neither document proposed specific force structures or end strength goals for the services,[6] but both were very clear in arguing the need to be able to address more than one major security challenge at a time. The commission's report went so far as to criticize the NDS for not making a stronger case for a larger military that would be capable of meeting the challenges posed by four named competitors—China, Russia, Iran, and North Korea—while also possessing the capacity to address lesser, though still important, military tasks that included presence, crisis response, and assistance missions.

Correlation of Forces as a Factor in Force Sizing

During the Cold War, the U.S. used the Soviet threat as its primary reference in determining its hard-power needs. At that time, the correlation of forces—a comparison of one force against another to determine strengths and weaknesses—was highly symmetrical. U.S. planners compared tanks, aircraft, and ships against their direct counterparts in the opposing force. These comparative assessments drove the sizing, characteristics, and capabilities of fleets, armies, and air forces.

The evolution of guided, precision munitions and the rapid technological advancements in surveillance and targeting systems since the late 1980s, however, have made comparing combat power more difficult. What was largely a platform-versus-platform model has shifted somewhat to a munitions-versus-target model.

The proliferation of precise weaponry means increasingly that each round, bomb, rocket, missile, and even (in some instances) individual bullet can hit its intended target, thus decreasing the number of munitions needed to prosecute an operation. It also means that the lethality of an operating environment increases significantly for the people and platforms involved. We have now reached the point at which, instead of focusing primarily on how many ships or airplanes the enemy can bring to bear against one's own force, one must consider how many "smart munitions" the enemy has when thinking about how many platforms and people are needed to win a combat engagement.[7]

In one sense, increased precision and the technological advances now being incorporated into U.S. weapons, platforms, and operating concepts make it possible to do far more than ever before with fewer assets.

- Platform signature reduction (stealth) makes it harder for the enemy to find and target them, and the increased precision of weapons makes it possible for fewer platforms to hit many more targets.

- The ability of the U.S. Joint Force to harness computers, modern telecommunications, space-based platforms—such as for surveillance, communications, and positioning-navigation-timing (PNT) support from GPS satellites—and networked operations potentially means that in certain situations, smaller forces can have far greater effect in battle than at any other time in history (although these same advances also enable enemy forces).

- Certain military functions—such as seizing, holding, and occupying territory—may require a certain number of soldiers no matter how state-of-the-art their equipment may be. For example, securing an urban area where line of sight is constrained and precision weapons have limited utility requires the same number of squads of infantry as were needed in World War II.

Regardless of the improved capability of smaller forces, there is a downside to fewer numbers. With smaller forces, each individual element of the force represents a greater percentage of its combat power. Each casualty or equipment loss therefore takes a larger toll

on the ability of the force to sustain high-tempo, high-intensity combat operations over time, especially if the force is dispersed across a wide theater or across multiple theaters of operation.

As advanced technology has become more affordable, it has become more accessible for nearly any actor, whether state or non-state. Consequently, it may well be that the outcomes of future wars will depend far more on the skill of the forces and their capacity to sustain operations over time than they will on some great disparity in technology. If so, readiness and capacity will take on greater importance than absolute advances in capability.

All of this illustrates the difficulties of and need for exercising judgment in assessing the adequacy of America's military power. Yet without such an assessment, all that remains are the defense strategy reviews, which are subject to filtering and manipulation to suit policy interests; annual budget submissions, which typically favor desired military programs at presumed levels of affordability and are therefore necessarily budget-constrained; and leadership posture statements, which often simply align with executive branch policy priorities.

The U.S. Joint Force and the Art of War

This section of the *Index* assesses the adequacy of America's defense posture as it pertains to a conventional understanding of "hard power," defined as the ability of American military forces to engage and defeat an enemy's forces in battle at a scale commensurate with the vital national interests of the U.S. While some hard truths in military affairs are appropriately addressed by mathematics and science, others are not. Speed, range, probability of detection, and radar cross-section are examples of quantifiable characteristics that can be measured. Specific future instances in which U.S. military power will be needed, the competence of the enemy, the political will to sustain operations in the face of mounting deaths and destruction, and the absolute amount of strength needed to win are matters of judgment and experience, but they nevertheless affect how large and capable a force one might need.

In conducting the assessment, we accounted for both quantitative and qualitative aspects of military forces, informed by an experience-based understanding of military operations and the expertise of external reviewers. The authors of these military sections bring a combined total of more than a hundred years of uniformed military experience to their analysis.

Military effectiveness is as much an art as it is a science. Specific military capabilities represented in weapons, platforms, and military units can be used individually to some effect. Practitioners of war, however, have learned that combining the tools of war in various ways and orchestrating their tactical employment in series or simultaneously can dramatically amplify the effectiveness of the force that is committed to battle.

Employment concepts are exceedingly hard to measure in any quantitative way, but their value as critical contributors in the conduct of war is undeniable. How they are used is very much an art-of-war matter that is learned through experience over time.

What Is Not Being Assessed

In assessing the current status of the military forces, this *Index* uses the primary measures used by the military services themselves when they discuss their ability to employ hard combat power.

- The Army's unit of measure is the brigade combat team (BCT);
- The Marine Corps structures itself by battalions;
- For the Navy, it is the number of ships in its combat fleet; and
- The most consistent measure for the Air Force is total number of aircraft, sometimes broken down into the two primary subtypes of fighters and bombers.

Obviously, this is not the totality of service capabilities, and it certainly is not everything needed for war, but these measures can be viewed as surrogates that subsume or represent the vast number of other things that make these units of measure possible and effective in battle. For example, combat forces depend on a vast logistics system that supplies everything from food and water to fuel, ammunition, and repair parts. Military operations require engineer support, and the force needs medical, dental, and administrative capabilities. The military also fields units that transport combat power and its sustainment wherever they may be needed around the world.

The point is that the military spear has a great deal of shaft that makes it possible for the tip to locate, close with, and destroy its target, and there is a rough proportionality between shaft and tip. Thus, in assessing the basic units of measure for combat power, one can get a sense of what is probably needed in the combat support, combat service support, and supporting establishment echelons.

The scope of this *Index* does not extend to analysis of everything that makes hard power possible; it focuses on the status of the hard power itself. It also does not assess the services' Reserve and National Guard components, although they account for roughly one-third of the U.S. military force and have been essential to the conduct of operations since September 2001.[8] Consistent assessment of their capability, readiness, and operational role is a challenge because each service determines the balance among its Active, Reserve, and National Guard elements differently (only the Army and Air Force have Guard elements; the Navy and Marine Corps do not). This balance can change from year to year and is based on factors that include cost of the respective elements, availability for operational employment, time needed to respond to an emergent crisis, allocation of roles among the elements, and political considerations.[9]

As with other elements essential to the effective employment of combat power—logistics, medical support, strategic lift, training, etc.—the U.S. military could not handle a major conflict without the Reserve and Guard forces. Nevertheless, to make the challenge of annually assessing the status of U.S. military strength using consistent metrics over time more manageable, this *Index* looks at something that is usually associated with the Active component of each service: the baseline requirement for a given amount of combat power that is readily available for use in a major combat operation. There are exceptions, however. For example, in this edition of the *Index*, four Army National Guard BCTs are counted as "available" for use because of the significant amounts of additional resources that have been dedicated specifically to these formations to raise their readiness levels.[10]

The *Index* also does not assess the U.S. Space Force, the newest of the military services within the Department of Defense and governed by Title 10 of the U.S. Code, although a section describing the origin, configuration, and functions of the service is included.[11] The Space Force describes itself as having been "established on December 20, 2019 with enactment of the Fiscal Year 2020 National Defense Authorization Act."[12] There are no viable metrics at this point by which to measure the service's capacity, capability, or readiness, and it is not yet clear how one would assess the Space Force's role in measuring "hard combat power," which is the focus of this publication.

The Defense Budget and Strategic Guidance

When it comes to the defense budget, how much we spend does not automatically determine the U.S. military's posture or capacity. As a matter of fact, simply looking at how much is allocated to defense does not tell us much about the capacity, modernity, or readiness of the forces. Proper funding is a necessary condition for a capable, modern, and ready force, but it is not sufficient by itself. It is possible that a larger defense budget could be associated with less military capability if the money were allocated inappropriately or spent wastefully. Nevertheless, the budget does

reflect the importance assigned to defending the nation and its interests in prioritizing federal spending.

Absent a significant threat to the country's survival, the U.S. government will always balance spending on defense against spending in all of the other areas of government activity that are deemed necessary or desirable. Ideally, defense requirements are determined by identifying national interests that might need to be protected with military power; assessing the nature of threats to those interests, what would be needed to defeat those threats, and the costs associated with that capability; and then determining what the country can afford or is willing to spend. *Any difference between assessed requirements and affordable levels of spending on defense would constitute a risk to U.S. security interests.*

This *Index* enthusiastically adopts this approach: interests, threats, requirements, resulting force, and associated budget. Spending less than the amount needed to maintain a two-MRC force results in policy debates about where to accept risk: force modernization, the capacity to conduct large-scale or multiple simultaneous operations, or force readiness.

The National Defense Strategy released in January 2018 by the Department of Defense is the DOD's current effort to establish the connection among interests, threats, requirements, and resources.[13] It serves to orient how the DOD intends to prepare the country's defense and establishes a public baseline of mission and associated requirements against which the country can measure its defense efforts. When discussing resources, the strategy calls for an increased, sustained, and predictable budget as the necessary precondition for its execution—something that proved elusive during the budgetary climate of two-year deals designed to circumvent the Budget Control Act of 2011 (BCA)[14] and now potentially affected by federal spending to offset the economic damage wrought by the COVID-19 pandemic.

The decision to fund national defense commensurate with interests and prevailing threats reflects our national priorities and risk tolerance. This *Index* assesses the ability of the nation's military forces to protect vital national security interests within the world *as it is* so that the debate about the level of funding for hard power is better informed.

The fiscal year (FY) 2020 base discretionary budget for the Department of Defense was $633.3 billion.[15] This represents the resources allocated to pay for the forces (manpower, equipment, and training); enabling capabilities (things like transportation, satellites, defense intelligence, and research and development); and institutional support (bases and stations, facilities, recruiting, and the like). The base budget does not pay for the cost of major ongoing overseas operations, which is captured in supplemental funding known as OCO (overseas contingency operations).

The debate about how much funding should be allocated to defense has been framed by the current Administration's 2016 campaign promise to rebuild the military,[16] an objective that is generally supported by Congress. Despite repeated emphasis on the importance of investing more to fix obvious readiness, capacity, and modernization problems, the debate has been determined by larger political dynamics that pitted those who want to see an overall reduction in federal spending against those who advocate higher levels of defense spending and those who want to see any increase in defense spending matched by commensurate increases in domestic spending.

The passage of the Bipartisan Budget Act of 2019 on August 2, 2019, altered the final two years of the BCA caps.[17] It set the cap for FY 2020 at $666.5 billion with $71.5 billion in OCO for a total of $738 billion. For FY 2021, the cap is at $671.5 billion with $69 billion in OCO for a total of $740.5 billion. These two years will bring an end to the BCA and the budgetary politics of the past 10 years, which largely failed to achieve its objective of decreasing the national debt.[18]

These changes in the BCA caps allowed the DOD to have more resources than it would under the full weight of the Budget Control Act. This in turn enabled the military services to

advance some of their priorities and achieve the improvements in readiness that these pages have shown in the past few years. However, to meet the challenges outlined in the National Defense Strategy, the Department will require more resources. Its senior leaders have expressed this need since before the strategy was released in January 2018.

Testifying before the House Armed Services Committee in 2017, both then-Secretary of Defense James N. Mattis and then-Chairman of the Joint Chiefs of Staff General Joseph Dunford emphasized the need for sustained budget growth so that U.S. forces can maintain a competitive advantage over likely adversaries. Mattis said that "he expects to ask for base budget growth 'along the lines of close to 5 percent growth, 3 to 5 percent growth for 2019 to '23," and Dunford stated that "[w]e know now that continued growth in the base budget of at least 3 percent *above inflation* is the floor necessary to preserve just the competitive advantage we have today, and we can't assume our adversaries will remain still."[19] The bipartisan commission that assessed the National Defense Strategy also assessed the need to have budgetary growth of between 3 percent and 5 percent above inflation.[20] Current Secretary of Defense Mark Esper also has stressed the need for annual budget growth of 3 percent to 5 percent to implement the National Defense Strategy.[21]

Chart 5 illustrates the growth that DOD senior leaders, validated by the NDS commission, have expressed as necessary compared to the trajectory of the defense budget as constrained by the BCA and its renegotiations. Over the past five fiscal years, from FY 2017 to FY 2021, the gap has ranged between $30 billion in the lower end of the projection and $100 billion at the higher end. These gaps illustrate the increased level of risk at which the U.S. military is currently operating.

The federal government's response to the coronavirus pandemic could influence how the defense budget is discussed and appropriated in future fiscal years. As part of the federal government's response, it approved $2 trillion of new emergency spending for FY 2020, which will lead to multitrillion-dollar deficits.[22] The increased debt load will likely demand adjustments in how the federal government allocates taxpayers' dollars, although how this will occur and the extent to which it will affect specific accounts is not yet known.

Purpose as a Driver in Force Sizing

The Joint Force is used for a wide range of purposes, only one of which is major combat operations. Fortunately, such events have been relatively rare, averaging approximately 15 years between occurrences.[23] In between (and even during) such occurrences, the military is used to support regional engagement, crisis response, strategic deterrence, and humanitarian assistance, as well as to support civil authorities and U.S. diplomacy.

All of the U.S. Unified Geographic Combatant Commands, or COCOMS—Northern Command (NORTHCOM); European Command (EUCOM); Central Command (CENTCOM); Indo-Pacific Command (INDOPACOM); Southern Command (SOUTHCOM); and Africa Command (AFRICOM)—have annual and long-term plans through which they engage with countries in their assigned regions. Engagements range from very small unit training events with the forces of a single partner country to larger bilateral and sometimes multilateral military exercises. Such events help to foster working relationships with other countries, acquire a more detailed understanding of regional political–military dynamics and on-the-ground conditions in areas of interest, and signal U.S. security interests to friends and competitors.

To support such COCOM efforts, the services provide forces that are based permanently in their respective regions or that operate in them temporarily on a rotational basis. To make these regional rotations possible, the services must maintain base forces that are large enough to train, deploy, support, receive back, and again make ready a stream of units that ideally is enough to meet validated COCOM demand.

The ratio between time spent at home and time spent away on deployment for any given unit is known as OPTEMPO (operational tempo), and each service attempts to maintain a ratio that both gives units enough time to educate, train, and prepare their forces and allows the individuals in a unit to maintain some semblance of a healthy home and family life. This ensures that units are fully prepared for the next deployment cycle and that servicemembers do not become "burned out" or suffer adverse consequences in their personal lives because of excessive deployment time.

Experience has shown that a ratio of at least 3:1 (three periods of time at home for every period deployed) is sustainable. If a unit is to be out for six months, for example, it will be home for 18 months before deploying again. Obviously, a service needs enough people, units, ships, and planes to support such a ratio. If peacetime engagement were the primary focus for the Joint Force, the services could size their forces to support these forward-based and forward-deployed demands.

Thus, the size of the total force must necessarily be much larger than any sampling of its use at any point in time.

In contrast, sizing a force for major combat operations is an exercise informed by history—how much force was needed in previous wars—and then shaped and refined by analysis of current threats, a range of plausible scenarios, and expectations about what the U.S. can do given training, equipment, employment concept, and other factors. The defense establishment must then balance "force sizing" between COCOM requirements for presence and engagement and the amount of military power (typically measured in terms of combat units and major combat platforms, which inform total end strength) that is thought necessary to win in likely war scenarios.

Inevitably, compromises are made that account for how much military the country is willing to buy. Generally speaking:

- **The Army** sizes to major warfighting requirements;
- **The Marine Corps** focuses on crisis response demands and the ability to contribute to one major war;
- **The Air Force** attempts to strike a balance that accounts for historically based demand across the spectrum because air assets are shifted fairly easily from one theater of operations to another ("easily" being a relative term when compared to the challenge of shifting large land forces), and any peacetime engagement typically requires some level of air support; and
- **The Navy** is driven by global presence requirements. To meet COCOM requirements for a continuous fleet presence at sea, the Navy must have three to four ships in order to have one on station. A commander who wants one U.S. warship stationed off the coast of a hostile country, for example, needs the use of four ships from the fleet: one on station, one that left station and is traveling home, one that just left home and is traveling to station, and one that is otherwise unavailable because of major maintenance or modernization work.

This *Index* focuses on the forces required to win two major wars as the baseline force-sizing metric for the Army, Navy, and Air Force and the one-war-plus-crisis-response paradigm for the Marine Corps. The three large services are sized for global action in more than one theater at a time; the Marines, by virtue of overall size and most recently by direction of the Commandant, focus on one major conflict while ensuring that all Fleet Marine Forces are globally deployable for short-notice, smaller-scale actions.[24] The military's effectiveness, both as a deterrent against opportunistic competitor states and as a valued training partner in the eyes of other countries, derives from its effectiveness (proven or presumed) in winning wars.

Our Approach

With this in mind, we assessed the state of America's military forces as it pertains to their

ability to deliver hard power against an enemy in three areas:

- Capability,
- Capacity, and
- Readiness.

Capability. Examining the capability of a military force requires consideration of:

- The proper tools (material and conceptual) with the design, performance characteristics, technological advancement, and suitability that the force needs to perform its function against an enemy successfully;
- The sufficiency of armored vehicles, ships, airplanes, and other equipment and weapons to win against the enemy;
- The appropriate variety of options to preclude strategic vulnerabilities in the force and give flexibilities to battlefield commanders; and
- The degree to which elements of the force reinforce each other in covering potential vulnerabilities, maximizing strengths, and gaining greater effectiveness through synergies that are not possible in narrowly stovepiped, linear approaches to war.

The capability of the U.S. Joint Force was on ample display in its decisive conventional war victory over Iraq in liberating Kuwait in 1991 and later in the conventional military operation in Iraq to depose Saddam Hussein in 2003. Aspects of its capability have also been seen in numerous other operations undertaken since the end of the Cold War. While the conventional combat aspect of power projection has been more moderate in places like Yugoslavia, Somalia, Bosnia and Serbia, and Kosovo, and even against the Taliban in Afghanistan in 2001, the fact that the U.S. military was able to conduct highly complex operations thousands of miles away in austere, hostile environments and sustain those operations as long as required is testament to the ability of U.S. forces to do things that the armed forces of few if any other countries can do.

A modern "major combat operation"[25] along the lines of those upon which Pentagon planners base their requirements would feature a major opponent possessing modern integrated air defenses; naval power (surface and undersea); advanced combat aircraft (to include bombers); a substantial inventory of short-range, medium-range, and long-range missiles; current-generation ground forces (tanks, armored vehicles, artillery, rockets, and anti-armor weaponry); cruise missiles; and (in some cases) nuclear weapons. Such a situation involving an actor capable of threatening vital national interests would present a challenge that is comprehensively different from the challenges that the U.S. Joint Force has faced in past decades.

Since 2018, the military community has focused on its suitability and readiness for major conventional warfare, given its focus on counterinsurgency, stability, and advise-and-assist operations since 2004 and the NDS directive to prepare for conflict in an era of great-power competition.[26] The Army in particular has noted the need to reengage in training and exercises that feature larger-scale combined arms maneuver operations, especially to ensure that its higher headquarters elements are up to the task.

This *Index* ascertains the relevance and health of military service capabilities by looking at such factors as average age of equipment, generation of equipment relative to the current state of competitor efforts as reported by the services, and the status of replacement programs that are meant to introduce more updated systems as older equipment reaches the end of its programmed service life. While some of the information is quite quantitative, other factors could be considered judgment calls made by acknowledged experts in the relevant areas of interest or as addressed by senior service officials when providing testimony

to Congress or examining specific areas in other official statements.

It must be determined whether the services possess capabilities that are relevant to the modern combat environment.

Capacity. The U.S. military must have a sufficient quantity of the right capability or capabilities. When speaking of platforms such as planes and ships, there is a troubling and fairly consistent trend that characterizes the path from requirement to fielded capability within U.S. military acquisition. Along the way to acquiring the capability, several linked things happen that result in far less of a presumed "critical capability" than supposedly was required.

- The military articulates a requirement that the manufacturing sector attempts to satisfy.
- "Unexpected" technological hurdles arise that take longer and much more money to solve than anyone envisioned.
- Programs are lengthened, and cost overruns are addressed, usually with more money.
- Then the realization sets in that the country either cannot afford or is unwilling to pay the cost of acquiring the total number of platforms originally advocated. The acquisition goal is adjusted downward, if not canceled altogether, and the military finally fields fewer platforms at a higher cost per unit than it originally said it needed to be successful in combat.

As deliberations proceed toward a decision on whether to reduce planned procurement, they rarely focus on and quantify the increase in risk that accompanies the decrease in procurement.

Something similar happens with force structure size: the number of units and total number of personnel the services say they need to meet the objectives established by the Commander in Chief and the Secretary of Defense in their strategic guidance.

- The Marine Corps has stated that it needs 27 infantry battalions to fully satisfy the validated requirements of the regional Combatant Commanders, yet it currently fields only 24 and has stated that it plans to drop further to 21 in order to make resources available for experimentation and modernization.[27]
- In 2012, the Army was building toward 48 brigade combat teams, but incremental budget cuts reduced that number over time to 31—less than two-thirds the number that the Army originally thought was necessary.
- The Navy has produced various assessments of fleet size since the end of the Cold War, from 313 ships to 355 ships, and in 2019 initiated yet another force structure review.

Older equipment can be updated with new components to keep it relevant, and commanders can employ fewer units more expertly for longer periods of time in an operational theater to accomplish an objective. At some point, however, sheer numbers of updated, modern equipment and trained, fully manned units are going to be needed to win in battle against a credible opponent when the crisis is profound enough to threaten a vital interest.

Capacity (numbers) can be viewed in at least three ways: compared to a stated objective for each category by each service, compared to amounts required to complete various types of operations across a wide range of potential missions as measured against a potential adversary, and as measured against a set benchmark for total national capability. This *Index* employs the two-MRC metric as a benchmark for most of the force.

The two-MRC benchmark for force sizing is the *minimum* standard for U.S. hard-power capacity because one will never be able to

TABLE 3

Historical U.S. Force Allocation

Troop figures are in thousands.

	Korean War	Vietnam War	Persian Gulf War	Operation Iraqi Freedom
ARMY				
Total Troop Deployment During Engagement	206.3	219.3	267.0	99.7
Divisions*	6	7	4	1
Reserve Component Divisions Total for Strategic Documents	n/a	n/a	n/a	n/a
Total Army End Strength During Engagement, During Year of Strategy Document Active	1,313.8	1,113.3	738.0	499.0
Total Active End Strength Recommendations	n/a	n/a	n/a	n/a
NAVY				
Total Fleet During Engagement	904	770	529	297
Aircraft Carriers	6	5	6	5
Carrier Air Wings	6	5	6	5
Large Surface Combatants	37	14	30	23
Small Surface Combatants	16	47	16	9
Attack Submarines	4	0	12	12
Amphibious Vessels	34	26	21	7
Combat Logistics and Support Ships	28	29	45	42
Fighter/Attack Squadrons	21	43	22	24
MARINE CORPS				
Total Troop Deployment During Engagement	33.5	44.7	90.0	66.2
Active Divisions*	1	2	2	1
Reserve Divisions	n/a	n/a	n/a	n/a
Marine Expeditionary Force	1	1	1	2
Air Wings Active/Reserve	1	1	1	1
Total Marine Corps End Strength During Engagement by Year of Strategy Document	187.0	289.0	196.3	178.0
Total Recommended End Strength	n/a	n/a	n/a	n/a
AIR FORCE				
Bombers or Bomber Squadrons**	21	23	3	4
Fighter Squadrons	26		30	30
Active Fighter Wings	7	8	10	10
Reserve Fighter Wings				
Airlift/Tankers	239	167	388	293

* Figures for engagements are numbers deployed; figures for documents are totals.

** Figures for Air Force bombers for Korean War, Vietnam War, Persian Gulf War, and Iraq are bomber squadrons. All other figures are bombers.

*** 2014 QDR prescribed nine heavy bomber squadrons, equaling 96 aircraft.

	1993 BUR	1997 QDR	2001 QDR	2006 QDR	2010 QDR	2010 Indep. Panel	2-MRC Paper	2014 QDR	2014 NDP
ARMY									
Total Troop Deployment During Engagement	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Divisions*	10	10	10	11	18	11	10	10	n/a
Reserve Component Divisions Total for Strategic Documents	n/a	5	8	8		7	8	8	n/a
Total Army End Strength During Engagement, During Year of Strategy Document Active	572.0	492.0	481.0	505.0	566.0	566.0	550.0	490.0	490.0
Total Active End Strength Recommendations	n/a	n/a	n/a	482.4	n/a	1,106.0	600.0	450.0	490.0
NAVY									
Total Fleet During Engagement	346	310	n/a	n/a	n/a	346	350	n/a	346
Aircraft Carriers	12	12	12	11	11	11	11	11	n/a
Carrier Air Wings	12	11	11	n/a	10	10	10	10	n/a
Large Surface Combatants	124	116	116	n/a	84–88	n/a	120	92	n/a
Small Surface Combatants				n/a	14–28	n/a	n/a	43	n/a
Attack Submarines	55	50	55	n/a	53–55	55	50	51	n/a
Amphibious Vessels	41	36	36	n/a	29–31	n/a	38	33	n/a
Combat Logistics and Support Ships	65	n/a	n/a	n/a	58	n/a	75	n/a	n/a
Fighter/Attack Squadrons	33	30	30	n/a	30	30	30	30	n/a
MARINE CORPS									
Total Troop Deployment During Engagement	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Active Divisions*	4	3	3	n/a	3	n/a	n/a	3	n/a
Reserve Divisions	1	1	1	n/a	1	n/a	n/a	1	n/a
Marine Expeditionary Force	3	3	3	n/a	3	3	3	2	n/a
Air Wings Active/Reserve	n/a	4	4	n/a	4	n/a	n/a	4	n/a
Total Marine Corps End Strength During Engagement by Year of Strategy Document	174.0	174.0	173.0	180.0	202.0	202.0	196.0	182.0	182.0
Total Recommended End Strength	n/a	n/a	n/a	175.0	n/a	243.0	202.0	182.0	182.0
AIR FORCE									
Bombers or Bomber Squadrons**	200	187	112	n/a	96	180	200	96***	n/a
Fighter Squadrons	54	54	46	n/a	42	66	54	48	n/a
Active Fighter Wings	13	12+	15	n/a	n/a	20	20	9	n/a
Reserve Fighter Wings	7	8	12	n/a	n/a	n/a		7	n/a
Airlift/Tankers	n/a	n/a	n/a	n/a	1023	1023	1,000	954	n/a

employ 100 percent of the force at any given time. Some percentage of the force will always be unavailable because of long-term maintenance overhaul, especially for Navy ships; unit training cycles; employment in myriad engagement and small-crisis response tasks that continue even during major conflicts; a standing commitment with allies to maintain U.S. forces in a given country or region; and the need to keep some portion of the force uncommitted to serve as a strategic reserve.

The historical record shows that, on average, the U.S. Army commits 21 BCTs to a major conflict; thus, a two-MRC standard would require that 42 BCTs be available for actual use. But an Army built to field only 42 BCTs would also be an Army that could find itself entirely committed to war, leaving nothing back as a strategic reserve, to replace combat losses, or to handle other U.S. security interests. Although new technologies and additional capabilities have made current BCTs more capable than those they replaced, one thing remains the same: Today's BCT, like its predecessors, can only be committed to one place at a time and must be able to account for combat losses, especially if it engages a similarly modernized enemy force. Thus, numbers still matter regardless of modernity.

Again, this *Index* assesses only the Active component of the service, though with full awareness that the Army also has Reserve and National Guard components that together account for half of the total Army. The additional capacity needed to meet these "above two-MRC requirements" could be handled by these other components or mobilized to supplement Active-component commitments. In fact, this is how the Army thinks about meeting operational demands and is at the heart of the long-running debate within the total Army about the roles and contributions of the various Army components. A similar situation exists with the Air Force and Marine Corps.

The balance among Active, Reserve, and Guard elements is beyond the scope of this study. Our focus here is on establishing a minimum benchmark for the capacity needed to handle a two-MRC requirement.

We conducted a review of the major defense studies (1993 BUR, QDR reports, and independent panel critiques) that are publicly available,[28] as well as modern historical instances of major wars (Korea, Vietnam, Gulf War, Operation Iraqi Freedom), to see whether there was any consistent trend in U.S. force allocation. The results of our review are presented in Table 5. To this we added 20 percent, both to account for forces and platforms that are likely to be unavailable and to provide a strategic reserve to guard against unforeseen demands.

Summarizing the totals, this *Index* concluded that a Joint Force capable of dealing with two MRCs simultaneously or nearly simultaneously would consist of:

- **Army:** 50 BCTs.
- **Navy:** at least 400 ships and 624 strike aircraft.
- **Air Force:** 1,200 fighter/attack aircraft.
- **Marine Corps:** 30 battalions.

America's security interests require that the services have the capacity to handle two major regional conflicts successfully.

Readiness. The consequences of the sharp reductions in funding mandated by sequestration have caused military service officials, senior DOD officials, and even Members of Congress to warn of the dangers of recreating the "hollow force" of the 1970s when units existed on paper but were staffed at reduced levels,

minimally trained, and woefully ill-equipped.[29] To avoid this, the services have traded quantity/capacity and modernization to ensure that what they do have is "ready" for employment.

Supplemental funding in FY 2017, a higher topline in FY 2018, and sustained increases in funding in FY 2019 and through FY 2020 have helped to stop the bleeding and have enabled the services to plan and implement readiness recovery efforts. Massive federal spending in response to the COVID-19 pandemic in calendar year (CY) 2020 could lead to fiscal pressure on defense accounts in future years, but for FY 2020, gains in readiness have been preserved.

It is one thing to have the right capabilities to defeat the enemy in battle. It is another thing to have enough of those capabilities to sustain operations and many battles against an enemy over time, especially when attrition or dispersed operations are significant factors. But sufficient numbers of the right capabilities are rather meaningless if the force is not ready to engage in the task.

Scoring. In our final assessments, we tried very hard not to convey a higher level of precision than we think is achievable using unclassified, open-source, publicly available documents; not to reach conclusions that could be viewed as based solely on assertions or opinion; and not to rely solely on data and information that can be highly quantified. Simple numbers, while important, do not tell the whole story.

We believe that the logic underlying our methodology is sound. This *Index* drew from a wealth of public testimony from senior government officials, from the work of recognized experts in the defense and national security analytic community, and from historical instances of conflict that seemed most appropriate to this project. It then considered several questions, including:

- How does one place a value on the combat effectiveness of such concepts as Air-Sea Battle, Multi-Domain Operations, Littoral Operations in a Contested Environment, Distributed Maritime Operations, Network-centric Operations, or Joint Operational Access?

- Is it entirely possible to assess accurately (1) how well a small number of newest-generation ships or aircraft will fare against a much larger number of currently modern counterparts when (2) U.S. forces are operating thousands of miles from home, (3) orchestrated with a particular operational concept, and (4) the enemy is leveraging a "home field advantage" that includes strategic depth and much shorter and perhaps better protected lines of communication and (5) might be pursuing much dearer national objectives than the U.S. is pursuing so that the political will to conduct sustained operations in the face of mounting losses might differ dramatically?

- How does one neatly quantify the element of combat experience, the erosion of experience as combat operation events recede in time and those who participated in them leave the force, the health of a supporting workforce, the value of "presence and engagement operations," and the related force structures and patterns of deployment and employment that presumably deter war or mitigate its effects if it does occur?

New capabilities such as unmanned systems, cyber tools, hypervelocity platforms and weapons, and the use of artificial intelligence to better understand and orchestrate operations have the potential to change military force posture calculations in the future, but at the present time, they are not realized in any practical sense.

This *Index* focused on the primary purpose of military power—to defeat an enemy in combat—and the historical record of major U.S. engagements for evidence of what the U.S. defense establishment has thought was necessary to execute a major conventional war successfully. To this we added the two-MRC

benchmark; on-the-record assessments of what the services themselves are saying about their status relative to validated requirements; and the analysis and opinions of various experts, both in and out of government, who have covered these issues for many years.

Taking it all together, we rejected scales that would imply extraordinary precision and settled on a scale that conveys broader characterizations of status that range from very weak to very strong. Ultimately, any such assessment is a judgment call informed by quantifiable data, qualitative assessments, thoughtful deliberation, and experience. We trust that our approach makes sense, is defensible, and is repeatable.

Endnotes

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23. Since World War II, the U.S. has fought four major wars: the Korean War (1950–1953); the Vietnam War (1965–1973); the Gulf War/Operation Desert Shield/Desert Storm (1990–1991); and the Iraq War/Operation Iraqi Freedom (2003–2011).
24. In previous editions of the *Index*, the capacity of the Marine Corps was assessed against a two-war requirement of 36 battalions: a historical average of 15 battalions for a major conflict (twice that for two) and a 20 percent buffer, bringing the total to 36. The Corps has consistently maintained that it is a one-war force and has no intention of growing to the size needed to fight two wars. Its annual budget requests and top-level planning documents reflect this position. Having assessed that the Indo-Pacific region will continue to be of central importance to the U.S., noting that China is a more worrisome "pacing threat" than any other competitor, and that the Joint Force lacks the ability to operate within the range of intensely weaponized, layered defenses featuring large numbers of precision-guided munitions, the Corps is reshaping itself to optimize its capabilities and organizational structures for this challenge. This *Index* concurs with this effort but assesses that the Corps will still need greater capacity to succeed in war in the very circumstances for which the Marines believe they must prepare. For a detailed examination of the current state of the Corps, see Dakota Wood, "The U.S. Marine Corps: A Service in Transition," Heritage Foundation *Backgrounder* No. 3501, June 16, 2020, https://www.heritage.org/sites/default/files/2020-06/BG3501_0.pdf.
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28. The Department of Defense, through the Joint Staff and Geographic Combatant Commanders, manages a relatively small set of real-world operational plans (OPLANS) focused on specific situations where the U.S. feels it is most likely to go to war. These plans are reviewed and updated regularly to account for changes in the Joint Force or with the presumed enemy. They are highly detailed and account not only for the amount of force the U.S. expects that it will need to defeat the enemy, but also for which specific units would deploy; how the force would actually flow into the theater (the sequencing of units); what ports and airfields it would use; how much ammunition, fuel, and other supplies it would need at the start; how much transportation or "lift" would be needed to get the force there (by air, sea, trucks, or rail); and the basic plan of attack. The Pentagon also routinely develops, explores, and refines various notional planning scenarios so that it can better understand the implications of different sorts of contingencies, which approaches might be more effective, how much of what type of force might be needed, and the regional issue or issues for which there would have to be an accounting. These types of planning events inform service efforts to develop,

equip, train, and field military forces that are up to the task of defending national security interests. All of these efforts and their products are classified national security information and therefore not available to the public.

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U.S. Army

Thomas W. Spoehr

The U.S. Army is America's primary land warfare component. Although it addresses all types of operations across the range of ground force employment, its chief value to the nation is its ability to defeat and destroy enemy land forces in battle. Operationally, as of March 3, 2020, the Army had "over 190,000 soldiers deployed in 140 countries all around the world."[1]

The summer of 2020 finds the Army, like the rest of the U.S. Department of Defense (DOD), dealing with and supporting national efforts to mitigate the effects of the SARS-CoV-2 virus. Thus far, the impacts have been moderate and manageable. As of July 1, 2020, DOD reported a total of 12,521 "cumulative cases" of coronavirus,[2] and this number can certainly be expected to grow. Army recruiting has shifted to virtual, basic training and has been modified to allow for greater social distancing, and normal permanent change of station moves for Army personnel, like the rest of DOD, were paused until at least the end of June 2020. The largest impact on the Army thus far has been forced cancellation of major training exercises and collective training opportunities. DEFENDER-Europe 20, "which was supposed to be the Army's largest exercise in Europe in 25 years," had to be truncated, although there still was some deployment training.[3]

Social distancing is not a true option for the U.S. Army. Realistic training involves manning combat vehicles and platforms where distancing is not possible. Command posts of all sizes bring soldiers into close proximity. If the COVID-19 pandemic continues past the summer, greater impacts on readiness should be expected.

To understand the Army of 2020 requires knowledge of what has transpired in the past two decades. Starting in 2001, the Army's focus became consumed by counterinsurgency (CI) operations in Iraq and Afghanistan. By 2016, however, the Army had begun to reorient toward great-power conflict. Publication of the National Security Strategy in December 2017[4] and the National Defense Strategy (NDS) in January 2018[5] gave further impetus to the need to reorient Army modernization programs, training, and doctrine to address near-peer conflict, especially conflict involving China and Russia. The 2018 National Defense Strategy captured the situation:

> Today, we are emerging from a period of strategic atrophy, aware that our competitive military advantage has been eroding. We are facing increased global disorder, characterized by decline in the long-standing rules-based international order—creating a security environment more complex and volatile than any we have experienced in recent memory. Inter-state strategic competition, not terrorism, is now the primary concern in U.S. national security.[6]

Two factors have placed the Army at a relative disadvantage compared to near-peer competitors in the past 10 years: years of relentless

counterinsurgency commitments and budget constraints imposed by the Budget Control Act (BCA) of 2011.[7] A narrow focus on CI slowed or stopped most Army modernization programs except those designed specifically for CI-type operations. Development of next-generation capabilities in air and missile defense, electronic warfare, precision fires, and ground combat vehicles was curtailed in favor of CI capabilities. Training centers prepared forces exclusively for counterinsurgency. The BCA reinforced the damage by removing billions of dollars of expected funding at the very time the Army was again beginning to concentrate on great-power competition. As a result of the BCA, Army end strength was shrinking to meet lower expected resources, remaining equipment programs were terminated, and funding for operations and maintenance was constrained.

The situation was aptly summarized in 2018 by former Defense Secretary James Mattis:

> Let me be clear: As hard as the last 16 years of war have been on our military, no enemy in the field has done as much to harm the readiness of U.S. military than the combined impact of the BCA's [Budget Control Act] defense spending caps, worsened by operating for 10 of the last 11 years under continuing resolutions of varied and unpredictable duration.[8]

The Army has since responded admirably, shifting its focus to concentrate on great-power competition. Combat Training Center (CTC) scenarios now focus nearly exclusively on high-end decisive action scenarios, new materiel programs like longer-range artillery and precision missiles with utility in near-peer competitor situations are underway, and organizational structures are being designed and in some cases implemented. Warfighting concepts and doctrine are also shifting to this new construct.

This is all appropriate, but unlike the aftermath of the Vietnam War, when the 1976 version of the Army's primary doctrinal manual omitted any mention of counterinsurgency operations, the Army thus far has also seen fit to maintain some capabilities like Security Force Assistance Brigades, counter-drone equipment, and robust Special Operations capabilities that have utility in operations at a lower level of intensity. As it moves into the future, the Army should continue to guard against the pendulum swinging too far in the new direction of great-power competition and maintain critical capabilities for CI and stability operations, as well as support for their intellectual underpinnings.

Beginning with supplemental appropriations in the summer of 2016, increased defense budgets initiated by the Trump Administration and approved by Congress have begun to bear fruit. Readiness levels have improved among Army Brigade Combat Teams (BCTs); numerous modernization programs have been initiated; and end strength has grown, albeit modestly.

Both former Secretary of Defense James Mattis and current Secretary of Defense Mark Esper have stated that DOD needs 3 percent–5 percent real growth in its budget from 2017 to 2023.[9] Starting with the 2018 budget request, however, the Army's funding levels first plateaued and then declined. The Army received a total of $179 billion in fiscal year (FY) 2018 and has requested $178 billion for FY 2021. Because of the inexorable march of inflation, the flat line in the budget for the three consecutive fiscal years of 2019, 2020, and 2021 represents a net loss of about 6 percent in buying power.[10] Secretary of the Army Ryan McCarthy has testified that with the prospect of a flat budget, the Army is faced with "either flattening [e]nd strength or tiering the modernization strategy," which means, "within the portfolios, choos[ing] divisions that you would scale first." This leaves the Army with "nothing but really, very difficult challenges, without an increased top line."[11]

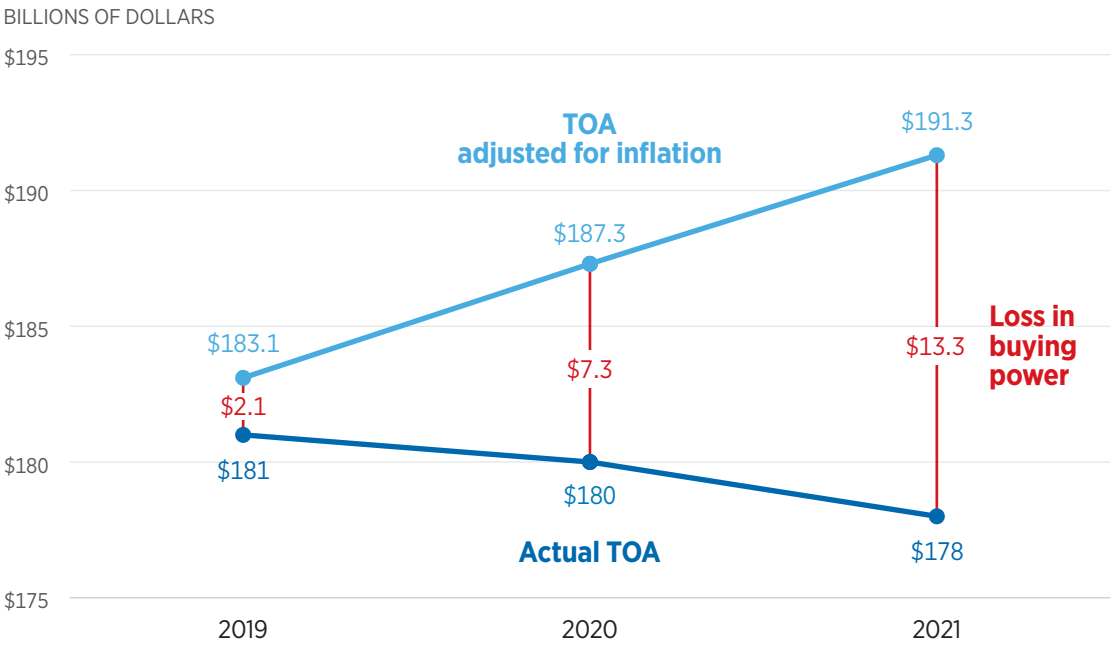
Capacity

Capacity refers to sufficiency of capabilities needed to execute the strategy. Among

CHART 5

Army Spending Takes Additional Hit Due to Inflation

The Army's total obligation authority (TOA) is declining in actual dollars, but because of inflation, those declines also result in an additional loss in buying power. From 2019 to 2021, those losses have totaled $22.7 billion.



SOURCES: Major General Paul A. Chamberlain, Director, Army Budget, "Army Fiscal Year 2021 Budget Overview," U.S. Army, February 10, 2020, p. 5, https://www.asafm.army.mil/Portals/72/Documents/BudgetMaterial/2021/pbr/Overview%20and%20Highlights/Army_FY_2021_Budget_Overview.pdf (accessed August 18, 2020), and U.S. Department of Defense, Office of the Under Secretary of Defense (Comptroller), *National Defense Budget Estimates for FY 2021*, April 2020, pp. 70 and 103, https://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2021/FY21_Green_Book.pdf (accessed August 18, 2020).

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the ways the Army quantifies its warfighting capacity is in numbers of Brigade Combat Teams, which are the basic building blocks for employment of Army combat forces. BCTs are usually employed within a larger framework of U.S. land operations but are equipped and organized so that they can conduct independent operations as circumstances demand.[12] According to the DOD Inspector General, an Armored BCT "has an approximate personnel strength of 4,700 soldiers," an Infantry BCT "has an approximate personnel strength of 4,400 soldiers," and a Stryker BCT "has an approximate personnel strength of 4,500 soldiers."[13]

However, the number of BCTs is a more telling measure of actual hard Army power. End strength reductions forced by the BCA and the priorities of the Obama Administration caused the Regular Army to decrease from 45 BCTs in FY 2013 to the 31 BCTs that remain in FY 2020.[14] Then, when the President and Congress reversed the drawdown in end strength and

authorized growth starting in 2017, instead of "re-growing" the numbers of BCTs, the Army chose primarily to "thicken" the force and raise the manning levels within the individual BCTs to increase unit readiness. The Army's goal is to fill operational units to 105 percent of their authorized manning by the end of 2020.[15]

The Army also has a separate air component organized into Combat Aviation Brigades (CABs), which can operate independently. CABs are made up of Army rotorcraft, such as the AH-64 Apache, and perform various roles including attack, reconnaissance, and lift. The number of Army aviation units has also experienced a reduction. In May 2015, the Army deactivated one of its 12 CABs, leaving only 11 in the Regular Army.

CABs and Stryker, Infantry, and Armored BCTs make up the Army's main combat forces, but they obviously do not make up the entirety of the Army. About 90,000 Regular Army troops form the Generating Force and provide such types of support as preparing and training troops for deployments, carrying out key logistics tasks, and overseeing military schools and Army educational institutions. The troops constituting the Generating Force cannot be reduced at the same ratio as BCTs or CABs, and the Army endeavors to insulate these soldiers from drawdown and restructuring proposals in order to "retain a slightly more senior force in the Active Army to allow growth if needed."[16]

In addition to the institutional Army, a great number of functional or multifunctional support brigades (amounting to approximately 42 percent of the active component force based on historical averages[17]) provide air defense; engineering; explosive ordnance disposal (EOD); chemical, biological, radiological, and nuclear protection; military police; military intelligence; and medical support among other types of battlefield support. Many of these units are proving valuable in responding to the COVID-19 crisis. Special operations forces such as the 75th Ranger Regiment, Special Forces Groups, and the 160th Special Operations Aviation Regiment are also included in these numbers.

The Army has begun the process of adapting its force structure to meet the anticipated new demands of near-peer competition. The foundations for these changes are contained in the Army's 2018 concept for multi-domain operations (MDO), which outlines how the Army views the future.[18] In April 2020, the Army announced that it is bundling its efforts to modify force structure for MDO under the designation "AimPoint Initiative." As part of this initiative, the Army intends to reactivate the V Corps Headquarters in the fall of 2020 and create three Multi-Domain Task Forces (MDTFs). The first MDTF already exists under U.S. Army Pacific Command as a pilot program and is intended to "focus on penetrating an enemy environment, employing assets that can counter enemy A2/AD [anti-access/aerial denial] capabilities and enemy network-focused targeting of U.S. units." The second MDTF is scheduled to be activated in Europe in 2021, and the third is scheduled to be activated in the Pacific in 2022.[19]

In 2017, to relieve the stress on the use of BCTs, the Army activated the first of six Security Force Assistance Brigades (SFABs). These units, composed of about 800 soldiers per unit, are designed specifically to train, advise, and mentor other partner-nation military units.[20] The Army had been using BCTs for this mission, but because train-and-assist missions typically require senior officers and noncommissioned officers, a BCT comprised predominantly of junior soldiers is a poor fit. Since 2018, SFABs have deployed to assist foreign partners in Afghanistan, Iraq, and Africa. The last SFAB to activate, the 5th SFAB, was scheduled to activate in the summer of 2020 at Joint Base Lewis–McChord, Washington.[21] Of the six SFABs, one is in the National Guard, and the other five are in the Regular Army.

In FY 2020, the Army was authorized a total end strength of 1,005,500 soldiers: 480,000 in the Regular Army, 189,500 in the Army Reserve, and 336,000 in the Army National Guard (ARNG).[22] Although these numbers admittedly sound impressive, Army leaders have consistently stated that the Army is too small to

execute the National Defense Strategy at less than significant risk. In 2017, in perhaps the clearest of these statements, General Mark Milley, then Chief of Staff of the Army, testified that in his judgment, the numbers should be 540,000–550,000 for the Regular Army, 350,000–355,000 for the National Guard, and 205,000–209,000 for the Army Reserve.[23] Since then, with the publishing of the 2018 NDS and its emphasis on great-power competition, the requirements placed on the Army have increased.

More recently, responding to written "Advance Policy Questions" from the Senate Armed Services Committee in conjunction with his nomination, Secretary of the Army Ryan McCarthy has stated that he believes the Army's "end strength levels are insufficient to meet national defense objectives" and that "I am concerned about the Army's ability to defeat a near-peer adversary while nearly simultaneously denying the objectives of another, defending the homeland, and sustaining counter terrorism efforts."[24] Current Army Chief of Staff General James McConville echoed this statement: "The total Army needs to be larger and fully resourced with timely, adequate, predictable, and sustainable funding to reduce the risk."[25]

Secretary McCarthy has said the nation needs a Regular Army of at least 500,000, but under current plans, the Army is many years from achieving that goal.[26] On March 31, 2020, the Regular Army stood at 479,233 soldiers—20,767 less than the minimum that Army leaders have testified is necessary.[27] The Army's FY 2021 budget request specifies an end strength of 485,900 for FY 2021 and projects an end strength of 490,500 by the end of FY 2025, which represents an average growth of 1,150 soldiers per year.[28] At that rate, the service will not reach its minimum stated goal of 500,000 until 2034, 14 years from now. The slowdown in planned growth is being driven first and foremost by a lack of funding, although recruiting has also emerged as a challenge.

Most outside experts agree that the U.S. Army is too small. In 2017, Congress established the bipartisan National Defense Strategy Commission to provide an "independent, non-partisan review of the 2018 National Defense Strategy." Among its findings, the commission noted that the NDS now charges the military with facing "five credible challengers, including two major-power competitors and three distinctly different geographic and operational environments." The commission assessed that "this being the case, a two-war force sizing construct makes more strategic sense today than at any previous point in the post-Cold War era." In other words, "*[s]imply put, the United States needs a larger force than it has today if it is to meet the objectives of the strategy.*"[29]

The Army also has transitioned from a force with a third of its strength typically stationed overseas, as it was during the Cold War, to a force that is based in the continental United States. In 1985, 31 percent of the active-duty Army was stationed overseas; by 2015, that figure had declined to 9 percent.[30] The desire to find a peace dividend following the dissolution of the Soviet Union, combined with a reluctance to close bases in the United States, led to large-scale base closures and force reductions overseas. Lack of a substantial overseas presence makes prompt response more difficult and lessens deterrence.

In addition to the increased strategic risk of not being able to execute the NDS within the desired time frame, the result of an insufficient number of BCTs and a diminished Army end strength has been a higher than desired level of operational tempo (OPTEMPO). Despite a reduction in large unit deployments, particularly to Iraq and Afghanistan, Army units continue to experience sustained demand. In March 2020, the Army was experiencing deployment-to-dwell ratios as high as 1 to 1, which is much higher than desired.[31]

Included in these deployments are the rotations of Armored BCTs to and from Europe and Korea. Rather than relying on forward-stationed BCTs, the Army rotates Armored BCTs to Europe and Korea on a "heel-to-toe" basis. There is disagreement as to which

represents the best option. Proponents of rotational BCTs argue that they arrive fully trained and remain at a high state of readiness throughout their typically nine-month overseas rotation; those who favor forward-stationed forces point to a lower cost, forces that typically are more familiar with the operating environment, and a more reassuring presence for our allies.[32] In reality, both are needed not only for the reasons mentioned, but also because the mechanisms by which a unit is deployed, received into theater, and integrated with the force stationed abroad must be practiced on a regular basis.

In an effort to mitigate risk, the Army is resourcing select Army National Guard BCTs with additional training days, moving from the standard number of 39 training days to as many as 63 per year to increase readiness levels. To apply these resources, the National Guard has implemented a multi-year training cycle to build readiness over time. As part of this concept, the Army increased the number of National Guard BCTs participating in a Combat Training Center (CTC) rotation from two to four starting in FY 2019. This continues in the fiscal year 2021 budget request.[33]

As a result of this change in strategy and the increased investment in the National Guard, the 2021 *Index of U.S. Military Strength* counts four ARNG BCTs in the overall Army BCT capacity count, reflecting their ability to be employed on a dramatically shortened timeline as a result of their training at a Combat Training Center and the increased number of resourced training days.

Capability

Capability in this context refers to the quality, performance, suitability, and age of the Army's various types of combat equipment. As a general rule, the Army is primarily using equipment developed in the 1970s, fielded in the 1980s, and incrementally upgraded since then. This modernization gap was caused by several factors: the predominant focus on the wars in Iraq and Afghanistan since 9/11; pressures caused by budget cuts, especially those associated with the Budget Control Act of 2011; and failures in major modernization programs like the Future Combat System, Ground Combat Vehicle, and Crusader artillery system.

Army leaders today clearly view this situation as a serious challenge. Secretary of the Army Ryan McCarthy has testified that "the most significant challenge" the Army faces "is being able [to] execute our aggressive modernization strategy while maintaining a sustainable level of readiness to meet current operational requirements."[34] Through 2022 and later, most of the Army's proposed programs will still be in development and sensitive to changes in funding or priorities. Even once the programs enter procurement, funding constraints will drive fielding into the 2030s, delaying the arrival of new capability.

As an example, the M109 series howitzer was first introduced in the early 1960s and has been upgraded multiple times since then. An important part of an artillery system is its range. Today, most modern countries have artillery systems that can outrange the Paladin 109A7, the Army's current self-propelled howitzer. The Paladin can fire an artillery shell about 22 kilometers–30 kilometers. The Russian 2S33 Msta-SM2 reportedly can hit targets at 40 kilometers.[35] Similarly, the German PzH 2000, Chinese PLZ-05, South Korean K9, and French CAESAR systems all outrange the Paladin.[36] The Army has an extended-range cannon in development that can fire to 70 kilometers, but it is not yet available and is not expected until at least 2023.[37]

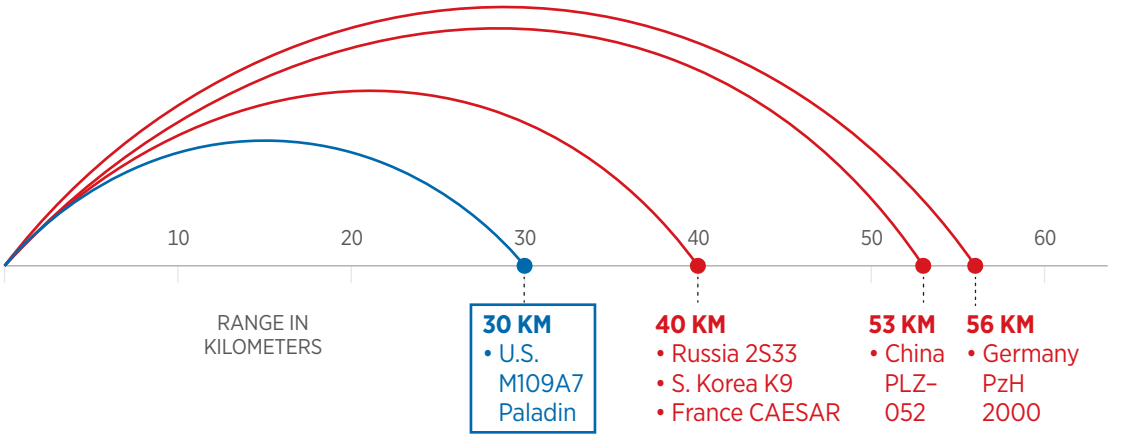
Within the Army's inventory of equipment are hundreds of combat systems, including small arms, trucks, aircraft, soldier-carried weapons, radios, tracked vehicles, artillery systems, missiles, and drones. The following paragraphs provide an update on some of the major systems as they pertain to Armored, Stryker, and Infantry BCTs and Combat Aviation Brigades, but it is by no means exhaustive.

Armored Brigade Combat Team (ABCT). The Armored BCT's "role is to close with the enemy using fire and movement to destroy or capture enemy forces, to repel enemy attacks

FIGURE 1

U.S. Artillery Falls Short—Literally—Compared to Rivals

The U.S. M109A7 Paladin artillery system, in the U.S. Army's arsenal since 2015, has a maximum range of only 30 kilometers—10 kilometers less than the range of Russia's 2S33 system and 23 kilometers short of China's PLZ–052.



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by fire, to engage in close combat, and to counterattack to control land areas, including populations and resources."[38] The Abrams Main Battle Tank (latest version: M1A2 SEPv3, service entry date 2017) and Bradley Fighting Vehicle (latest version: M2A4) are the primary combat platforms in Armored BCTs. The M-1 tank and Bradley first entered service in 1980 and 1981, respectively. Today, there are 87 M-1 Abrams tanks and 152 Bradley Fighting Vehicle variants in an ABCT.[39] Despite upgrades, the M-1 tank and the Bradley are now 40 years old, and their replacements will likely not arrive until the platforms are at least 50 years old.

The Army's replacement program for the Bradley, the Optionally Manned Fighting Vehicle, was formerly on an aggressive timeline, but the Army cancelled the request for proposals on January 16, 2020, and is now reworking the requirements in conjunction with industry.

"The Army now plans for the first unit to be equipped in the fourth quarter of FY2028."[40] A potential replacement for the M-1 tank is even further down the road; the Army does not intend to decide "what direction we want to go for decisive lethality and survivability on the battlefield" until at least 2023.[41]

Also in Armored BCTs, the venerable M113 multi-purpose personnel carrier, which fills multiple roles like mortar carrier and ambulance, entered service in 1960 and is scheduled to be replaced by the new Armored Multi-Purpose Vehicle (AMPV), which passed acquisition milestone C on January 25, 2019, and was scheduled to begin low-rate initial production in the first half of FY 2020. In a signal of budget pressure, program problems, or both, the Army reduced its planned procurement of the AMPV in its FY 2021 budget request.[42] At the new projected average procurement rate of about 190 vehicles per year starting in 2022, the Army will not reach its stated objective of 2,897 AMPVs until around 2037.[43]

Stryker Brigade Combat Team (SBCT). The Stryker BCT "is an expeditionary combined arms force organized around mounted infantry" and able to "operate effectively in most terrain and weather conditions due to their rapid strategic deployment and mobility."[44] Stryker BCTs are equipped with approximately 321 eight-wheeled Stryker vehicles. These vehicles are among the Army's newest combat platforms, having entered service in 2001. In response to an Operational Needs Statement, the Stryker BCT in Europe received Strykers fitted with a 30mm cannon to provide an improved anti-armor capability.[45] Based on the success of that effort, the Army decided to outfit at least three of its SBCTs—the ones equipped with the Double V-hull, which affords better underbody protection against such threats as improvised explosive devices (IEDs)—with the XM813 30mm autocannon, although the competition to integrate those weapons is currently delayed because of the COVID-19 pandemic.[46] The Army is also integrating Javelin missiles on the Stryker platform.

Infantry Brigade Combat Team (IBCT). The Infantry BCT "is an expeditionary, combined arms formation optimized for dismounted operations in *complex terrain*—a geographical area consisting of an urban center larger than a village and/or of two or more types of restrictive terrain or environmental conditions occupying the same space."[47] Infantry BCTs have fewer vehicles and rely on lighter platforms such as trucks and High Mobility Multipurpose Wheeled Vehicles (HMMWVs) for mobility.

The Joint Lightweight Tactical Vehicle (JLTV) is designed to combine the protection offered by Mine Resistant Ambush Protected Vehicles (MRAPs) with the mobility of the original unarmored HMMWV. The vehicle features design improvements that increase its survivability against anti-armor weapons and IEDs. The Army plans to procure 49,099 JLTVs over the life of the program, replacing about 50 percent of the current HMMWV fleet. Requested FY 2021 funding of $894.4 million would procure 1,920 JLTVs and 1,334 trailers.[48] This is a reduction of $202 million from the amount planned just a year ago and reflects the budget pressures the Army is facing. Taking into account the 5,162 JLTVs the Army has already procured, and procuring at a rate of 1,920 vehicles per year starting in 2021, the Army will not reach its acquisition objective for the JLTV until 2043, forcing continued reliance on aging HMMWVs, which began fielding in 1983.

The Army is developing a system called Mobile Protected Firepower to provide IBCTs with the firepower to engage enemy armored vehicles and fortifications. In FY 2020, the Army is scheduled to receive 24 prototypes (12 each) from General Dynamics Land Systems and BAE for testing and evaluation.[49] A full-rate production decision is planned for the third quarter of FY 2025.[50]

Airborne BCTs are the first IBCTs to receive a new platform, the Ground Mobility Vehicle (GMV), to increase their speed and mobility. The GMV provides enhanced tactical mobility for an IBCT nine-soldier infantry squad with their associated equipment. The first GMVs

were delivered in September 2018.[51] The Army has approved "a procurement objective of 11 IBCT sets at 59 vehicles per IBCT (649 vehicles) to be completed by FY 2024."[52]

Combat Aviation Brigade. Combat Aviation Brigades are composed of AH-64 Apache attack, UH-60 Black Hawk medium-lift, and CH-47 heavy-lift Chinook helicopters. The Army has been methodically upgrading these fleets for decades.

The H-60 medium-lift helicopter acquisition objective is 2,135, which is planned to be filled by 1,375 H-60M and 760 recapitalized 60-A/L/V aircraft. The FY 2021 procurement request for the UH-60M is approximately $830.4 million, which will procure 36 aircraft (38 less than the 74 requested in FY 2020). With the FY 2021 procurement quantities, the Army will have procured 1,159 UH/HH-60Ms, or 54.2 percent of its acquisition objective of 2,135 for that aircraft.[53]

The CH-47F Chinook, a rebuilt variant of the Army's CH-47D heavy-lift helicopter, has an acquisition objective of 550 aircraft and is expected to remain the Army's heavy-lift helicopter for the next several decades, as there is no replacement on the horizon. The FY 2021 budget request of $229.6 million supports the procurement of seven aircraft, of which six will be MH-47G and one a CH-47F. With the FY 2021 procurement, the Army will have purchased 382 CH-47Fs, or 69 percent of its acquisition objective of 550.[54]

The AH-64E heavy attack helicopter has an acquisition objective of 812 aircraft, which is being satisfied by building new aircraft remanufacturing older AH-64 models. The FY 2021 procurement request of $961.5 million for remanufacturing and $69.2 million for new builds will buy 52 AH-64E aircraft. This means that the Army will have procured a total of 562 aircraft, or 69 percent of its acquisition objective of 812.[55]

Overall, the Army's equipment inventory, while increasingly dated, is well maintained. Despite high usage in Afghanistan and Iraq, because the Army deliberately undertook a "reset" plan that Congress supported with supplemental funding, most Army vehicles are relatively "young" because recent remanufacture programs for the Abrams and Bradley vehicles have extended the service lives of both vehicles beyond FY 2028.[56]

In addition to the viability of today's equipment, the military must look to the health of future equipment programs. Although future modernization programs are not current hard-power capabilities that can be applied against an enemy force today, they are a leading indicator of a service's overall fitness for future sustained combat operations. In future years, the service may be able to engage an enemy but be forced to do so with aging equipment and no program in place to maintain viability or endurance in sustained operations.

The U.S. military services are continually assessing how best to stay a step ahead of competitors: whether to modernize the force today with currently available technology or wait to see what investments in research and development produce years down the road. Technologies mature and proliferate, becoming more accessible to a wider array of actors over time.

After years of a singular focus on counterinsurgency due to the wars in Iraq and Afghanistan, followed by a concentration on the readiness of the force, the Army is now playing catch-up in the area of equipment modernization. Former Chairman of the Joint Chiefs of Staff General Joseph Dunford has stated that "[t]he U.S. military advantage over near-peer competitors is eroding,"[57] and nowhere is that more apparent than when examining U.S. Army equipment.

When the M-1 Abrams was introduced in 1980, for example, it was indisputably the world's best tank. Now, in 2020, Russia is beginning the process to export their T-14 Armata tank, which has an unmanned turret, reinforced frontal armor, an information management system that controls all elements of the tank, a circular Doppler radar, an option for a 155mm gun, and 360-degree ultraviolet high-definition cameras. The M-1 remains a great tank, but the decisive advantage that the U.S. once enjoyed has disappeared.[58]

The Army established a new four-star headquarters, Army Futures Command, to manage modernization, achieving full operational capability in July 2019.[59] Additionally, the Army established eight cross-functional teams (CFTs) to improvement the management of its top modernization priorities.[60] Army leadership—in particular the Under Secretary and Vice Chief of Staff of the Army—are devoting an extraordinary amount of time to issues of equipment modernization, but only time will tell whether the new structures, commands, and emphasis will result in long-term improvement in modernization posture. The Army aspires to develop and procure an entire new generation of equipment based on its six new modernization priorities: long-range precision fires, a next-generation combat vehicle, future vertical lift, the network, air and missile defense, and soldier lethality.

Although the Army has put in place new organizations, plans, and strategies to manage modernization, the future is uncertain. The Army has shown great willingness to make tough choices and reallocate funding toward its modernization programs. For the program years FY 2020–FY 2024, the service moved $33 billion around to fund its six modernization priorities.[61] Some are predicting that the COVID-19 pandemic, along with accompanying concerns about the federal debt, might create conditions that restrain future DOD budget growth. Still others point to the impending November 2020 election and predict that a change in Administrations could also portend a budget downturn. Formidable DOD budget challenges in the next five years include bills for nuclear deterrence programs, rising personnel costs, health care, and the need to invest in programs to respond to China's increasingly aggressive activities. The Army desperately needs time and funding to modernize its inventory of equipment.

The Army's principal modernization programs are not currently encumbered by any major problems, but there is justifiable concern about past difficulties and current status. Cancellation of the OMFV program in January 2020 was an ominous sign that the Army has not shaken off past acquisition management issues. It also probably resulted in the loss of hundreds of millions of dollars of Army buying power. Many new research and development programs have been initiated with an extraordinary amount of publicity, excitement, and oversight. Only time will tell whether this enthusiasm is well-founded.

Readiness

The Army has made considerable progress in increasing the readiness of its forces. Its goal is to have 66 percent of the Regular Army and 33 percent of National Guard BCTs at the highest levels of readiness. In March 2020, Secretary McCarthy and General McConville reported that "74 percent of Active Component Brigade Combat Teams have been at the highest levels of tactical readiness."[62] This means that 23 of the Army's 31 active BCTs were at either C1 or C2, the two highest levels of tactical readiness, and ready to perform all or most of their wartime missions immediately.[63] This is double the number of ready active BCTs compared to 2017. Army leaders have also said that "nearly half" of the Army's 58 BCTs "are at the highest levels of readiness."[64] Since we know that 23 active component BCTs are at the highest levels of readiness, we can infer that four to five of the 27 National Guard BCTs probably are as well.

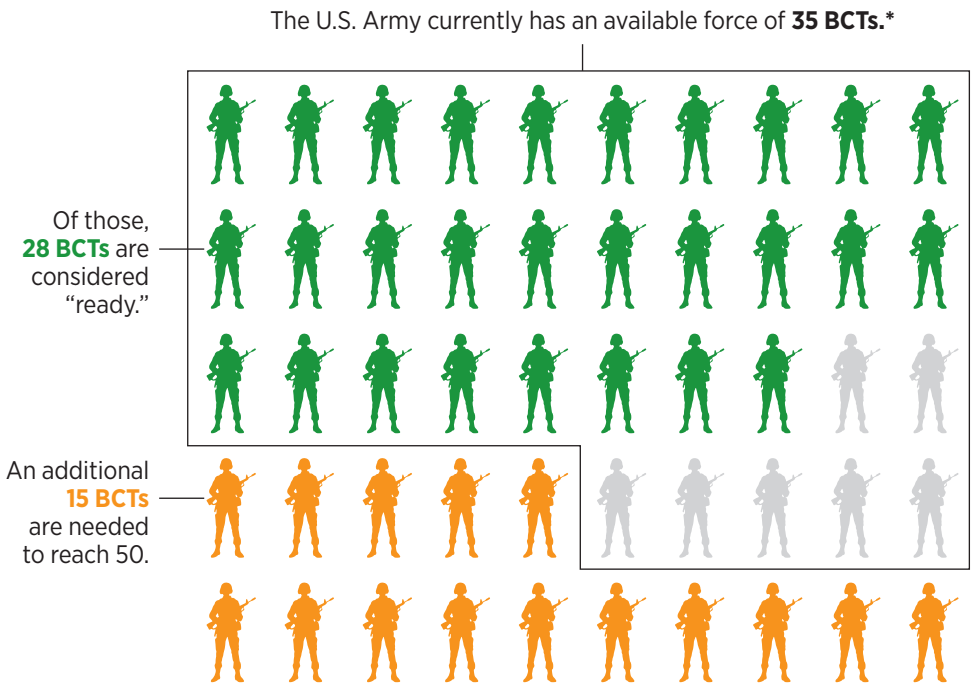
As part of the $712.6 billion provided for defense overall in the FY 2020 defense appropriations bill, Congress provided much-needed relief to the Army by appropriating approximately $180 billion. This influx of resources, combined with on-time funding, has had a very positive effect on the rebuilding of readiness.[65]

In the FY 2021 budget request, training activities are relatively well resourced. When measuring training resourcing, the Army uses operating tempo full-spectrum training miles and flying hours, which reflect the number of miles that formations are resourced to drive their primary vehicles on an annual basis and the number of hours that aviators can fly their helicopters per month.[66] According to the

FIGURE 2

Army Readiness: Brigade Combat Teams

Based on historical force requirements, The Heritage Foundation assesses that the Army needs a total of 50 Brigade Combat Teams (BCTs). In addition to active-duty forces, the Army National Guard has four BCTs that operate at a high level of readiness.



* Includes four Army National Guard BCTs.

SOURCES: The Honorable Ryan D. McCarthy, Secretary of the Army, and General James P. McConville, Chief of Staff, United States Army, statement "On the Posture of the United States Army" before the Committee on Armed Services, U.S. Senate, March 26, 2020, p. 4, https://www.armed-services.senate.gov/imo/media/doc/McCarthy--McConville_03-26-20.pdf (accessed August 19, 2020), and *Congressional Quarterly*, "House Armed Services Committee Holds Hearing on the Fiscal 2021 Budget Request for the Army," March 3, 2020, p. 7, https://plus.cq.com/alertmatch/434900672?0&deliveryId=57664418&uid=congressionaltranscripts-5851233&utm_medium=alertemail&utm_source=%E2%80%A6 (accessed August 19, 2020).

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Army's budget justification exhibits, "[t]he FY 2021 budget funds 1,598 Operating Tempo Full Spectrum Training Miles (OTFSTM) and 10.8 flying hours per crew, per month" to meet "required training readiness levels."[67] The OTFSTM is higher than resourced levels of 1,549 miles and lower than the 11.6 flying hours enacted in the FY 2020 budget.[68]

The Army reports broadly increasing readiness across all units. Part of this improvement is due to the Army's success in reducing the percentage of soldiers who are nondeployable. Nonetheless, structural readiness problems evidenced by too small a force attempting to satisfy too many global presence requirements and Operations Plan (OPLAN)

warfighting requirements will continue to challenge the Army.

As part of its Sustainable Readiness Model (SRM),[69] the Army uses Combat Training Centers (CTCs) to train its forces to desired levels of proficiency. The CTC program's mission is to "provide realistic joint and combined arms training...approximating actual combat" and increase "unit readiness for deployment and warfighting."[70] The Army requested resources for 24 CTC rotations in FY 2021, including four for the Army National Guard.[71]

Scoring the U.S. Army

Capacity Score: Weak

Historical evidence shows that, on average, the Army needs 21 Brigade Combat Teams to fight one major regional conflict (MRC). Based on a conversion of roughly 3.5 BCTs per division, the Army deployed 21 BCTs in Korea, 25 in Vietnam, 14 in the Persian Gulf War, and around four in Operation Iraqi Freedom—an average of 16 BCTs (or 21 if the much smaller Operation Iraqi Freedom initial invasion operation is excluded). In the 2010 Quadrennial Defense Review, the Obama Administration recommended a force capable of deploying 45 Active BCTs. Previous government force-sizing documents discuss Army force structure in terms of divisions and consistently advocate for 10–11 divisions, which equates to roughly 37 Active BCTs.

Considering the varying recommendations of 35–45 BCTs and the actual experience of nearly 21 BCTs deployed per major engagement, our assessment is that 42 BCTs would be needed to fight two MRCs.[72] Taking into account the need for a strategic reserve, the Army force should also include an additional 20 percent of the 42 BCTs.

Because of the investment the Army has made in National Guard readiness with the provision of extra training days and four CTC rotations, this *Index* counts four additional ARNG BCTs in the Army's overall BCT count, giving the service 35 (31 Regular Army plus four ARNG), but 35 is still not enough to meet the two-MRC construct. The Army's overall capacity score therefore remains unchanged from 2020.

- **Two-MRC Benchmark:** 50 Brigade Combat Teams.
- **Actual Projected 2020 Level:** 35 (31 Regular Army plus four ARNG) Brigade Combat Teams.

The Army's current BCT capacity meets 70 percent of the two-MRC benchmark and thus is scored as "weak."

Capability Score: Marginal

The Army's aggregate capability score remains "marginal." This aggregate score is a result of "marginal" scores for "Age of Equipment," "Size of Modernization Programs," and "Health of Modernization Programs." More detail on these programs can be found in the equipment appendix following this section. The Army scored "weak" for "Capability of Equipment."

In spite of modest progress with the JLTV and AMPV, and in spite of such promising developments as creation of Army Futures Command, CFTs, and the initiation of new Research, Development, Testing and Evaluation (RDTE) funded programs, new Army equipment programs remain in the development phase and in most cases are two to three years from entering procurement phases. Thus, they are not yet replacing legacy platforms and cannot contribute to warfighting capability today—which is what this *Index* measures. These planned procurements are highly sensitive to any turbulence or reduction in funding.

Readiness Score: Very Strong

As noted, the Army has said that "nearly half" of its 58 BCTs "are at the highest levels of readiness."[73] Four to five of those BCTs are

National Guard Brigades that have benefited from the Army's efforts to focus personnel, equipment, and training on those units, and 23 are Regular Army BCTs out of 31 that are ready (74 percent). The Army's internal requirement for Active BCT readiness is 66 percent, or 20.5 BCTs ready. Using the assessment methods of this *Index*, this results in a percentage of service requirement of 100 percent, or "very strong."

Overall U.S. Army Score: Marginal

The Army's overall score is calculated based on an unweighted average of its capacity, capability, and readiness scores. The unweighted average is 3.33; thus, the overall Army score is "marginal." This was derived from the aggregate score for capacity ("weak"); capability ("marginal"); and readiness ("very strong"). This score is the same as the assessment of the 2020 *Index*, which also rated the Army as "marginal."

U.S. Military Power: Army

	VERY WEAK	WEAK	MARGINAL	STRONG	VERY STRONG
Capacity		✓			
Capability			✓		
Readiness					✓
OVERALL			✓		

ARMY SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2020 ■ Pending

Main Battle Tank

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
M1A1/2 Abrams Inventory: **678/1619** Fleet age: **30.5/13.5** Date: **1980/1993** The Abrams is the main battle tank used by the Army in its armored brigade combat teams (BCTs). Its main benefits are lethality, protection, and mobility. The Abrams went through a remanufacture program to extend its life to 2045.	3	4	**Decisive Lethality Platform (DLP)** The DLP program is intended to replace the Abrams tank. This program is part of the Next Generation Combat Vehicle (NGCV) program, which is number two among the Army's "Big Six" modernization priorities. The soonest a replacement for the Abrams tank could be introduced is 2030.		

Infantry Fighting Vehicle

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
M2 Bradley Inventory: **4,006** Fleet age: **20** Date: **1981** The Bradley is a tracked vehicle meant to transport infantry and provide covering fire. The Bradley complements the Abrams tank in armored BCTs. The Bradley underwent a remanufacture program to extend its life to 2045.	3	3	**Optionally Manned Fighting Vehicle (OMFV)** In March 2019, the Army issued a request for proposals to competitively build prototypes of the OMFV, but then did an about-face and cancelled the solicitation in January 2020. The Army is now redefining the requirements and intends to seek digital designs from companies in mid/late 2020. The program has likely slipped to first fieldings in 2028. This program is part of the Next Generation Combat Vehicle (NGCV) program, which is number two among the Army's "Big Six" modernization priorities.		

Armored Fighting Vehicle

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
Stryker Inventory: **4,859** Fleet age: **10** Date: **2001** The Stryker is a wheeled vehicle that is the main platform in Stryker BCTs. The program was considered an interim vehicle to serve until the arrival of the Future Combat System (FCS), but that program was cancelled due to technology and cost hurdles. The original Stryker is being replaced with a double-V hull configuration (DVH) to increase survivability and a 30mm gun to increase lethality. Its components allow for rapid acquisition and fielding. The Stryker is expected to remain in service for 30 years.	4	4	None		

NOTE: See page 374 for details on fleet ages, dates, and procurement spending.

ARMY SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2020 ■ Pending

Armored Personnel Carrier

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
M113 Armored Personnel Carrier Inventory: **4,339** Fleet age: **36** Date: **1960** The tracked M113 serves in a supporting role for armored BCTs and in units above brigade level. The APC is being slowly replaced by the Armored Multi Purpose Vehicle (AMPV). Plans are to use the platform until 2045.	1	2	**Armored Multi-Purpose Vehicle (AMPV)** Timeline: **2018–TBD** The AMPV has been adapted from the Bradley Fighting Vehicle which largely allowed the program to bypass the technology development phase. The fleet will consist of five variants. The first unit is set to be equipped at the end of 2021. **PROCUREMENT** 474 2,391 **SPENDING** *($ millions)* $2,666 $11,126	2	3

Light Wheeled Vehicle

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
HMMWV Inventory: **99,800** Fleet age: **18** Date: **1985** The HMMWV is used to transport troops and for a variety of other purposes, such as serving as ambulances. The expected life span of the HMMWV is 15 years. A portion of the HMMWV fleet will be replaced by the Joint Light Tactical Vehicle (JLTV).	2	1	**Joint Light Tactical Vehicle (JLTV)** Timeline: **2015–2036** The JLTV vehicle program replaces some of the Army's HMMWVs and provides improved protection, reliability, and survivability of vehicles. This is a joint program with USMC. In June 2019, the Army approved the JLTV for full-rate production. Production is underway. The Army has been forced to reduce procurement quantities due to current budget shortfalls. **PROCUREMENT** 13,438 35,661 **SPENDING** *($ millions)* $6,492 $19,219	3	3

NOTE: See page 374 for details on fleet ages, dates, and procurement spending.

Attack Helicopter

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
AH-64 D Apache Inventory: **381** Fleet age: **14.5** Date: **1997** The Apache is used in Combat Aviation Brigades and is the Army's attack helicopter. It can destroy armor, personnel, and material targets. The expected life cycle is about 20 years.	2	3	**AH-64E Reman** Timeline: **2010–TBD** The AH-64E Reman (short for remanufactured) is a program to remanufacture older Apache helicopters into the more advanced AH-64E version. The AH-64E will have more modern and interoperable systems and be able to carry modern munitions, including the JAGM missile. **PROCUREMENT***: 431 / 189 **SPENDING*** *($ millions)*: $10,639 / $3,986	3	5
AH-64E Inventory: **351** Fleet age: **4** Date: **2012** The AH-64E variant is a remanufactured version with substantial upgrades in powerplant, avionics, communications, and weapons capabilities. The expected life cycle is about 20 years.	5	5	**AH-64E New Build** Timeline: **2010-2027** The AH-64E New Build program produces new-build, not re-built, Apaches. The program is meant to modernize and sustain the current Apache inventory. The AH-64E has more modern and interoperable systems and is able to carry modern munitions, including the JAGM missile. **PROCUREMENT***: 79 / 2 **SPENDING*** *($ millions)*: $2,404	3	5

* Additional procurement expected.
NOTE: See page 374 for details on fleet ages, dates, and procurement spending.

Medium Lift

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
UH-60A Black Hawk Inventory: **157** Fleet age: **35.5** Date: **1978** The UH-60A is a utility helicopter that provides air assault, aeromedical evacuation, and supports special operations. The expected life span is about 25 years. This variant of the Black Hawk is now being replaced by the newer UH-60M variant.	1	2	**UH-60M Black Hawk** Timeline: **2004–TBD** The UH-60M, currently in production, is intended to modernize and replace current Black Hawk inventories. The newer M-variant will improve the Black Hawk's range and lift by upgrading the rotor blades, engine, and computers. The UH-60M will replace both the UH-60A and the UH-60L. **PROCUREMENT*** 1,123 / 145 **SPENDING*** *($ millions)* $21,175 / $6,650	3	5
UH-60L Black Hawk Inventory: **958** Fleet age: **14.5** Date: **1989** The UH-60L is the follow-on helicopter to the UH-60A. As the UH-60A is retired, the M-variant will be the main medium-lift rotorcraft used by the Army. They are expected to remain in service until at least 2030.	3	3	**UH-60V Black Hawk** Timeline: **2021–TBD** The Army plans to upgrade older model UH-60L to the UH-60V configuration which incorporates a digital cockpit, like one on the UH-60M. This is an Army cost-savings measure as it is cheaper to make a UH-60V from a UH-60L, than to buy a new UH-60M. The UH-60V will only replace the UH-60L.	1	4
UH-60M Black Hawk Inventory: **1,070** Fleet age: **7.5** Date: **2005** The UH-60M, currently in production, is intended to modernize and replace current Black Hawk inventories. The newer M-variant will improve the Black Hawk's range and lift by upgrading the rotor blades, engine, and computers.	5	4			

NOTE: See page 374 for details on fleet ages, dates, and procurement spending.

ARMY SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2020 ■ Pending

Heavy Lift

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
CH-47F Chinook Inventory: **439** Fleet age: **9** Date: **2002** The F-variant includes a new digital cockpit and monolithic airframe to reduce vibrations. It transports forces and equipment while providing other functions such as parachute drops and aircraft recovery. The expected life span is 35 years. The Army plans to use the CH-47F until the late 2030s.	5	5	**CH-47F** Timeline: **2001–TBD** Currently in production, the CH-47F program is intended to keep the fleet of heavy-lift rotorcraft healthy as older variants of the CH-47, notably the CH-47D, are retired. The program includes both remanufactured and new builds of CH-47s. The F-variant has engine and airframe upgrades to lower the maintenance requirements. Total procurement numbers include the MH-47G configuration for U.S. Special Operations Command. **PROCUREMENT*** 1,183 / 172 **SPENDING*** *($ millions)* $1,369 / $25,517	3	5
MH-47G Inventory: **67** Fleet age: **9** Date: **2014** MH-47G is a special operations variant of the CH-47 Chinook multi-role helicopter used in heavy-lift missions such as the transportation of troops, ammunition, vehicles, equipment, fuel and supplies, as well as civil and humanitarian relief missions. The helicopter can conduct long-range missions at low levels and in adverse weather conditions, both during the day and at night.	5	5			

Intelligence, Surveillance, and Reconnaissance (ISR)

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
MQ-1C Gray Eagle Inventory: **158** Fleet age: **4.5** Date: **2011** The Gray Eagle is a medium-altitude long-endurance (MALE) unmanned aerial vehicle (UAV) used to conduct ISR missions. The use of MALE UAVs is a new capability for the Army. The Gray Eagle is currently in production.	4	4	**MQ-1C Gray Eagle** Timeline: **2010–2022** The MQ-1C UAV provides Army reconnaissance, surveillance, and target acquisition capabilities. The Army is continuing to procure MQ-1Cs to replace combat losses. **PROCUREMENT** 277 **SPENDING** *($ millions)* $6,140 / $1	3	5

* Additional procurement expected.
NOTES: See Methodology for descriptions of scores. Fleet age is the average between the first and last year of delivery. The date is the year of first delivery. The timeline is from the first year of procurement to the last year of delivery/procurement. Spending does not include advanced procurement or research, development, test, and evaluation (RDT&E).

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U.S. Navy

Brent Sadler

The President's fiscal year (FY) 2021 budget request seeks nearly $160 billion for the U.S. Navy. This budget request seeks a balance of readiness, lethality, and capacity to provide a Navy that is "ready to fight today" while investing in the means to win future wars.[1] At the same time, working in concert with the other services and under the leadership of U.S. Indo-Pacific Command (INDOPACOM), the Navy is the primary military component of our government's efforts to ensure "a free and open Indo-Pacific," by which is meant an Indo-Pacific that is "free from coercion by other nations" and free to choose trading partners and exercise sovereignty.[2]

The demands of being a force in readiness for combat while also competing in the day-to-day great-power competition with Russia and China are placing increasing strain on the fleet. In 2000, the Navy had 318 battle force ships, and today, despite growing maritime challenges, it must meet its operational obligations with only 300. Yet the average number of ships underway since 2000 has "remained roughly constant."[3] Confronting persistent and increasingly dire maritime challenges while recovering from a series of fatal collisions in 2017 and overcoming institutional confusion caused by highly visible leadership changes, the Navy is at an inflection point.

Strategic Framework. The Navy, Marine Corps, and Coast Guard (known collectively as the sea services) have enabled the U.S. to project power across the oceans, controlling activities on the seas when and where needed. However, competitors increasingly contest U.S. maritime presence, stressing the ability of the current fleet to execute national missions and causing allies and potential security partners around the world to question the nation's reliability.

As the U.S. military's primary maritime arm, the Navy provides enduring forward global presence that enables the U.S. to respond quickly to global crises. As a result, naval forces are often the first responders, preserving and safeguarding U.S. security interests. To this end, the Navy's strategic approach has been to focus its investments in several functional areas: power projection, control of the seas, maritime security, strategic deterrence, and domain access. This approach is informed by several key documents:

- The 2017 National Security Strategy;[4]
- The 2018 National Defense Strategy (NDS);[5]
- The Global Force Management Allocation Plan (GFMAP);[6] and
- The Chief of Naval Operations (CNO) December 2019 Fragmentary Order.[7]

Significantly, the 2018 NDS directs the building of a more lethal, resilient, and agile force to deter and defeat aggression by great-power competitors across the spectrum of military operations. In recent years, this

TABLE 4

Navy Force Structure Assessment

Ship Type/Class	Current Fleet	2016 Force Structure Assessment	*Index* Recommendation*
Ballistic Missile Submarines	14	12	12
Aircraft Carriers	11	12	13
Large Surface Combatants	91	104	105
Small Surface Combatants	32	52	71
Attack Submarines	52	66	65
Guided Missile Submarines	4	0	0
Amphibious Warships	33	38	45
Combat Logistics Force	30	32	54
Command and Support	32	39	35
Total	**299**	**355**	**400**

* The recommendation for a 400-ship navy comes from Thomas Callender, "The Nation Needs a 400–Ship Navy," Heritage Foundation *Special Report* No. 205, October 26, 2018, https://www.heritage.org/defense/report/the-nation-needs-400-ship-navy.
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requirement has necessitated a shift to an emphasis on forward presence that ensures the Navy's positional advantage to execute sea control and denial of key maritime theaters.[8] The GFMAP specifies the global forward force presence to meet the challenges posed by our competitors.

Shortly after assuming his responsibilities as CNO, Admiral Michael M. Gilday issued a fragmentary order (FRAGO) updating the current Navy strategy. This update does not diverge from the previous Navy strategy, which focused on implementing the National Defense Strategy by supporting investments in readiness, capability, and capacity.[9] Typically, a FRAGO is a temporary update before a fuller revision is released.[10] That said, the Navy's goal remains being "ready to fight and win."[11]

However, competitors like China and Russia have studied how the U.S. military operates and have developed capabilities and implemented concepts of operations that challenge our Navy below the level of armed conflict. Too often, the fact that the U.S. does not have an effective response enables a competitor to achieve its objective, thus undermining the rules-based status quo. For the past several years, acknowledging today's reality and closing this strategic and tactical seam has been a focus of what INDOPACOM Commander Admiral Philip S. Davidson calls "win before fighting."[12] The Navy's effectiveness in this "gray zone" can contribute significantly to a free and open Indo-Pacific against malign actors that seek political objectives without firing a shot.

With this in mind, attempts to measure the capacity, capability, and readiness of the Navy increasingly must take into account metrics beyond conventional warfighting and include operational effectiveness across the spectrum

of day-to-day competition with China and Russia. For the Navy, however, conventional warfighting remains the principal factor informing its size, set of capabilities, and operational readiness. This *Index* therefore focuses on these elements as the primary criteria by which to measure U.S. naval strength:

- Sufficient **capacity** to defeat adversaries in major combat operations and provide a credible peacetime forward presence to maintain freedom of shipping lanes and deter aggression;
- Sufficient technical **capability** to sustain America's advantage against potential adversaries; and
- Sufficient **readiness** to ensure that the fleet can "fight tonight" given proper material maintenance, personnel training, and physical well-being.

Concepts of Operations. Under increasing threat from anti-ship ballistic missiles, cruise missiles, and submarines, the fleet has worked to develop countermeasures to include new concepts of operations.[13] As field testing of these concepts begins, the experience gained will significantly inform future force structure and likely be a key element in the forthcoming Integrated Naval Force Structure Assessment (INFSA) expected in the fall of 2020.

Capacity

Force Structure. The Navy measures capacity by the size of its battle force, which is composed of ships it considers directly connected to combat missions.[14] This *Index* continues the *2020 Index*'s budget-agnostic benchmark of 400 ships for the minimum manned battle force fleet. A fleet of this size is better able to maintain a global forward presence to deter potential aggressors while assuring allies and attracting maritime partners. To this end, the *Index* uses the fleet size required to handle two major wars or major regional contingencies (MRCs) simultaneously or in closely overlapping time frames as the benchmark against which to measure service capacity.

An accurate assessment of the Navy's capacity takes into account both presence and deterrence. A 400-ship fleet can provide:

- 13 Carrier Strike Groups (CSG), with 11 operationally available and 20 percent as a strategic reserve;
- 13 carrier air wings, with a minimum of 624 strike fighter aircraft;[15]
- 15 Expeditionary Strike Groups (ESGs), requiring 38 amphibious warfare vessels under the two-MRC construct, to ensure the ability to execute two Marine Expeditionary Brigade (MEB)–level operations simultaneously;[16]
- The historical steady-state demand of approximately 100 ships constantly forward deployed in key regions around the world; and
- Sufficient capacity to maintain the Navy's ships properly and ensure that its sailors are adequately trained to "fight tonight."[17]

This benchmark represents a significant increase from the FY 2018 National Defense Authorization Act (NDAA), which specified a battle force fleet of 355 ships,[18] and the Navy's own 2016 Force Structure Assessment (FSA).[19] It is worth noting that the 2016 FSA also concluded that a 653-ship force would be necessary to address all of the demands registered in the FY 2017 Global Force Management (GFM) request but deemed this to be unrealistic given resource constraints.[20] Given such a large disparity and demands levied by the 2018 National Defense Strategy, the Navy's leadership has indicated that the next FSA (the INFSA) will address the force-level requirements of supporting concepts such as Marine Expeditionary Advance Base Operations (EABO).[21]

The need to meet growing national security needs while remaining in budget is forcing the

Navy to rethink force structure. To this end, according to Acting Secretary of the Navy Thomas Modly, CNO Gilday, and Marine Corps Commandant General David Berger, the Navy will have to incorporate more unmanned vessels and larger numbers of smaller vessels.[22]

While the 2020 INFSA has yet to be released, public statements from the Navy's leadership and evolving concepts of operations make it increasingly clear the Navy's future battle force will be composed of a mixture of manned and unmanned ships for a combined total of approximately 435 warships.[23] Given the Navy's continuing fleet readiness demands and the NDS's focus on the "reemergence of long-term strategic competition,"[24] there is a growing argument for an even larger and more capable fleet.

Shipbuilding Capacity. Over a decade, from 2007–2017, as U.S. shipbuilding capacity languished, China's navy grew by more than 27 percent to 335 warships, and its commercial shipbuilding grew by 60 percent.[25] As of March 2020, the U.S. Navy had contracted to build 79 ships with 47 ships under construction and delivery of 12 ships expected in FY 2020.[26] The FY 2021 budget includes $21 billion for the construction of eight new ships with 44 additional battle force ships and 17 unmanned ships to be purchased over the next five years in the Future Years Defense Program (FYDP).[27]

Specific to FY 2021, procurement includes one *Columbia*-class submarine and one *Virginia*-class submarine; two *Arleigh Burke* Flight III destroyers; one guided missile frigate; one LPD (amphibious transport dock) Flight II; and two towing, salvage, and rescue (T-ATS) ships.[28] In a cost-saving effort, the Navy has requested a two-ship block buy in FY 2021, which the Senate Armed Services Committee supports. Assuming that the Navy gets the required congressional authorizations, such a block purchase could be executed in October 2020.[29] Despite these acquisitions, the Navy will struggle to meet the 355-ship goal by 2034.

Larger outlays for new ship construction necessarily impose greater demands on shipyard infrastructure. The Navy's procurement of 12 ships in FY 2020 marked a significant increase in shipbuilding measured against similar outlays over the past 20 years.[30] At the same time, to keep pace with the growing workload at public shipyards facilitating nuclear warships, new hiring has increased public shipyard labor by 16 percent since 2013.[31]

On average, a large U.S. warship joins the fleet three to five years after it is purchased. Importantly, any decision regarding production, maintenance, or design alternations during this long production period can have significant implications for the delivery of needed ships. Production of nuclear-powered warships (i.e., submarines and aircraft carriers) involves particular issues of shipyard capacity. The industrial base, for example, has limited excess capacity over the next 30 years to accelerate the production of attack submarines.[32]

With respect to aircraft carriers, the FY 2019 NDAA states: "It is the sense of Congress that the United States should accelerate the production of aircraft carriers to rapidly achieve the Navy's goal of having 12 operational aircraft carriers."[33] The Congressional Research Service has argued that purchasing one new aircraft carrier every three years would enable the Navy to meet this goal by 2030;[34] however, given the time that has already passed, such a timeline may not be entirely realistic.

The Navy's FY 2020 budget request included a two-ship aircraft carrier procurement of CVN-80 and CVN-81 in FY 2020, realizing an estimated $3.9 billion in savings over buying the ships separately.[35] Under considerable bipartisan pressure, the Navy also delayed the decommissioning of USS *Truman* (CVN-75).[36] Keeping *Truman* operational involves increased operational costs and extensive shipyard refueling, necessitating an additional $16.9 million in FY 2021, $234.7 million in FY 2022, and an additional $1.3 billion in FY 2023 and FY 2024.[37] Unless the Office of the Secretary of Defense and Congress provide increased funding to the Department of the Navy beginning in FY 2021, the Navy will be forced either to make cuts in its shipbuilding plan or

to curtail the development of the new lethal technologies for which the planned savings were earmarked.

Despite congressional mandates that a fleet of 12 aircraft carriers be maintained, early indications are that Secretary of the Navy Kenneth Braithwaite will defer to DOD's Cost Assessment and Program Evaluation (CAPE) and decisions by Secretary of Defense Mark Esper with regard to the number of carriers. Unofficial reporting of an internal Pentagon study suggests that the aircraft carrier fleet could shrink to nine.[38] Adding to this, days after that report was leaked, during a commencement speech at the U.S. Naval Academy, Esper pointed to a fleet consisting of more small surface warships, to include more lightly or unmanned ships, in order to deploy a larger fleet that is more lethal and sustainable.[39] In the absence of a 2020 INFSA, it is impossible to ascertain either the validity of this proposal or how the capacity and capability required can be mitigated if the Navy is directed to implement further reductions in its aircraft carrier fleet.

Munitions. USINDOPACOM is the primary driver of the Navy's procurement of munitions. As the Combatant Command responsible for war plans in the Pacific, USINDOPACOM bases its needs on the distances and maritime nature of war in that setting, which drives requirements for the most advanced long-range munitions. Top priorities for increased procurement are Long Range Anti-Ship Missiles (LRASM); SM-6 long-range, AIM-120D medium-range, and AIM-9X short-range anti-air missiles; MK-48 torpedoes; and BGM-109 Block IV Maritime Strike Tomahawk missiles. In order to sustain the Navy forward in conflict, upgrading of storage facilities, reassessment of prepositioning, and recapitalization of sealift are required based on the evolving Pacific security environment.[40]

The relatively small numbers of key munitions being purchased raise several concerns: sufficiency of the precision-guided munitions stockpiles, the surge capacity of industry to meet demand while in conflict, and security of the supply chain.[41] Even should munitions be staged and produced in the numbers needed, there remain serious concerns about the ability to move them and restock warships in a timely manner during conflict: a role for which sealift is critical.[42]

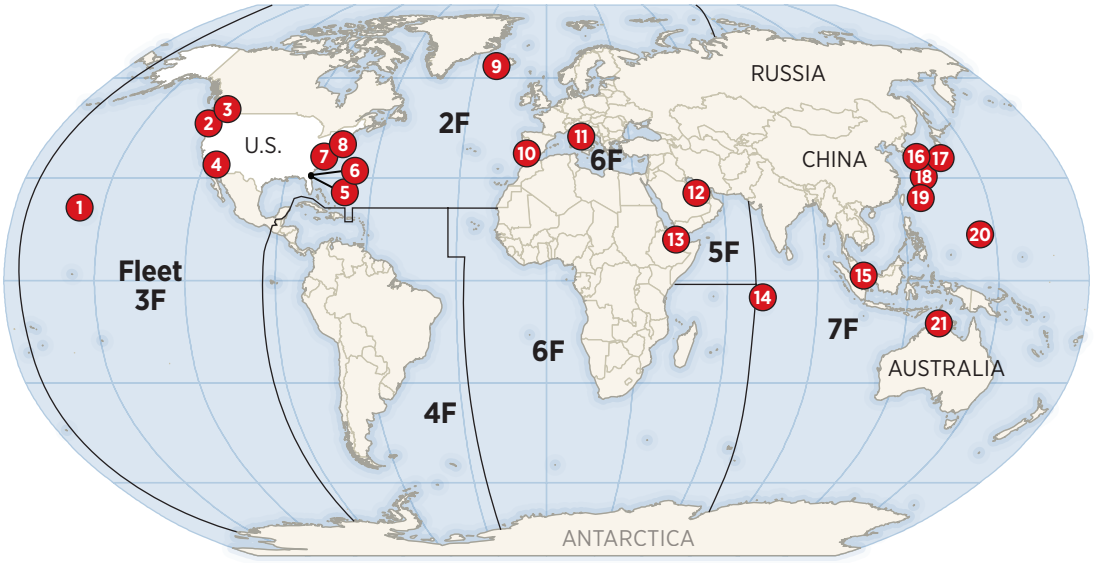
Manpower. The Navy assesses that end-strength manpower will need to grow by approximately 35,000 sailors to support a 355-ship Navy.[43] To improve personnel readiness and meet the demands of a growing fleet, the Navy is adding 5,100 sailors in FY 2020.[44] The proposed FY 2021 budget continues these increases in active-duty manning end strength by an additional 7,300 sailors.[45] Although the Navy is working proactively to address manning shortfalls and anticipate the demands of a growing fleet, Admiral Christopher Grady, Commander of United States Fleet Forces Command, informed Congress in February 2019 that the Navy has about 6,200 fewer sailors than it needs to meet at-sea manning requirements.[46]

After insufficient crew manning was found to be a contributing factor in the fatal USS *Fitzgerald* and USS *John S. McCain* collisions, the Navy increased the minimum required number of sailors on all ship classes between 4 percent and 14 percent, exacerbating manning shortfalls. The Navy is taking proactive approaches to meet these challenges head on by increasing the number of recruiters; focusing 70 percent of recruiting campaigns on digital platforms; reassessing some outdated recruiting policies; and offering targeted recruitment bonuses for critical Navy occupations such as nuclear power specialties, special forces (SEALs), and explosive ordnance disposal technicians.

However, the Navy faces several persistent challenges in meeting the growing demand for sailors: Only 29 percent of young adults qualify to join the military, and only 7 percent of young Americans are interested in enlisting in the Navy.[47] Despite this, the Navy has been able to make progress, reducing gapped billets from 6,500 to 4,900 over the year ending in December 2019 while meeting retention goals for all zones in 2019 and retaining 76 percent of the force.[48] Moreover, despite a three-week pause

MAP 8

Key U.S. Naval Installations



1. **Joint Base Pearl Harbor-Hickham, HI**
   U.S. Pacific Fleet headquarters
2. **Naval Base Kitsap**
3. **Naval Station Everett, WA**
4. **Naval Base San Diego and Naval Base Coronado, CA**
   U.S. Third Fleet headquarters
5. **Naval Station Mayport, FL**
   U.S. Fourth Fleet headquarters
6. **Naval Submarine Base King's Bay, GA**
7. **Naval Base Norfolk and Joint Expeditionary Base Little Creek, VA**
   U.S. Fleet Forces Command and U.S. Second Fleet headquarters
8. **Naval Submarine Base New London, CT**
9. **Keflavik, Iceland—Expeditionary Maritime Operations Center**
10. **Naval Station Rota, Spain**
11. **Naval Support Activity Gaeta, Italy**
    U.S. Sixth Fleet headquarters
12. **Naval Support Activity, Bahrain**
    U.S. Fifth Fleet headquarters
13. **Lemonnier, Djibouti—Camp Lemonnier**
14. **Diego Garcia—Navy Support Facility Diego Garcia**
15. **Singapore—Commander Logistics Group Western Pacific**
16. **Buson, South Korea—Fleet Activities Chinhae Navy Base**
17. **U.S. Fleet Activity Yokosuka, Japan**
    U.S. Seventh Fleet headquarters
18. **U.S. Fleet Activity Sasebo, Japan**
19. **Okinawa, Japan—Naval Base White Beach**
20. **Naval Base Guam—Navy Expeditionary Force Command Pacific headquarters**
21. **Darwin, Australia—Marine Rotational Force Darwin**

NOTE: Fleet boundaries are approximate.
SOURCE: Heritage Foundation research.

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in recruit training caused by the coronavirus, the Navy remains confident that larger class sizes will allow it to meet its FY 2020 recruiting goal of 40,800 new sailors.[49]

Posture/Presence. To provide continual presence and readiness for the fleet, the FY 2021 budget funds each ship 58 days underway while deployed, and 24 days underway while non-deployed per quarter with an increase of 6.5 percent over last year for ship operations funding. Importantly, the FY 2021 budget increases the Flying Hour program by 5.8 percent with the objective of having squadrons combat-ready upon deployment.[50] As of July 10, 2020, of a total battle force of 300 ships, 64 (21 percent) were deployed forward, and 32 (11 percent) were being used for local operations and training.[51]

While the Navy remains committed to deploying roughly a third of its fleet at all times, it increasingly struggles to maintain this ratio. Given Combatant Commanders' requirements for naval presence, there is impetus to have as many ships forward deployed as possible by:

- **Homeporting:** The ships, crew, and their families are stationed at the port or based abroad (e.g., a CSG in Yokosuka, Japan).

- **Forward Stationing:** Only the ships are based abroad while crews are rotated out to the ship.[52] This deployment model is currently used for Littoral Combat Ships (LCS) and *Ohio*-class guided missile submarines (SSGNs) manned with rotating blue and gold crews, effectively doubling the normal forward deployment time (e.g., LCS in Singapore).

These options allow one forward-based ship to provide a greater level of presence than four ships based in the continental United States (CONUS) by offsetting the time needed to transit ships to and familiarize their crews with distant theaters.[53] This is captured in the Navy's GFM planning assumptions: a forward-deployed presence rate of 19 percent for a CONUS-based ship compared to a 67 percent presence rate for an overseas-homeported ship.[54]

Capability

A complete measure of naval capabilities requires an assessment of U.S. platforms against enemy weapons in plausible scenarios employing contemporary operational concepts. The Navy routinely conducts war games, exercises, and simulations to assess this, but insight into these assessments is limited by their classified nature. This *Index* therefore assesses capability based on remaining hull life, mission effectiveness, payloads, and the feasibility of maintaining the platform's technological edge.

Most of the Navy's battle force fleet consists of legacy platforms; of the Navy's current 20 classes of ships, only eight are in production. Investments to improve lethality comprise approximately 21 percent of the Navy's budget, with future capability at approximately 11 percent and modernization at approximately 10 percent.[55] Highlights by platform follow.

Strategic Nuclear Deterrence (SSBN). *Columbia*-class is set to relieve the aging *Ohio*-class SSBN fleet. Because of the implications of this for the nation's strategic nuclear deterrence, *Columbia*-class SSBN remains the Navy's top acquisition priorty.[56] From a purely resourcing perspective, the FY 2021 budget should ensure that the first *Columbia*-class SSBN is delivered on time for its first deterrent patrol in 2031 and that construction of a second SSBN begins in FY 2024 with serial production beginning in FY 2026.[57]

Nuclear Attack Submarines (SSN). SSNs are multi-mission platforms whose stealth enables covert intelligence collection; surveillance; anti-submarine warfare (ASW); anti-surface warfare (ASuW); special operations forces insertion and extraction; land attack strikes; and offensive mine warfare. The Navy's FY 2020 budget and shipbuilding plan reduced submarine procurement to eight Block V submarines with the Virginia Payload Module (VPM) enhancement, resulting in a reduced total Tomahawk carrying capacity of 28 missiles by 11 *Virginia*-class submarines.[58]

Despite this, the FY 2021 National Defense Authorization Act working its way through Congress includes $472 million in additional funds for advance procurement to preserve a future option to buy up to 10 *Virginia*-class submarines through FY 2023.[59]

Aircraft Carriers (CVN). The Navy has 11 nuclear-powered aircraft carriers: 10 *Nimitz*-class and one *Ford*-class. The Navy has not announced any delay in USS *Ford*'s first operational deployment in FY 2022. The second ship in the class, *John F. Kennedy* (CVN-79), christened on December 7, 2019, and launched two-months early on December 16, 2019, is 68 percent construction complete.

Large Surface Combatants. Retirement of the two oldest *Ticonderoga*-class cruisers, scheduled for FY 2020, has been deferred to FY 2021 to allow the Navy to assess the cost of maintaining them versus the increased lethality that would come from modernizing these ships.

The Navy's FY 2021 budget request procures two *Arleigh Burke*–class DDG-51 Flight III destroyers as part of a 10-ship Multi-Year Procurement (MYP), bringing the class size to 87 ships.[60] To reach the goal of 355 ships by 2034, according to the Chief of Naval Operations, the Navy plans several "class-wide service life extensions." The FY 2020 budget, for example, included $4 billion for modernization of 19 guided missile destroyers from FY 2021 through FY 2024.[61] In an effort to sustain the industrial base for these ships, the Senate Armed Services Committee's NDAA mark for the FY 2021 budget included $260 million in additional funds to procure *Arleigh Burke*–class long lead time materials.[62] On July 23, 2020, the Senate passed its version of the FY 2021 NDAA, which includes these additional funds.[63] The House version passed on July 21, 2020, does not include these funds.[64] Resolution of this difference one way or the other for FY 2021 is not likely to affect the immediate build rate of these ships.

The *Zumwalt*-class DDG-1000's primary mission is surface strike (the use of missiles to attack surface ships and possibly land targets).[65] The DDG-1000 was on track for final delivery at the end of March 2020 with continued testing to achieve Initial Operational Capability (IOC) by September 2021.[66] The DDG-1001 was commissioned on January 26, 2019, and as of March 2020 was undergoing combat system installation.[67]

Small Surface Combatants. By October 2021, beginning with USS *Montgomery* in 2019, nine Littoral Combat Ships will have deployed overseas.[68] Mission packages (MP) provide various warfighting capabilities—surface warfare (SUW); anti-submarine warfare (ASW); and mine countermeasures (MCM)—on one LCS hull form. MCM MP certification will be completed on *Independence* variants and *Freedom* variants by the end of calendar year 2020.[69] The complete mine mission packages will not reach IOC until 2022 at the earliest.

The FY 2020 budget removed planned life extensions for four mine countermeasure ships and accelerated retirement of all *Avenger*-class MCMs by FY 2023.[70] If delays occur, the Navy risks losing a certified and fully operational MCM capability beginning in FY 2023.

Instead of requesting additional Littoral Combat Ships, the Navy has focused investment on an initial contract for FFG(X) guided missile frigates in FY 2020. On April 30, 2020, the Navy awarded Fincantieri $795 million to build the lead ship at its Marinette Marine shipyard in Wisconsin based on a proven design currently in service with the French and Italian navies.[71] The FY 2021 budget supports purchase of the second ship with annual procurement beginning in FY 2023.[72]

Amphibious Ships. Commandant of the Marine Corps General David Berger issued the 38th "Commandant's Planning Guidance" in July 2019 and "Force Design 2030" in March 2020. Both documents signaled a break with past Marine Corps requests for amphibious lift, specifically moving away from the requirement for 38 amphibious ships that it had determined were necessary to support an amphibious force of two Marine Expeditionary Brigades (MEB).[73] The Commandant envisions a larger yet affordable fleet of smaller, low-signature amphibious

ships that enable littoral maneuver and associated logistics support in a contested theater.[74] The current Navy amphibious fleet remains centered on fewer large ships.

The Navy's 12 landing ships (LSDs), the *Whidbey Island*–class and *Harpers Ferry*–class amphibious vessels, are currently scheduled to reach the end of their 40-year service lives in 2025. The 13-ship LPD-17 Flight II program will replace these legacy landing ships. The *San Antonio*–class LPD-28, currently 65 percent complete, will be delivered in September 2021,[75] and the Senate Armed Services Committee NDAA mark for the FY 2021 budget includes $500 million in additional funds to procure long lead time materials for LPD-32 and LPD-33.[76] The Senate version of the FY 2021 NDAA passed on July 23, 2020, includes these additional funds; the House version passed on July 21, 2020, does not. Resolution of this difference one way or the other is not expected to affect the build rate in the immediate future.

As of July 15, 2020, the Navy had nine amphibious assault ships in the fleet: eight *Wasp*-class LHDs and the USS *America* LHA-6.[77] USS *Tripoli* (LHA-7) was delivered on February 28, 2020, and fabrication has begun on LHA-8, supporting an FY 2024 delivery.[78] The Senate Armed Services Committee NDAA mark for the FY 2021 budget included $250 million in additional funds to accelerate construction of LHA-9.[79] The Senate version of the FY 2021 NDAA passed on July 23, 2020, includes these additional funds; the House version passed on July 21, 2020, does not. How the two chambers resolve this difference could affect the Navy's ability to sustain its amphibious capacity in the wake of the July 2020 fire on USS *Bonhomme Richard*, which makes earlier delivery of the LHA-9 more important.

Unmanned Systems. Currently, the Navy does not include unmanned ships in counting its battle force size. The FY 2021–FY 2025 budget includes $12 billion for unmanned platforms, an increase of 129 percent over FY 2020 that is invested specifically in unmanned surface vessels (USV) and unmanned undersea vessels (UUV).[80] The Navy's single Medium USV (MUSV) *Sea Hunter* prototype and a second scheduled for delivery in late FY 2020 will join two Large USV (LUSV) by FY 2022 under Surface Development Squadron One (SURFDEVRON 1)[81] to develop associated operating requirements.[82] In a show of concern, both the Senate and House Armed Services Committees' NDAA marks for the FY 2021 budget included stipulations that the Navy qualify the reliability of engines and power generators before procuring unmanned surface vessels.[83]

In 2019, the Marine Corps' Long Range Unmanned Surface Vessel conducted autonomous navigation from Norfolk, Virginia, to Cherry Point, North Carolina, during the Advanced Naval Technology Exercise-East Super Swarm Exercise.[84] Because the Marine Corps will procure three vessels to conduct further evaluation and demonstration, it is unclear how this effort aligns with similar investments in the Navy's *Sea Hunter* program.

Logistics, Auxiliary, and Expeditionary Ships. Expeditionary support vessels are highly flexible platforms consisting of two types: Expeditionary Sea Base (ESB) for prepositioning and sustaining forward operations and shallow-draft high-speed Expeditionary Fast Transport (EPF). ESB-6 and ESB-7 are planned for delivery in FY 2022 and FY 2023, respectively, and an enhanced medical capability is planned for EPF-14.[85]

The Navy's Combat Logistics Force (CLF) consists of dry-cargo and ammunition ships (T-AKE); fast combat support ships (T-AOE); and oilers (AO). The CLF provides critical support that includes at-sea replenishment that enables the Navy to sustain the fleet at sea for prolonged periods.[86] T-AO 205 is 76 percent complete, and delivery is planned for June 2021.[87] The FY 2021 budget request increases towing, salvage, and rescue (T-ATS) procurement for a total of two ships and also increases resources for CLF operations and sustainment and the acquisition of two Maritime Prepositioning Force (MPF) ships.[88]

Strike Platforms and Key Munitions. The proposed budget for FY 2021 continues the Navy's focus on developing long-range,

offensive strikes launched from ships, submarines, and aircraft, including Conventional Prompt Strike (CPS); the Maritime Strike Tomahawk (MST); the Joint Standoff Weapon Extended Range (JSOW-ER); the Long-Range Anti-Ship Missile (LRASM); and the Standard Missile-6 (SM-6).

Specifically, the budget sustains the rapid prototyping of upgraded SM-2 Block IIIC and SM-6 Block IB.[89] It also supports procurement of 155 Block V Tactical Tomahawk (TACTOM) cruise missiles, 156 Navigation/Communication upgrade kits to improve performance in A2/AD environments, and 44 Maritime Strike Tomahawk (MST) kits in addition to 48 LRASM.[90] The Senate Armed Services Committee NDAA mark for the FY 2021 budget included $26 million for 10 additional TACTOMs for a new total of 165 missiles to be purchased.[91] It also included $35 million in additional funds to procure 10 additional LRASM for a new total of 58 missiles to be purchased, in part by shifting funding from Joint Air-to-Surface Stand-off Missile (JASSM) production.[92] The Senate version of the FY 2021 NDAA passed on July 23, 2020, includes these additional funds; the House version passed on July 21, 2020, does not.

Shore-Based Anti-Ship Capabilities. Following the August 2019 U.S. withdrawal from the Intermediate-Range Nuclear Forces (INF) Treaty, new conventional strike options became viable, especially when considering the use of medium-range missiles that would have great relevance along the first island chain in any conflict with China.[93] The FY 2020 budget included $76 million to develop ground-launched cruise missiles.[94] In a sign of confidence in this capability, the Senate Armed Services Committee NDAA mark for the FY 2021 budget included $59.6 million in additional funds to procure 36 ground-based anti-ship missiles.[95] Both the House and Senate versions of the FY 2021 NDAA, passed on July 21 and July 23, 2020, respectively, include this additional funding, indicating bipartisan support for increasing the Army's role in maritime combat.

Electronic Warfare. Electronic Warfare (EW) is a critical element of successful modern warfare, the goal being control of the electromagnetic spectrum (EMS) by exploiting, deceiving, or denying its use by an enemy while ensuring its use by friendly forces. The final dedicated EW aircraft, EA-18G, was delivered in July 2019, meeting the Navy's requirement of nine carrier air wings, five expeditionary squadrons, and one reserve squadron.[96] Anticipating the EA-18G's retirement in the 2030s, the Navy has been exploring follow-on manned and unmanned systems to replace the EA-18G. In order to maintain this critical warfighting capability at capacity, however, the Navy will need to decide soon on a future platform.

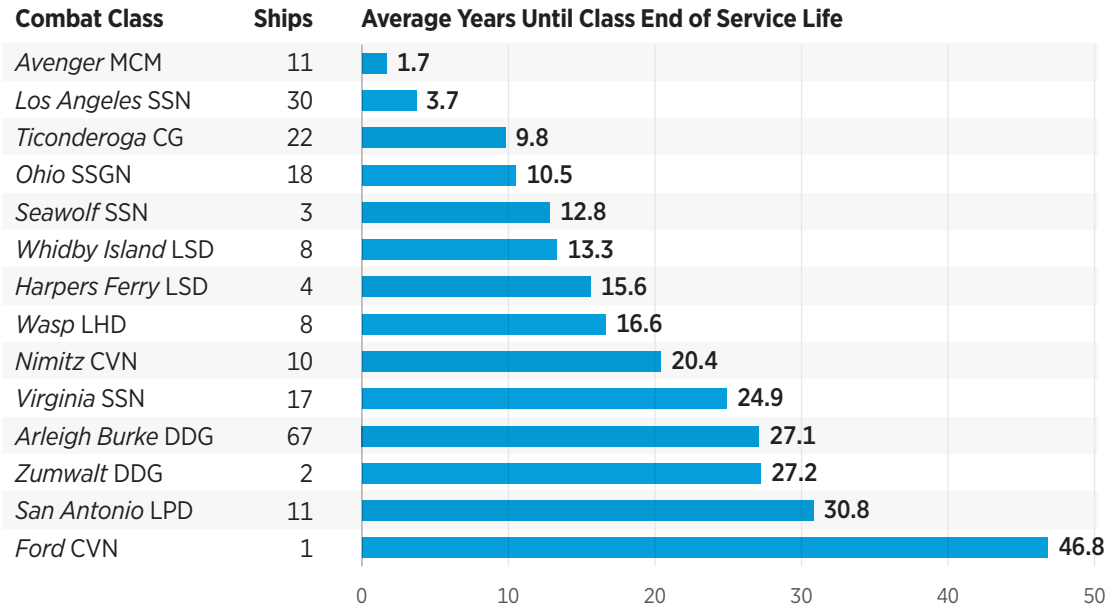
Air Early Warning. The E-2D forms the hub of the Naval Integrated Control-Counter Air system and provides critical Theater Air and Missile Defense capabilities. The Navy's FY 2021 budget procures four aircraft with an additional 10 aircraft to be procured over the next two years.[97] Sustaining effective air early warning and air control of unmanned platforms remains a critical element of naval power projection.

High Energy Laser (HEL). The FY 2020 budget included $101 million for the Navy Laser Family of Systems (NLFoS).[98] The FY 2021 budget would sustain these investments with $170.3 million requested for directed energy programs.[99] A recent milestone was achieved when USS *Portland* (LPD-27) used its HEL Weapon System Demonstrator to shoot down an unmanned aerial vehicle (UAV) over the Pacific on May 16, 2020.[100]

Command and Control. The Navy has consolidated information management in the Office of the Chief Information Officer (CIO). The Navy plans to spend $4.17 billion from FY 2021–FY 2026 to bolster cyber defense and resiliency to attack.[101] Such investments are meant to prevent competitors' efforts to nullify the Navy's technological advantage or interfere in its logistic infrastructure (much of it on unclassified networks), which is especially critical during early phases of a crisis.

CHART 6

Navy Combat Ships Nearing End of Service Life



NOTE: Figures are based on calculations for October 2020.
SOURCE: Naval Sea Systems Command, Naval Vessel Register, "Fleet Size," http://www.nvr.navy.mil/NVRSHIPS/FLEETSIZE.HTML (accessed August 19, 2020).

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Readiness

In the 1980s, the Navy had nearly 600 ships in the fleet and kept roughly 100 (17 percent) deployed at any one time. Today, the fleet numbers 300 ships, of which 92 (30.7 percent) are at sea or deployed. The commanding officer's discretion time for training and crew familiarization is a precious commodity that is made ever scarcer by the increasing operational demands on fewer ships.

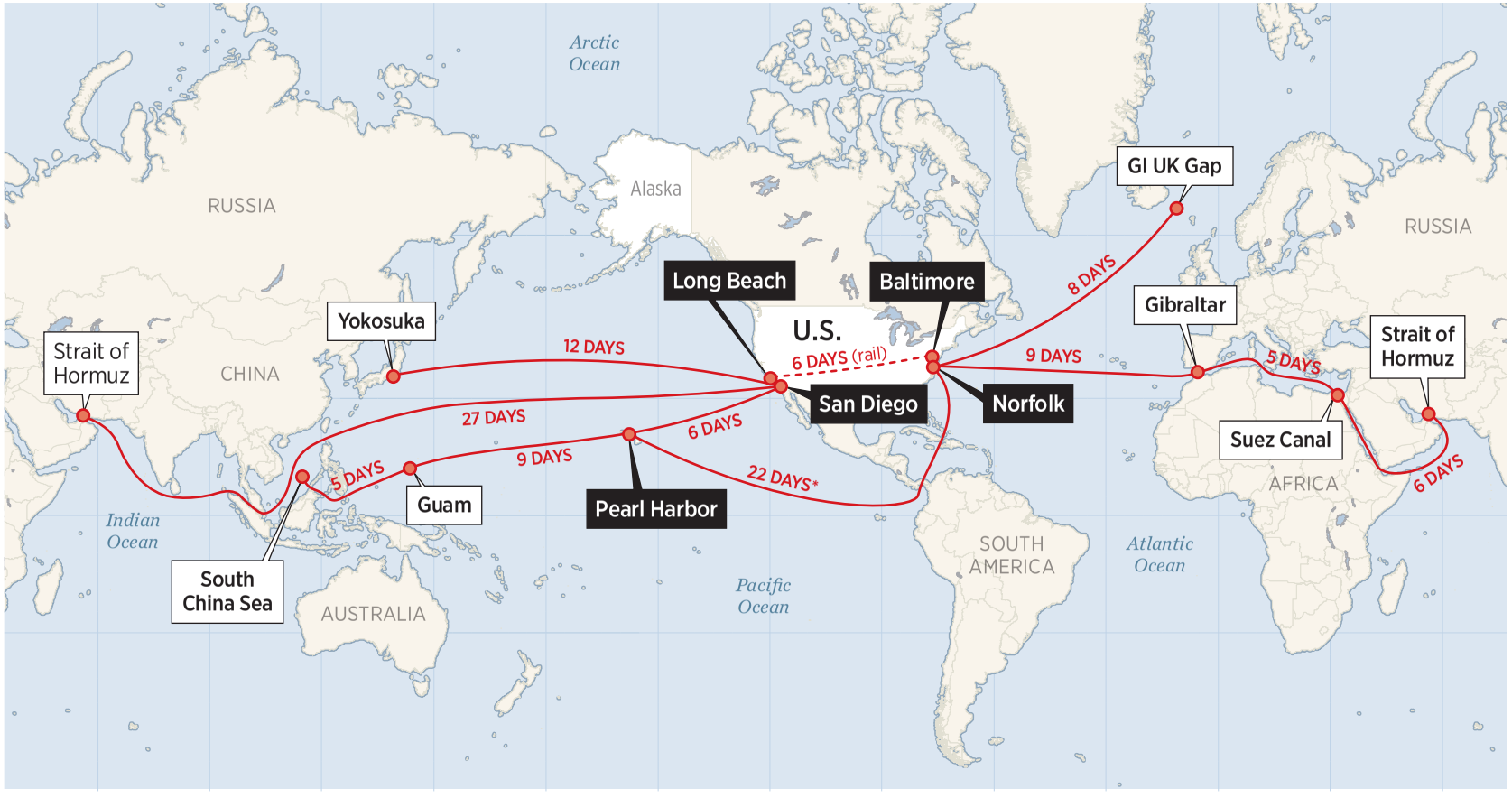
FY 2019 marked the first time in over a decade that the Defense Department and the Navy did not operate under a continuing resolution for at least part of the fiscal year. Having a full fiscal year to plan and execute maintenance and operations helped the Navy continue on its path to restoring fleet readiness, but Admiral John Richardson, Chief of Naval Operations, testified before the Senate Armed Services Committee in April 2018 that it would take until 2021 or 2022 to restore fleet readiness to an "acceptable" level and that the continued lack of "stable and adequate funding" would delay these efforts.[102] Having to begin FY 2020 under a continuing resolution introduced uncertainty again, causing the planned maintenance periods of two ships, the USS *Bainbridge* (DDG-96) and USS *Gonzalez* (DDG-66), to be postponed.[103]

Impact of COVID-19. The Navy, like the rest of the nation, was not as prepared as it should have been for the COVID-19 pandemic. The coronavirus's most visible impact on the Navy was the sidelining of the USS *Theodore*

MAP 9

Steaming Times to Areas of Vital U.S. National Interest

Steam times are approximates based on an average speed of 15 knots.



* Assumes no delay in passage through the Panama Canal.

SOURCE: Heritage Foundation research.

Roosevelt (CVN-71) in Guam for 55 days. As of September 23, 2020, the Navy had registered 9,930 uniformed military COVID-19 cases with one death.[104] The Navy also has scaled back the major biannual Rim of the Pacific Exercise (RIMPAC) to include only the at-sea portions of the event and has created a limited number of "safe haven" COVID-free ports where warships can call.[105]

Impacts on maintenance at the Navy's four public shipyards necessitated the activation of 1,629 reservists to backfill a quarter of the civilian workforce deemed to be at "high risk" for COVID-19.[106] Despite Navy press statements of June 2, 2020, that the *Columbia* program remains on track, its timeline has been affected, and how these reservists will mitigate those delays remains an open question.[107] As the pandemic passes, the several audits and inspector general investigations initiated following USS *Roosevelt*'s experience are expected to lead to numerous recommendations as to how the Navy can improve its resilience in responding to future pandemics.

Maintenance and Shipyard Capacity. Naval Sea Systems Command completed its Shipyard Optimization and Recapitalization Plan in September 2018.[108] To assist in its execution, on October 1, 2019, the Navy established a new office under a Deputy Assistant Secretary of the Navy for Sustainment that will align Navy and Marine Corps maintenance and modernization efforts.[109] In conjunction with implementing the $21 billion multi-year Shipyard Infrastructure Optimization Plan (SIOP), the Senate Armed Services Committee in its mark of the FY 2021 budget directed the establishment of a joint Department of the Navy–Department of Labor shipbuilding industrial base working group.[110] Improving public shipyard capacities is only just beginning, and the SIOP represents only one of several sustained efforts required.

A critical factor in assuring timely and quality warship maintenance periods at private shipyards is workload stability. For a sense of scale, as of December 2019, there were 45 ships in maintenance at private yards with 100 ships in various stages of planning for work in these shipyards. In essence, maintenance on one-half of the Navy's fleet is conducted by private shipyards.[111] The Navy has achieved some predictability by awarding multiple maintenance periods, giving shipyards a backlog of work that creates confidence in hiring and retaining a skilled workforce and making investments in infrastructure.

Training, Ranges, and Live Fires. Ship and aircraft operations and training are a critical element of fleet readiness. To this end, the Navy is seeking to expand and update instrumentation of the training range at Naval Air Station Fallon, Nevada, to enable practice with the most advanced weapon systems.[112] At the same time, core proficiency training in basic seamanship remains a priority.

During the summer of 2017, the U.S. Navy experienced the worst peacetime surface ship collisions in over 41 years when the USS *John S. McCain* (DDG-56) and USS *Fitzgerald* (DDG-62) collided with commercial vessels, claiming the lives of 17 sailors. Subsequently, the Vice Chief of Naval Operations ordered the *Comprehensive Review of Recent Surface Force Incidents*, which recommended corrective actions to address the root causes of poor operational risk management and unit readiness.[113] Concurrently, the Secretary of the Navy directed a *Strategic Readiness Review*, which made broad institutional recommendations that include (among others) the following:

- "The creation of combat ready forces must take equal footing with meeting the immediate demands of Combatant Commanders."
- "The Navy must establish realistic limits regarding the number of ready ships and sailors and, short of combat, not acquiesce to emergent requirements with assets that are not fully ready."
- "The Navy must realign and streamline its command and control structures to tightly align responsibility, authority, and accountability."

- "Navy leadership at all levels must foster a culture of learning and create the structures and processes that fully embrace this commitment."[114]

Despite the fact that the Navy implemented several maintenance and training reforms to improve fleet and aviation readiness, it will take several years of Navy leadership oversight and stable funding to ensure that sailors and platforms are returned to required readiness. It will take even longer to implement the recommendations in the *Strategic Readiness Review*'s recommendations on the institutional culture.

Scoring the U.S. Navy

Capacity Score: Weak

This *Index* assesses that a minimum of 400 battle force ships is required for the U.S. Navy to do what is expected of it. The Navy's current battle force fleet of 300 ships and intensified operational tempo combine to reveal a Navy that is much too small relative to its tasks. The result is a score of "weak," unchanged from the *2020 Index*. Depending on the Navy's ability to fund more aggressive growth options and service life extensions as identified in the FY 2020 30-year shipbuilding plan, the Navy's capacity score could fall further.

Capability Score: Marginal Trending Toward Weak

The overall capability score for the Navy remains "marginal" with downward pressure as the Navy's technological edge narrows against peer competitors China and Russia. The combination of a fleet that is aging faster than old ships are being replaced with new ships and the rapid growth of competitor navies with corresponding deployment of the most modern technologies does not bode well for U.S. naval power.

Readiness Score: Marginal Trending Toward Weak

The Navy's readiness is rated "marginal" trending toward "weak" as the Navy takes overdue readiness corrective actions that are complicated by an inadequate fleet size and overwhelmed maintenance infrastructure. Echoing the CNO, on the current trajectory relative to principal competitors (i.e., Russia and China), it will take at least until 2022 for the Navy to restore its readiness to required levels.

Overall U.S. Navy Score: Marginal Trending Toward Weak

The Navy's overall score for the *2021 Index* is "marginal" trending toward "weak." Correcting this trend will require successfully addressing several readiness and capacity bottlenecks while seeing to it that America has an operational fleet with the numbers and capabilities that it needs to counter Russian and Chinese advances in capability.

U.S. Military Power: Navy

	VERY WEAK	WEAK	MARGINAL	STRONG	VERY STRONG
Capacity		✓			
Capability			✓		
Readiness			✓		
OVERALL			✓		

Aircraft Carrier

PLATFORM	Age Score	Capability Score
***Nimitz*-Class Aircraft Carrier (CVN-68)** Inventory: **10** Fleet age: **28** Date: **1975** The *Nimitz*-class is a nuclear-powered multipurpose carrier. The aircraft carrier and its embarked carrier air wing can perform a variety of missions including maritime security operations and power projection. Its planned service life is 50 years. The class will start retiring in FY 2025 and will be replaced by *Ford*-class carriers.	3	3
***Ford*-Class Aircraft Carrier (CVN-78)** Inventory: **1** Fleet age: **3** Date: **2017** The *Ford*-class incorporates new technologies that will increase aircraft sortie rates, reduce manning, provide greater electrical power for future weapons systems, and decrease operating costs. Its planned service life is 50 years.	5	4

REPLACEMENT PROGRAM	Size Score	Health Score
***Ford*-Class Aircraft Carrier (CVN-78)** Timeline: **2017–2032** Currently in production, the *Ford*-class will replace the *Nimitz*-class aircraft carriers. The *Ford*-class design uses the basic *Nimitz*-class hull form but incorporates several improvements to achieve: 33 percent higher sortie rate; a smaller crew with approximately 600 fewer sailors; two-and-a-half times greater electrical power, and more than $4 billion in life-cycle cost savings over the *Nimitz*-class **PROCUREMENT** 3 **SPENDING** *($ millions)* $34,680 $18,291	2	2

NOTE: See page 402 for details on fleet ages, dates, and procurement spending.

NAVY SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2020 ■ Pending

Large Surface Combatant

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
***Ticonderoga*-Class Cruiser (CG-47)** Inventory: **22** Fleet age: **31.5** Date: **1983** The *Ticonderoga*-class is a multi-mission battle force ship equipped with the Aegis Weapons System. While it can perform strike, anti-surface warfare and anti-submarine warfare, its primary focus is air and missile defense. Having a life expectancy of 40 years, the Navy plans to retire eight of the 22 CGs between FY 2021 and FY 2024.	2	3	***Zumwalt*-Class Destroyer (DDG-1000)** Timeline: **2016–2022** The DDG-1000 was designed to be a new-generation destroyer capable of handling more advanced weapon systems for long-range strike with a hull design aimed to reduce radar detectability for its original primary mission of naval surface fire support (NSFS) . The DDG-1000 program was intended to produce a total of 32 ships, but this number reduced to three. The first DDG-1000 was commissioned in October 2016. **PROCUREMENT** 3 **SPENDING** *($ millions)* $12,987 $208	1	1
***Zumwalt*-Class Destroyer (DDG-100)** Inventory: **1** Fleet age: **4** Date: **2016** The *Zumwalt*-class is multi-mission destroyer that incorporates several technological improvements, such as a stealthy hull design and integrated electric-drive propulsion system. Although it has passed sea trials, it continues to experience problems with its combat systems. The third and final ship of the class was commissioned in FY 2020.	5	2			
***Arleigh Burke*-Class Destroyer (DDG-51)** Inventory: **67** Fleet age: **15** Date: **1991** The *Arleigh Burke*-class is a multi-mission guided missile destroyer featuring the Aegis Weapons System with a primary mission of air defense. The Navy plans to extend the service life of the entire class to 45 years from its original life expectancy of 35-40 years.	4	4	***Arleigh Burke*-Class Destroyer (DDG-51)** Timeline: **1991–2029** DDG–51 production was restarted in FY 2013 to make up for the reduction in DDG–1000 acquisitions. Beginning in FY 2017, all DDG-51s procured will use the Flight III design, which includes the Advanced Missile Defense Radar (AMDR), a more capable missile defense radar. **PROCUREMENT** 82 15 **SPENDING** *($ millions)* $89,948 $28,020	4	4

NOTE: See page 402 for details on fleet ages, dates, and procurement spending.

NAVY SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2020 ■ Pending

Small Surface Combatant

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
Littoral Combat Ship (LCS) Inventory: **19** Fleet age: **6.5** Date: **2008** The Littoral Combat Ship includes two classes: the *Independence*-class and the *Freedom*-class. The modular LCS design depends on mission packages (MP) to provide warfighting capabilities in the SUW, ASW, and MCM mission areas. The ship has an expected service life of 25 years.	5	2	**Littoral Combat Ship (LCS)** Timeline: **2009–2019** The LCS is intended to fulfill the mine countermeasure, antisubmarine warfare, and surface warfare roles for the Navy. It will be the only small surface combatant in the fleet once the Navy's MCM ships retire and until the new FFG(X) enter service. **PROCUREMENT** 33 **SPENDING** *($ millions)* $16,719 $80	2	2
***Avenger*-Class Mine Counter Measure (MCM-1)** Inventory: **11** Fleet age: **28.5** Date: **1989** *Avenger*-class ships are designed as mine sweepers/hunter-killers capable of finding, classifying, and destroying moored and bottom mines. The class has an expected 30–year service life. The remaining MCMs are expected to be decommissioned throughout the 2020s. While there is no direct replacement single-mission MCM ship in production, the Navy plans to fill its mine countermeasure role with the LCS and its MCM MP.	1		**FFG(X)** A new program called the FFG(X) will augment the LCS program to fill out the remaining 20–ship small surface combatant requirement for a total of 52 Small Surface Combatants.		

SSGN Cruise Missile Submarine

PLATFORM	Age Score	Capability Score	MODERNIZATION PROGRAM	Size Score	Health Score
***Ohio*-Class (SSGN-726)** Inventory: **4** Fleet age: **37.5** Date: **1981** The SSGNs provide the Navy with large stealthy strike and special operations mission capabilities. From 2002 to 2007, the four oldest *Ohio*-class ballistic missile submarines were converted to guided missile submarines. Each SSGN is capable of carrying up to 154 Tomahawk land-attack cruise missiles and up to 66 special operations forces for clandestine insertion and retrieval. All four SSGNs will retire between FY 2026 and FY 2028. The Navy has tentative plans to replace the SSGNs with a new Large Payload Submarine beginning in FY 2036.	2	4	None		

NOTE: See page 402 for details on fleet ages, dates, and procurement spending.

NAVY SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2020 ■ Pending

Attack Submarines

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
***Seawolf*-Class (SSN-21)** Inventory: **3** Fleet age: **19** Date: **1997** The *Seawolf*-class is exceptionally quiet, fast, well-armed, and equipped with advanced sensors. Though lacking a vertical launch system, the *Seawolf*-class has eight torpedo tubes and can hold up to 50 weapons in its torpedo room. Although the Navy planned to build 29 submarines, the program was cut to three submarines. The *Seawolf*-class has a 33-year expected service life. They have been succeeded by the *Virginia*-class attack submarine.	3	4	***Virginia*-Class (SSN-774)** Timeline: **2004–2019** The Virginia Payload Module (VPM) will be incorporated into eight of the 11 planned Block V submarines beginning in FY 2019. VPM includes four large-diameter, vertical launch tubes that can carry up to 28 additional Tomahawk missiles or other payloads. **PROCUREMENT** 30 28 **SPENDING** *($ millions)* $79,794 $68,285	2	3
***Los Angeles*-Class (SSN-688)** Inventory: **30** Fleet age: **34** Date: **1976** The *Los Angeles*-class comprises the largest portion of the Navy's attack submarine fleet. They are multi-mission submarines that can perform covert intelligence collection, surveillance, ASW, ASuW, and land attack strike. The *Los Angeles*-class has a 33-year expected service life. The last *Los Angeles*-class submarine is expected to retire in the late 2020s and is being replaced by the *Virginia*-class.	1	3			
***Virginia*-Class (SSN-774)** Inventory: **19** Fleet age: **8** Date: **2004** The *Virginia*-class is the U.S. Navy's next-generation attack submarine. The *Virginia*-class includes several improvements over previous attack submarine classes that provide increased acoustic stealth, improved SOF support, greater strike payload capacity and reduced operating costs. The planned service life of the *Virginia*-class is 33 years. The *Virginia*-class is in production and will replace the *Los Angeles*-class and *Seawolf*-class attack submarines as they are decommissioned.	4	4			

NOTE: See page 402 for details on fleet ages, dates, and procurement spending.

NAVY SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2020 ■ Pending

SSBN Ballistic Missile Submarine

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
***Ohio*-Class (SSBN)** Inventory: **14** Fleet age: **31** Date: **1981** The *Ohio*-class SSBN is most survivable leg of the U.S. military's strategic nuclear triad. The *Ohio* SSBN's sole mission is strategic nuclear deterrence, for which it carries long-range submarine-launched ballistic missiles. The *Ohio*-class's expected service life is 42 years. The *Ohio*-class fleet will begin retiring in 2027 at an estimated rate of one submarine per year until 2039. The *Ohio*-class is being replaced by the *Columbia*-class SSBN.	2	4	***Columbia*-Class (SSBN–826)** Timeline: **TBD** The 12-ship *Columbia*-class will replace the existing *Ohio*-class nuclear ballistic submarine force, which provides a credible and survivable sea-based strategic deterrent. The Navy's FY 2021 budget estimates total procurement cost for 12 ships to be $109.8 billion. The first patrol of the lead ship, SSBN 826, is scheduled for FY 2031.		

PROCUREMENT

12

SPENDING *($ millions)*

$109,800

Amphibious Warfare Ship

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
***Wasp*-Class Amphibious Assault Ship (LHD-1)** Inventory: **8** Fleet age: **21** Date: **1989** The *Wasp*-class can support amphibious landing operations with Marine Corps landing craft via its well deck. It can also support Marine Air Combat Element operations with helicopters, tilt-rotor aircraft and Vertical/Short Take-Off and Landing (V/STOL). This ship has a planned 40–year service life.	3	3	***America*-Class (LHA–6)** Timeline: **2004–TBD** LHA Flight 0 (LHA-6 and 7) were built without a well deck to provide more space for Marine Corp aviation maintenance and storage as well as increased JP-5 fuel capacity. LHA Flight 1 (LHA-8 and beyond) will reincorporate a well deck for increased mission flexibility. The *America*-class is in production with three LHA-6s already procured. Advance procurement for LHA-9 will begin in FY 2023.	3	3
***America*-Class Amphibious Assault Ship (LHA-6)** Inventory: **1** Fleet age: **6** Date: **2014** This new class of large-deck amphibious assault ships is meant to replace the retiring *Wasp*-class LHD. LHAs are the largest of all amphibious warfare ships, resembling a small aircraft carrier. The *America*-class is designed to accommodate the Marine Corps' F-35Bs.	5	4			

PROCUREMENT

3 1

SPENDING *($ millions)*

$10,640 $3,376

NOTE: See page 402 for details on fleet ages, dates, and procurement spending.

Amphibious Warfare Ship

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
***San Antonio*-Class Amphibious Transport Dock (LPD-17)** Inventory: **11** Fleet age: **8.5** Date: **2006** The LPDs have well decks that allow the USMC to conduct amphibious operations with its landing craft. The LPD can also carry four CH-46s or two MV-22s. 11 of the planned 13 Flight I LPD-17-class ships are operational with the remaining two under construction. The class has a 40–year planned service life.	5		***San Antonio*-Class Amphibious Transport Dock (LPD-17)** Timeline: **2006-2017** The 13 LPD-17s are replacements for the *San Antonio*-class LPDs. Both Flight I and Flight II LPDs are multi-mission ships designed to embark, transport, and land elements of a Marine landing force by helicopters, tilt rotor aircraft, landing craft, and amphibious vehicles. **PROCUREMENT** 13 **SPENDING** *($ millions)* $21,309 $63	5	4
***Whidbey Island*-Class Dock Landing Ship (LSD-41)** Inventory: **8** Fleet age: **31.5** Date: **1985** *Whidbey Island*-class ships were designed specifically to transport and launch four Marine Corps Landing Craft Air Cushion vehicles. They have an expected service life of 40 years. All eight ships in the class will retire between FY 2026 and FY 2033. The *Whidbey Island*-class will be replaced by LPD–17 Flight II program, which began procurement in FY 2018.	2	3	**LPD-17 Flight II** Timeline: **2025–TBD** Previously known as LX(R), the LPD–17 Flight II program will procure 13 ships to replace the Navy's LSD-type ships. The Navy originally planned to procure the first Flight II ship in FY 2020, however accelerated procurement funding enabled procurement of the first LPD-17 Flight II in FY 2018. The Navy delayed the second ship planned for FY 2020 until FY 2021. **PROCUREMENT** 1 8 **SPENDING** *($ millions)* $2,164 $3,577	5	4
***Harpers Ferry*-Class Dock Landing Ships (LSD-49)** Inventory: **4** Fleet age: **24** Date: **1994** The *Harpers Ferry*-class reduced LCAC capacity to two while increasing cargo capacity. They have an expected service life of 40 years, and all ships will be retired by FY 2038. The LSD-49 will be replaced by the LPD–17 Flight II, which began procurement in FY 2018.	3				

NOTE: See page 402 for details on fleet ages, dates, and procurement spending.

NAVY SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2020 ■ Pending

Airborne Early Warning

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
E-2C Hawkeye Inventory: **50** Fleet age: **37** Date: **1973** The E-2C Hawkeye is a battle management and airborne early warning aircraft. The E-2C fleet received a series of upgrades to mechanical and computer systems around 2000. While still operational, the E-2C is nearing the end of its service life and is being replaced by the E-2D Advanced Hawkeye.	1	3	**E-2D Advanced Hawkeye** Timeline: **2014–2022** The E-2D Advanced Hawkeye replaces the legacy E-2C and is in production. The Navy received approval for a five-year multi-year procurement plan beginning in FY 2019 for 24 aircraft to complete the program of record. **PROCUREMENT** 96 / 18 **SPENDING** *($ millions)* $14,483 / $3,910	4	4
E-2D Advanced Hawkeye Inventory: **32** Fleet age: **4** Date: **2014** The E-2D program is the next-generation, carrier-based early-warning, command, and control aircraft that provides improved battle space detection, supports theater air missile defense, and offers improved operational availability.	5	4			

Electronic Attack Aircraft

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
EA-18G Growler Inventory: **158** Fleet age: **7** Date: **2009** The EA-18G Growler is the U.S. Navy's electronic attack aircraft, providing tactical jamming and suppression of enemy air defenses. The final EA-18G aircraft was delivered in FY 2018, bringing the total to 160 aircraft and fulfilling the Navy's requirement. It replaced the legacy EA-6B Prowlers.	5	4	None		

NOTE: See page 402 for details on fleet ages, dates, and procurement spending.

NAVY SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2020 ■ Pending

Fighter/Attack Aircraft

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
F/A-18E/F Super Hornet Inventory: **584** Fleet age: **16** Date: **2001** The F/A-18 E/F Super Hornet has longer range, greater weapons payload, and increased survivability than the F/A-18A-D Legacy Hornet. The Navy plans to achieve a 50/50 mix of two F-35C squadrons and two F/A-18E/F Block III squadrons per carrier air wing by the mid-2030s The ongoing service life extension program will extend the life of all Super Hornets to 9,000 flight hours.	3	3	**F-35C Joint Strike Fighter** Timeline: **2019–TBD** The C-variant is the Navy's fifth-generation aircraft, bringing radar-evading technology to the carrier deck for the first time. The F-35C performs a variety of missions to include air-to-air combat, air-to-ground strikes, and ISR missions. **PROCUREMENT** 118 251 **SPENDING** *($ millions)* $19,831 $30,276	2	3
F-35C Joint Strike Fighter Inventory: **28** Fleet age: **2** Date: **2019** The C-variant is the Navy's fifth-generation aircraft, bringing radar-evading technology to the carrier deck for the first time. The F-35C performs a variety of missions to include air-to-air combat, air-to-ground strikes, and ISR missions.	5	4	**F/A-18 Super Hornet** The Navy plans to buy 108 Block III Super Hornets by 2024 and modernize most of its existing Super Hornets to Block II standards. All of Block III Super Hornets will have a lifespan of 10,000 flight hours, which is 50 percent greater than that of earlier F/A-18E/F aircraft.		

NOTES: See Methodology for descriptions of scores. Fleet age is the average age of platform since commissioning. The date for ships is the year of commissioning. Inventory for aircraft is estimated based on the number of squadrons. The date for aircraft is the year of initial operational capability. The timeline for ships is from the year of first commissioning to the year of last delivery. The timeline for aircraft is from the year of first year of delivery to the last year of delivery. Spending does not include advanced procurement or research, development, test, and evaluation (RDT&E). The total program dollar value reflects the full F–35 joint program, including engine procurement. The Navy is also procuring 67 F-35Cs for the Marine Corps. Age of fleet is calculated from date of commissioning to January 2016.

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Endnotes

1. The Honorable Thomas B. Modly, Acting Secretary of the Navy; Admiral Michael M. Gilday, Chief of Naval Operations; and General David H. Berger, Commandant of the U.S. Marine Corps, statement "On Fiscal Year 2021 Department of the Navy Budget" before the Committee on Armed Services, U.S. Senate, March 5, 2020, p. 21, https://www.armed-services.senate.gov/imo/media/doc/Modly--Gilday--Berger_03-05-20.pdf (accessed July 13, 2020). Emphasis in original. See also stenographic transcript of Hearing to Receive Testimony on Posture of the Navy in Review of the Defense Authorization Request for Fiscal Year 2021 and the Future Years Defense Program, Committee on Armed Services, U.S. Senate, March 5, 2020, https://www.armed-services.senate.gov/imo/media/doc/20-14_03-05-2020.pdf (accessed July 13, 2020).
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5. James Mattis, Secretary of Defense, *Summary of the 2018 National Defense Strategy of the United States of America: Sharpening the American Military's Competitive Edge*, U.S. Department of Defense, January 2018, https://dod.defense.gov/Portals/1/Documents/pubs/2018-National-Defense-Strategy-Summary.pdf (accessed July 13 2020).
6. The Global Force Management Allocation Plan (GFMAP) is a classified document that specifies forces to be provided by the services for use by operational commanders. It is an extension of a reference manual maintained by the Joint Staff, *Global Force Management Allocation Policies and Procedures* (CJCSM 3130.06B), which is also a classified publication. See U.S. Department of Defense, Joint Chiefs of Staff, "Adaptive Planning and Execution Overview and Policy Framework," unclassified Chairman of the Joint Chiefs of Staff Guide 3130, March 5, 2019, p. B-2, https://www.jcs.mil/Portals/36/Documents/Library/Handbooks/CJCS%20GUIDE%203130.pdf?ver=2019-03-18-122038-003 (accessed July 13, 2020).
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8. Modly, Gilday, and Berger, statement "On Fiscal Year 2021 Department of the Navy Budget," March 5, 2020, p. 8.
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10. On March 2, 2020, the CNO announced work on a forthcoming maritime strategy that will bring together the Navy, Marine Corps, and Coast Guard. This new strategy harkens back to 2007's "A Cooperative Strategy for 21st Century Seapower" and its 2015 update, and when it is released in late 2020, it will replace the current FRAGO as the Navy's strategy. While synchronizing the naval services for a more effective economy of force, however, it must not ignore the Navy's specific challenges as articulated in the FRAGO.
11. Gilday, "FRAGO 01/2019: A Design for Maintaining Maritime Superiority," p. 1.
12. Davidson, statement before the Senate Armed Services Committee, February 12, 2019, pp. 13 and 14.
13. A leading concept is Multi-Domain and Distributed Operations, which seeks to enable U.S. forces to outmaneuver adversaries physically and cognitively, advancing the 20th century concept of combined arms into the 21st century's requirement to operate across all domains at all times. In 2018, USINDOPACOM successfully demonstrated Multi-Domain and Distributed Operations in a major exercise, progressing the concept from experimentation to validation. For the Navy's part, new concepts that emphasize a diffuse fleet presence are being developed and field tested. Principally, Distributed Maritime Operations (DMO), which aims to complicate an adversary's targeting by disaggregating the fleet, is supported in turn by the concept of Distributed Lethality, which masses fires at range from a diverse family of platforms, weapons, and axis of attack. At the same time, new Marine Corps operational concepts such Littoral Operations in a Contested Environment (LOCE) and Expeditionary Advanced Base Operations (EABO) call for smaller and more dispersed Marine units conducting missions ranging from intelligence, surveillance, and reconnaissance (ISR) to coastal defense to forward arming and refueling points (FARPs) for F-35B operations. Such dispersed expeditionary operations imply a larger number of smaller amphibious ships than the current LHA and LPD programs, possibly ranging in size from an Expeditionary Fast Transport Ship (T-EPF) to an Expeditionary Sea Base (ESB).

14. U.S. Department of Defense, Department of the Navy, Office of the Secretary, "General Guidance for the Classification of Naval Vessels and Battle Force Ship Counting Procedures," SECNAV Instruction 5030.8C, June 14, 2016, pp. 1–2, http://www.nvr.navy.mil/5030.8C.pdf (accessed July 13, 2020).
15. The full array of aircraft comprising a carrier air wing also includes one EA-18G Growler electronic attack squadron, one E-2D Hawkeye airborne early warning squadron, two SH-60 Seahawk helicopter squadrons, and one C-2 Greyhound logistics support squadron.
16. U.S. Navy, "Executive Summary: 2016 Navy Force Structure Assessment (FSA)," December 15, 2016, p. 2, http://static.politico.com/b9/99/0ad9f79847bf8e8f6549c445f980/2016-navy-force-structure-assessment-fsa-executive-summary.pdf (accessed July 13, 2020). The full FSA was not released to the public. Importantly, in July 2019, the Marine Corps cancelled the 38-amphibious ship requirement as a formal force-sizing demand for the Navy. General David H. Berger, Commandant of the Marine Corps, stated his belief that future naval warfare, and the Marine Corps' role in it, against a peer-competitor will require new types of smaller vessels that will be harder for an enemy to find and target, as well as better able to support an evolving concept of distributed naval warfare, and that can be purchased in greater quantity at a lower price per vessel. Nevertheless, the long-standing 38-ship requirement has informed Navy shipbuilding plans and remains a central factor in current ship acquisition contracts. See U.S. Department of the Navy, U.S. Marine Corps, "Commandant's Planning Guidance, 38th Commandant of the Marine Corps," p. 4, https://www.hqmc.marines.mil/Portals/142/Docs/%2038th%20Commandant%27s%20Planning%20Guidance_2019.pdf?ver=2019-07-16-200152-700 (accessed July 13, 2020).
17. Thomas Callender, *The Nation Needs a 400-Ship Navy*, Heritage Foundation *Special Report* No. 205, October 26, 2018, https://www.heritage.org/defense/report/the-nation-needs-400-ship-navy.
18. Ronald O'Rourke, "Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress," Congressional Research Service *Report for Members and Committees of Congress*, June 3, 2020, pp. 3 and 43, https://crsreports.congress.gov/product/pdf/RL/RL32665 (accessed July 13, 2020).
19. U.S. Navy, "Executive Summary: 2016 Navy Force Structure Assessment (FSA)," p. 1.
20. Ibid., pp. 1–2.
21. The Honorable James F. Geurts, Assistant Secretary of the Navy for Research, Development and Acquisition ASN(RD&A); Vice Admiral William R. Merz, Deputy Chief of Naval Operations for Warfare Systems (OPNAV N9), and Lieutenant General David H. Berger, Deputy Commandant, Combat Development and Integration, and Commanding General, Marine Corps Combat Development Command, statement on "The Department of the Navy Fiscal Year 2020 Budget Request for Seapower and Projection Services" before the Subcommittee on Seapower and Projection Forces, Committee on Armed Services, U.S. House of Representatives, March 26, 2019, pp. 2–3, https://armedservices.house.gov/_cache/files/9/1/919f5faa-95da-41d8-88b9-395b063c36ee/C72CB2C30F9989D64E8C8BF8F1A18801.hhrg-116-as28-wstate-geurtsj-20190326.pdf (accessed July 13, 2020).
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24. Mattis, *Summary of the 2018 National Defense Strategy of the United States of America*, p. 1.
25. Modly, Gilday, and Berger, statement "On Fiscal Year 2021 Department of the Navy Budget," March 5, 2020, p. 2.
26. The Honorable James F. Geurts, Assistant Secretary of the Navy, Research, Development and Acquisition ASN(RD&A); Vice Admiral James W. Kilby, Deputy Chief of Naval Operations, Warfighting Requirements and Capabilities (OPNAV N9); and Lieutenant General Eric Smith, Deputy Commandant, Combat Development and Integration, and Commanding General, Marine Corps Combat Development Command, statement on "The Department of the Navy Fiscal Year 2021 Budget Request for Seapower and Projection Forces" before the Subcommittee on Seapower and Projection Forces, Committee on Armed Services, U.S. House of Representatives, March 4, 2020, p. 3, https://www.congress.gov/116/meeting/house/110637/witnesses/HHRG-116-AS28-Wstate-GeurtsJ-20200304.pdf (accessed July 14, 2020).
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28. Ibid.
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30. Geurts, Merz, and Berger, statement on "The Department of the Navy Fiscal Year 2020 Budget Request for Seapower and Projection Services," March 26, 2019, p. 3.
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32. The Navy's FY 2020 30-year shipbuilding plan identified opportunities to build three additional *Virginia*-class submarines over the next six years and an additional nine next-generation SSNs between FY 2037 and FY 2049. The Navy's FY 2020 budget requested three *Virginia*-class SSNs. This is the first time in over 20 years that the Navy has procured three SSNs in one fiscal year. Since the advance procurement for the third *Virginia* SSN was not included in the Navy's FY 2019 budget, construction of this third submarine will most likely not commence until FY 2023. Critical parts and equipment for this additional submarine above the planned 10-submarine block buy have not been purchased yet, and the shipyards (Electric Boat and Huntington Ingalls Industries Newport News Shipbuilding) have not planned for this submarine as part of their *Virginia*-class construction.
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U.S. Air Force

John Venable

The U.S. Air Force (USAF), originally part of the Army Signal Corps, became a separate service in 1947, and its mission has expanded significantly over the years. Initially, operations were divided among four major components—Strategic Air Command, Tactical Air Command, Air Defense Command, and Military Air Transport Service—that collectively reflected the Air Force's "fly, fight, and win" nature. Space's rise to prominence in the early 1950s brought a host of faculties that would expand the service's portfolio and increase its capabilities in the mission areas of intelligence, surveillance, and reconnaissance (ISR) and command and control (C2). The addition of the Space Force as the fifth uniformed service within the Department of Defense (DOD) and the global SARS-CoV-2 (COVID-19) pandemic have had a notable impact on the Air Force in the year since the *2020 Index of Military Strength* was published.

With the birth of the Space Force in December 2019,[1] the Air Force began to move its space portfolio of assets and personnel to the new service. This change will affect at least three mission areas: air and space superiority, ISR, and C2. Each of these mission areas was born from air-breathing assets, and while the loss of the space portfolio will reduce the service's inherent capabilities, they will remain within the Department of the Air Force (DOAF) and allow the Air Force to focus the weight of its efforts on the core missions within the air and cyber domains.

Today's Air Force has five principal missions:

- Air superiority (Space superiority is now the responsibility of the Space Force);
- Intelligence, surveillance, and reconnaissance;
- Mobility and lift;
- Global strike; and
- Command and control.

The summer of 2020 finds the Air Force, like the rest of DOD, dealing with and supporting national efforts to mitigate the effects of COVID-19. The pandemic has had several different and at times offsetting impacts on the service. As of August 2, 2020, the total number of COVID-19 cases in the Department of the Air Force (military, civilian, dependent, and contractor) was 7,187, and this number will certainly grow.[2] Air Force recruiting and other training pipelines like pilot training have slowed, and this has affected Air Force accessions. However, the pandemic's impact on the economy has reduced external hiring opportunities, and this should increase retention of the most experienced airmen over the next several months if not years.[3]

Day-to-day training opportunities and major exercises designed to hone readiness and deployment faculties have been reduced. DEFENDER-Europe 20, for example, which was scheduled to be the largest deployment and employment exercise in Europe since

the end of the Cold War, was truncated.[4] Sortie rates and flying hours likewise have been reduced. And all of this comes on the heels of reductions in force size and a drought in readiness from which the Air Force has been trying to recover for the past several years.

Unlike some of the other services, the Air Force did not grow larger during the post-9/11 buildup. Instead, it grew smaller as acquisitions of new aircraft failed to offset programmed retirements of older aircraft. Following the sequestration debacle in 2012, the Air Force began to trade size for quality.[5] Presidential defense budgets from 2012 through 2017 during the Obama Administration proved merely aspirational, and as the service sustained the war on terrorism, it struggled to sustain the type of readiness required to employ in a major regional contingency (MRC) against a near-peer threat.

The Air Force was forced to make strategic trades in capability, capacity, and readiness to meet the operational demands of the war on terrorism and develop the force it needed for the future. The collective effects left the Air Force of 2016 with just 55 total force fighter squadrons, and the readiness levels within those organizations was very low. Just four of the Air Force's 32 active-duty fighter squadrons were ready for conflict with a near-peer competitor, and just 14 others were considered ready even for low-threat combat operations.[6]

During a series of speeches in 2018, Air Force Secretary Heather Wilson and Air Force Chief of Staff General David Goldfein referenced a series of statistics and an in-depth study, "The Air Force We Need" (TAFWN), to convey the message that the service's capacity, capability, and readiness levels were below the requirements outlined by the 2018 National Defense Strategy (NDS).[7] TAFWN stated that the service needed to grow by 25 percent, from 312 to 386 squadrons, and its most senior leaders conveyed the need for more time in the air for its aircrews,[8] all of which required a bigger budget. The funding the service needed to acquire those weapons systems and increase readiness arrived with the Trump Administration, which has significantly increased the DOAF's budget over the past four years.[9] Unfortunately, the Air Force has not increased aircraft acquisition in line with that funding surge, nor has it made significant or even proportional improvements in its capability or readiness levels.

Capacity

At the height of the Cold War buildup in 1987, the active-duty Air Force had an inventory of 3,082 fighter, 331 bomber, 576 air refueling, and 331 strategic airlift platforms. When the strategic reserve assets within the Air National Guard (Guard) and Air Force Reserve (Reserve) are added, the 1987 totals were 4,468 fighter, 331 bomber, 704 Air refueling, and 362 strategic airlift platforms. Following the fall of the Iron Curtain, the United States shifted from a force-sizing construct centered on great-power competition to one capable of winning two simultaneous or nearly simultaneous major regional contingencies (MRCs).

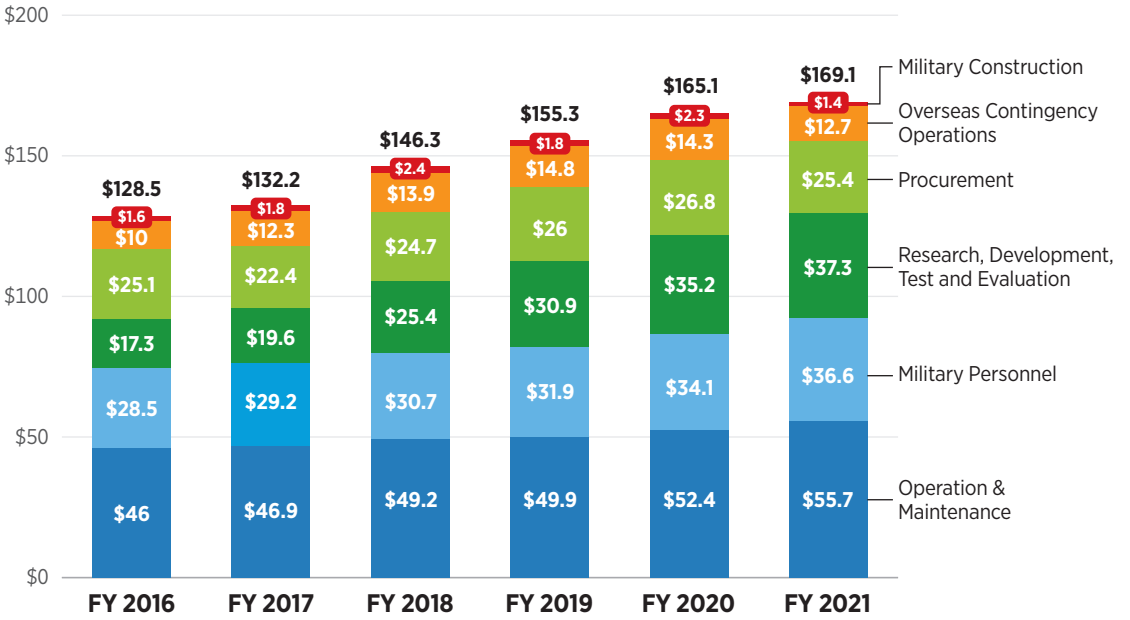
Fifteen years of trading capacity for readiness funding to further modernization has led to serious reductions in the bottom-line number of available fighter, bomber, tanker, and airlift platforms. It is projected that the active-duty Air Force will have 1,481 fighter, 122 bomber, 243 tanker, and 182 strategic airlift platforms at the end of 2020. When the strategic reserve is added, the Air Force will have a total force of 2,141 fighters, 140 bombers, 493 tankers, and 274 airlift platforms,[10] which equates to 47 percent of the fighter and bomber assets and 72 percent of the tanker and airlift assets that it possessed the last time the United States was prepared to fight a peer competitor.

Recognizing the threat from a rising China and resurgent Russia, the 2018 National Defense Strategy directed the services to prepare for a large-scale, high-intensity conventional conflict with a peer adversary. Later that same year, the Air Force released TAFWN, which conveyed the capacity and capabilities it would need to execute the NDS. Based on thousands of war-game simulations, the study assessed that the service needed, among other things,

CHART 7

Air Force Budgets, 2016–2021

IN BILLIONS OF U.S. DOLLARS



NOTE: FY 2021 figures are proposed.

SOURCE: Extracted from U.S. Air Force budget summaries for the years 2017 through 2021. For example: Table 1, "Air Force Budget Highlights Summary," in U.S. Department of Defense, Secretary of the Air Force, Office of Financial Management and Budget (SAF/FMB), *United States Air Force Fiscal Year 2018 Budget Overview*, May 2017, p. 15, http://www.saffm.hq.af.mil/LinkClick.aspx?fileticket=m3vZOmfR368%3d&portalid=84 (accessed August 1, 2020), and Table 1, "Department of the Air Force Budget Summary," in U.S. Department of Defense, Secretary of the Air Force, Office of Financial Management and Budget (SAF/FMB), *United States Air Force FY 2021 Budget Overview*, February 2020, p. 2, https://www.saffm.hq.af.mil/Portals/84/documents/FY21/SUPPORT_/FY21%20Budget%20Overview_1.pdf?ver=2020-02-10-152806-743 (accessed August 1, 2020).

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one additional airlift squadron and seven additional fighter, five additional bomber, and 14 additional tanker squadrons to execute the NDS. That equates to an additional 182 fighter, 50 bomber, 210 air refueling, and 15 airlift platforms,[11] as well as $80 billion in funding to procure those platforms.[12]

Considering the shortfall conveyed in TAFWN, and assuming that funding was made available, one would expect the Air Force to increase its procurement budget and accelerate acquisition of fifth-generation offensive platforms and next-generation tanker aircraft throughout the Future Years Defense Program (FYDP) by a substantial margin. In 2017, for the first time in more than 26 years, the Department of the Air Force began to enjoy real budget growth that was not associated with a contingency.[13] Assuming the President's budget request for fiscal year (FY) 2021 is approved as submitted, the DOAF's funding will have increased by 31 percent since 2016, making this an excellent opportunity to refresh and actually increase the Air Force aircraft fleet.[14]

Since the end of FY 2018 when TAFWN was announced, however, funding for aircraft procurement has grown from $24.8 billion in FY 2019 to just $25.4 billion in FY 2021—a growth rate of 2 percent that has not even kept up with inflation. In spite of the need to recapitalize and grow the fleet, the Air Force is holding acquisition of the KC-46 steady at an average of 15 aircraft a year and actually decreasing procurement of the F-35 by 12 jets each year to compensate for the acquisition of the F15EX over the same five-year period.

The research, development, test, and evaluation (RDT&E) budget, on the other hand, has gone from 17 percent of total obligational authority in FY 2018 to 22 percent in FY 2021, rising by $10.7 billion to $37.3 billion.[15] Much of that funding is being used to develop and field the digital backbone for the Airborne Battle Management System (ABMS). The ABMS is envisioned as relying on a common digital architecture and a heavy dose of artificial intelligence to help move information, process targets, and optimize their engagement. The cost, however, has been high: The Air Force has had to forgo significant recapitalization of its fleet and hope that Congress will provide enough supplemental funding to field the capacity and capability that the service needs to execute the 2018 NDS.

To paraphrase General David Goldfein, there is no congressional lobby, no constituency for a digital highway, but there are plenty in Congress who will support Air Force weapons systems that will use it.[16] Congress, for example, added 14 F-35As to the Air Force's programmed acquisition of 48 in 2019 for a total of 62 fifth-generation fighters.[17]

A belief that congressional "adds" will overcome pending aircraft retirements[18] to field TAFWN ignores the reality of an ever-expanding political divide in Congress and extraordinary levels of national debt that will only grow worse with the COVID-19 pandemic. The idea that aircraft production lines will somehow surge to come to the rescue in a peer-level crisis may seem plausible to some, but even if Congress throws an unlimited amount of cash at them, there would not likely be enough time to bring those weapons systems into the force to meet the scenario and timing requirements within the 2018 NDS.[19]

That said, the reduction in programmed fourth-generation fighter retirement rates, coupled with the arrival of F-35As on Air Force flight lines in Florida, Arizona, Utah, Alaska, and Vermont, has allowed the service to increase its total aircraft inventory for the second year in a row.[20] The Air Force added 53 aircraft to its roster for a projected total of 5,504 at the end of FY 2020.[21]

Previous editions of the *Index of U.S. Military Strength* have used "combat-coded" fighter aircraft within the active component of the U.S. Air Force to assess capacity. Combat-coded aircraft and related squadrons are aircraft and units with an assigned wartime mission, which means that those numbers exclude units and aircraft assigned to training, operational test and evaluation (OT&E), and other missions.

The software and munitions carriage and delivery capability of aircraft in noncombat-coded units renders them incompatible with and/or less survivable than combat-coded versions of the same aircraft. For example, all F-35As may appear to be ready for combat, but training wings and test and evaluation jets have hardware and software limitations that would severely curtail their utility and effectiveness in combat. While those jets could be slated for upgrades, hardware updates sideline jets for several months, and training wings and certain test organizations are generally the last to receive those upgrades.

Of the 5,504 manned and unmanned aircraft projected to be in the USAF's inventory at the end of FY 2020, 1,428 are active-duty fighters, and 1,011 of those are combat-coded aircraft.[22] This number includes all active-duty backup inventory aircraft as well as attrition reserve spares.[23]

The number of fighters and fighter squadrons available for deployment to contingency operations affects more than wartime readiness; it also affects retention. The constant churn of overseas deployments and stateside

TABLE 5

Precision-Guided Munitions Expenditures and Programmed Acquisitions

TOTAL MUNITIONS EXPENDED OR ACQUIRED PER YEAR

	EXPENDITURES			ACQUISITIONS			
	FY 2017	**FY 2018**	**FY 2019**	**FY 2018**	**FY 2019**	**FY 2020**	**FY 2021***
JDAM	30,664	5,462	7,354	35,106	36,000	25,000	16,800
HELLFIRE	1,536	2,110	2,449	3,629	3,734	3,859	2,497
SDB-I/II	4,507	749	1,289	7,312	6,254	8,253	3,595
APKWS	Unknown	Unknown	Unknown	10,621	6879	3,927	10,200
JASSM–ER	360	19	16	360	360	390	400
LGB	276	373	106	0	0	0	0
TOTALS	**38,092**	**9,462**	**11,963**	**57,777**	**53,976**	**42,178**	**34,241**

* Estimate based on data from President's Budget.

SOURCES: Department of the Air Force, "FY 20201 Budget Overview," February 10, 2020, p. 6, Table 2, https://www.saffm.hq.af.mil/Portals/84/documents/FY21/SUPPORT_/FY21%20Budget%20Overview_1.pdf?ver=2020-02-10-152806-743 (accessed August 20, 2020), and Headquarters U.S. Air Force, Deputy Chief of Staff for Operations, written response to Heritage Foundation request for information on Air Force manning levels, June 10, 2018, and July 24, 2020.

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temporary duty (TDY) assignments is one of the primary reasons cited by pilots for separating from the service. This problem can be solved in two ways: by decreasing operational tempo, which is not at the discretion of the Air Force, and/or by increasing capacity. Although the Air Force has made a string of budgetary decisions *not* to increase the rate at which it builds additional capacity, it continually highlights the need to do so.[24]

Capacity also relies on the stockpile of available munitions and the production capacity of the munitions industry. The actual number of munitions within the U.S. stockpile is classified, but there are indicators that make it possible to assess the overall health of this vital area. The inventory for precision-guided munitions (PGM) was severely stressed by nearly 18 years of sustained combat operations and budget actions that limited the service's ability to procure replacements and increase stockpiles. During the past three years, however, funding for munitions has improved significantly, and the preferred munitions inventory is starting to recover to pre-war levels.

In an effort to continue rebuilding the PGM stockpile, the Air Force will purchase 34,241 precision-guided munitions and guidance kits in FY 2021. Typically, there is a delay of 24–36 months between conclusion of a contract and delivery of these weapons, which means that munitions are often replaced three years after they were expended. (See Table 5.)

Capability

The risk assumed with capacity has placed an ever-growing burden on the capability of Air Force assets. The ensuing capability-over-capacity strategy centers on the idea of developing and maintaining a *more*-capable force that can win against the advanced fighters and surface-to-air missile systems now being

developed by top-tier potential adversaries like China and Russia, which are also increasing their capacity.

Any assessment of capability includes not only the incorporation of advanced technologies, but also the overall health of the inventory. Most aircraft have programmed life spans of 20 to 30 years based on a programmed level of annual flying hours. The bending and flexing of airframes over time in the air generates predictable levels of stress and fatigue on everything from metal airframe structures to electrical wiring harnesses.

The average age of Air Force aircraft is 30 years, and some fleets, such as the B-52 bomber, average 59 years. In addition, KC-135s comprise 87 percent of the Air Force's tankers and are over 58 years old on average. The average age of the F-15C fleet is over 36 years, leaving less than 4 percent of its useful service life remaining,[25] and that fleet comprises 56 percent of USAF air superiority platforms.[26]

The planes in the fleet of F-16Cs are almost 30 years old on average,[27] and the service has used up nearly 85 percent of their expected life span. In 2018, the Air Force announced its intent to extend the service lives of 300 F-16s through a major service life extension program (SLEP) that will allow those jets to continue to fly through 2050.[28] SLEPs lengthen the useful life of airframes, and these F-16 modifications also include programmed funding for the modernization of avionics within those airframes. However, these modifications are costly, and the added expense consumes available funding, reducing the amount the service has to invest in modernization, which is critical to ensuring future capability. Even with a SLEP, there is a direct correlation between aircraft age and the maintainability of those platforms. (See Table 6.)

The Air Force's ISR and lift capabilities face similar problems in specific areas that affect both capability and capacity. The majority of the Air Force's ISR aircraft are now unmanned aerial vehicles (UAVs). The Air Force intends to add 46 MQ-9s to its inventory by the end of 2021 for a total of 31 Reapers.[29] The service lost an RQ-4 in 2019 and intends to reduce its inventory of these strategic reconnaissance platforms from 31 to eight in FY 2021. With an average age of 38 years, the U-2, a manned high-altitude reconnaissance aircraft, is still very much in demand and currently has no scheduled retirement date.[30]

The E-8 Joint Surveillance Target Attack Radar System (J-STARS) and the RC-135 Rivet Joint are critical ISR platforms. Each was built on the Boeing 707 platform, and the last one came off the production line 41 years ago. The FY 2020 National Defense Authorization Act directed the Air Force not to retire the E-8 until a replacement system is available. In its stead, the Air Force is working on an incremental approach for a J-STARS replacement that focuses on advanced and disaggregated sensors (a system of systems) that will require enhanced and hardened communications links. Known as the Advanced Battle Management System (ABMS),[31] it is envisioned as an all-encompassing approach to both airborne and ground Battle Management Command and Control (BMC2) that will allow the Air Force to fight and support joint and coalition partners in high-end engagements.[32]

With respect to air combat, the Active Air Force has just 105 F-15Cs left in its fleet, and concerns about what platform will fill this role when the F-15C is retired are fully justified. The Department of Defense planned to purchase 750 F-22A stealth air superiority fighters to replace the F-15C, but draconian cuts in the program of record reduced the acquisition to a total of just 183 F-22As for the Active, Guard, and Reserve force.[33]

The ability to fulfill the operational need for air superiority fighters will be further strained in the near term because of the F-22's low availability rates and a retrofit that always causes some portion of those jets to be unavailable for operational use. The retrofit is a mix of structural alterations that are required for the airframe to reach its promised service life, and the process takes six F-22s off the flight line at any given time. The retrofit is forecasted to continue through 2021.[34]

TABLE 6

U.S. Air Force Total Aircraft Inventory (Page 1 of 3)

INCLUDES ALL ACTIVE DUTY, AIR NATIONAL GUARD, AND AIR FORCE RESERVE AIRCRAFT

	FY 2020					MISSION CAPABLE (MC)				FY 2021		
Type	Active Duty	Air National Guard	Air Force Reserve	Total Active, Guard and Reserve	Average Age in Years	MC Rate FY 2018	MC Rate FY 2019	Change	Average Daily MC Aircraft, FY 2020	Programmed Retirements	Programmed Acquistions	Estimated Total Aircraft Inventory
A010C	143	85	55	283	38	73%	71%	-1.80%	201	-44	—	239
AC130J	34	0	0	34	3	87%	86%	-0.88%	29	—	3	37
AC130U	7	0	0	7	29	87%	86%	-1.38%	6	-3	—	4
B-1B	61	0	0	61	32	52%	46%	-5.58%	28	-17	—	44
B-2A	20	0	0	20	25	61%	60%	-0.53%	12	—	—	20
B-52H	58	0	18	76	58	69%	66%	-3.27%	50	—	—	76
C-130H	2	127	42	171	29	68%	66%	-2.49%	112	-24	—	147
C-130J	109	16	10	135	10	77%	77%	0.02%	104	—	11	146
C-17A	146	50	26	222	16	83%	82%	-0.77%	183	—	—	222
CV022B	51	0	0	51	7	59%	53%	-5.55%	27	—	—	51
E003B	10	0	0	10	41	69%	74%	5.41%	7	—	—	10
E003C	1	0	0	1	36	70%	73%	3.19%	1	—	—	1
E003G	20	0	0	20	39	66%	74%	8.36%	15	—	—	20
E008C	0	16	0	16	19	67%	67%	0.36%	11	—	—	16
EC130H	11	0	0	11	46	73%	73%	0.19%	8	-1	—	10
EC130J	0	7	0	7	19	66%	57%	-8.62%	4	—	—	7
F015C	88	123	0	211	35	71%	70%	-0.95%	148	—	—	211
F015D	9	14	0	23	35	69%	72%	3.45%	17	—	—	23
F015E	218	0	0	218	27	71%	71%	0.29%	155	—	—	218

TABLE 6

U.S. Air Force Total Aircraft Inventory (Page 2 of 3)

INCLUDES ALL ACTIVE DUTY, AIR NATIONAL GUARD, AND AIR FORCE RESERVE AIRCRAFT

	FY 2020					MISSION CAPABLE (MC)				FY 2021		
Type	Active Duty	Air National Guard	Air Force Reserve	Total Active, Guard and Reserve	Average Age in Years	MC Rate FY 2018	MC Rate FY 2019	Change	Average Daily MC Aircraft, FY 2020	Programmed Retirements	Programmed Acquistions	Estimated Total Aircraft Inventory
F016C	443	288	52	783	29	70%	73%	2.97%	571	–3	—	780
F016D	104	45	2	151	29	66%	70%	4.37%	106	—	—	151
F022A	166	20	0	186	12	52%	51%	–1.43%	94	—	—	186
F035A	250	20	0	270	4	50%	62%	11.60%	166	—	56	326
HC130J	19	12	0	31	5	81%	80%	–1.19%	25	—	3	34
HC130N	0	3	0	3	25	61%	68%	7.13%	2	—	—	3
HH060G	60	23	15	98	29	71%	66%	–4.80%	65	–27	—	71
HH060W	0	0	0	0	0	—	—	—	—	—	7	7
KC010A	59	0	0	59	35	80%	79%	–0.90%	47	–16	—	43
KC046A	40	12	0	52	1	n/a	63%	0.00%	33	—	16	68
KC135R	116	140	74	330	58	73%	73%	–0.50%	239	–13	—	317
KC135T	25	24		49	59	74%	71%	–2.89%	35	—	—	49
LC130H	0	10	0	10	34	45%	40%	–4.72%	4	—	—	10
MC012W	29	0	0	29	9	100%	100%	0.00%	29	—	—	29
MC130H	16	0	0	16	31	68%	69%	0.65%	11	—	—	16
MC130J	46	0	0	46	5	79%	78%	–1.46%	36	—	4	50
MQ001B	7	0	0	7	12	92%	100%	7.52%	7	—	—	7
MQ009A	245	24	0	269	6	90%	89%	–0.68%	240	—	46	315
OC135B	2	0	0	2	57	65%	82%	17.46%	2	—	—	2

TABLE 6

U.S. Air Force Total Aircraft Inventory (Page 3 of 3)

INCLUDES ALL ACTIVE DUTY, AIR NATIONAL GUARD, AND AIR FORCE RESERVE AIRCRAFT

	FY 2020					MISSION CAPABLE (MC)				FY 2021		
Type	Active Duty	Air National Guard	Air Force Reserve	Total Active, Guard and Reserve	Average Age in Years	MC Rate FY 2018	MC Rate FY 2019	Change	Average Daily MC Aircraft, FY 2020	Programmed Retirements	Programmed Acquistions	Estimated Total Aircraft Inventory
RC135S	3	0	0	3	57	79%	90%	11.39%	3	—	—	3
RC135U	2	0	0	2	54	83%	91%	8.07%	2	—	—	2
RC135V	8	0	0	8	55	71%	74%	3.10%	6	—	—	8
RC135W	12	0	0	12	56	60%	69%	9.49%	8	—	—	12
RQ004B	31	0	0	31	8	74%	76%	1.75%	23	–20	—	11
T001A	178	0	0	178	25	59%	61%	1.51%	108	—	—	178
T038A	53	0	0	53	53	73%	74%	1.48%	39	—	—	53
T038C	442	0	0	442	52	61%	63%	2.05%	279	—	—	442
U2	31	0	0	31	28	77%	78%	1.00%	24	—	—	31

SOURCES: Headquarters U.S. Air Force, Deputy Chief of Staff for Operations, written response to Heritage Foundation request for information on Air Force manning levels, July 24, 2020; Brian W. Everstine, "Breaking Down USAF's 70-Percent Overall Mission Capable Rate," *Air Force Magazine*, May 19, 2020, https://www.airforcemag.com/breaking-down-usafs-70-percent-overall-mission-capable-rate/ (accessed August 1, 2020); and table, "Aircraft Total Active Inventory (TAI) (As of Sept 30, 2019)," in "Air Force & Space Force Almanac," *Air Force Magazine*, Vol. 103, No. 6 (June 2020), p. 63, https://www.airforcemag.com/app/uploads/2020/06/June2020_Fullissue5.pdf (accessed August 1, 2020).

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The Air Force's number-one acquisition priority remains the F-35A, the next-generation fighter scheduled to replace all legacy multirole and close air support aircraft. The jet's full operating capability (FOC) was delivered in early 2018.[35] The rationale for the Air Force's planned acquisition of 1,763 aircraft is to replace every F-117, F-16, and A-10 aircraft on a one-for-one basis.[36] The F-35A's multirole design favors the air-to-ground mission, but its fifth-generation faculties will also be dominant in an air-to-air role, allowing it to augment the F-22A in many scenarios.[37] Heritage analysis has identified a requirement for a total of 1,260 F-35s, and the Air Force should reduce the program to that level and accelerate the rate at which it acquires those platforms.[38]

A second top acquisition priority is the KC-46A air refueling tanker. The KC-46 has experienced a series of delays, the most recent of which involves the air refueling system that currently cannot refuel operational fighters. The Air Force will have 52 KC-46s (40 active and 12 in the Guard) by the end of FY 2020 and will receive 16 more in FY 2021 for a total of 68 on the ramp by the end of FY 2021.[39] The plan is to acquire the remaining 111 tankers for a total of 179 by the end of FY 2028. The KC-46 will replace less than half of the current tanker fleet and will leave the Air Force with over 200 aging KC-135s (already averaging 58 years old) that still need to be recapitalized.[40]

The third major USAF acquisition priority is the B-21 Raider, formerly called the Long-Range Strike Bomber (LRSB). The USAF awarded Northrop Grumman the B-21 contract to build the Engineering and Manufacturing Development (EMD) phase, which includes associated training and support systems and initial production lots. The program completed an Integrated Baseline Review for the overall B-21 development effort as well as the jet's Preliminary Design Review. The Air Force is committed to a minimum of 100 B-21s at an average cost of $564 million per plane.[41]

With the budget deal that was reached for FY 2018 and FY 2019, the Secretary of the Air Force announced the service's intent to retire all B-1s and B-2s and sustain a fleet comprised of 100 B-21s and 71 B-52s.[42] The B-21 is programmed to begin replacing portions of the B-52 and B-1B fleets by the mid-2020s.[43] In the interim, the Air Force continues to execute a SLEP on the remaining fleet of B-1s in the inventory to restore the bomber's engines to their original specifications. The Air Force currently has 61 B-1s, but the current state of repair of 17 of those jets is so poor that the Air Force has conveyed its intent to retire them in FY 2021.[44] The Air Force plans to modernize the B-2's Defense Management System, Stores Management Operational Flight Program, and Common Very-Low-Frequency/Low Frequency Receiver Program to ensure that this penetrating bomber remains viable in highly contested environments, keeping it fully mission capable until it is replaced by the B-21.

Modernization efforts for the B-52 are also underway. The jet was designed in the 1950s, and the current fleet entered service in the 1960s. The FY 2018 budget funded the re-engineering of this fleet, and the aircraft will remain in the inventory through 2050.

When the Secretary of the Air Force and the Chief of Staff rolled out the Air Force's plan to expand the number of squadrons from 312 to 386, one of the stated elements of that campaign was to fill the ranks of those new squadrons with only the newest generation of aircraft—F-35s, B-21s, and KC-46s—because of the capabilities that those platforms bring to bear.[45] Curiously, the Air Force is now acquiring the fourth-generation F-15EX, based primarily on projected operating cost savings, to increase fighter capacity.[46] Although the service will certainly increase its numbers with that approach, the capability of the F-15X system will not be survivable in the high-threat environment in which deployed assets will be required to fight by the time that fielding has been completed. Thus, the Air Force is using precious acquisition dollars to buy an aircraft of rather limited utility.

Readiness

The 2018 National Defense Strategy's focus on peer-level war was designed to bring a clear and rapid paradigm shift away from the tiered levels of readiness the Air Force had adopted because of years of relentless deployments and funding shortfalls. In a move that would refine the service's focus on great-power competition as spelled out by the new NDS, Secretary of Defense James Mattis directed the Air Force to increase the mission-capable rates of the F-16, F-22, and F-35 aircraft to 80 percent by the end of September 2019.[47] The move was designed to make more of an all-too-small fleet of combat aircraft available to deploy in numbers required to deter or defeat a peer adversary.

Early in 2019, General Goldfein stated that the service would likely not meet the 80 percent mission-capable (MC) threshold directive until 2020, and in the spring of 2020, he made it clear that the threshold was no longer a focus for the Air Force. MC rates are a measure of how much of a certain fleet is "ready to go" at a given time, and the general stated in clear terms that he felt they were an inaccurate portrayal of the service's overall health. Instead of using that historic marker for readiness, the service wants to highlight how deployable the fleet is within a short period of time.[48]

The service is focusing on the number of "force elements"— fighters, bombers, and tankers—that it has across all of the Air Force and how quickly those forces need to be ready. One of the examples that Goldfein used was the rapid deployment of a "task force" of four B-52s to the Middle East in May 2019.[49] The bombers, from Barksdale Air Force Base, Louisiana, had two days to deploy and immediately began to fly combat missions even though the B-52 fleet had a mission-capable rate of 65.73 percent at the time. While the ability to prepare and then deploy four of 58 bombers rapidly is a capability, it may be more in line with responding to a regional contingency than it is with the capacity requirements spelled out in the 2018 NDS.

In the USAF's official FY 2020 posture statement, Secretary Wilson and Chief of Staff Goldfein said that more than 90 percent of the "lead force packages" within the service's 204 "pacing squadrons" are "ready to 'fight tonight.'" They went on to say that those "pacing squadrons are on track to reach 80% readiness before the end of Fiscal Year 2020."[50] They were unable to declare that pacing squadrons had actually achieved that level of readiness, saying only that pacing squadron mission-capable rates had increased and that the Air Force was continuing its efforts to improve MC rates across the entire fleet.[51]

The definitions for "pacing unit" and "pacing squadrons" are somewhat elusive. Assuming that a pacing squadron is an operational unit that is fully qualified and ready to execute its primary wartime mission (C1), one is still left wondering what the "lead force packages" within those 204 pacing/mission-ready units are and what the limits on the remaining portions of those units might be. Taken together, these statements imply that only portions of the Air Force's combat-coded squadrons are currently qualified to execute the unit's primary wartime mission.

In 2017, the Secretary of the Air Force and the Chief of Staff informed Congress that "[w]e are at our lowest state of full spectrum readiness in our history."[52] In the three years since their testimony, DOD has stifled open conversation or testimony about readiness, limiting the Air Force's ability to be forthcoming with open-source readiness indicators. While this makes any assessment of readiness difficult, there are three areas that can support an assessment: MC rates, aircrew training, and deployability.

MC rates are defined as the percentage of aircraft possessed by a unit that are capable of executing the unit's mission set. Several factors drive MC rates, but two are common to mature systems: manning and operations and maintenance (O&M) funding. Taken together, they dictate the number of sorties and flight hours that units have available for aircrew training. Multiplying the MC rates by the actual number

TABLE 7

Maintenance Manning

Skill Level	2018	2019
Apprentice: 3-level	117%	118%
Journeyman: 5-level	91%	96%
Craftsman: 7-level	97%	101%
Leadership: 9-level	99%	99%

SOURCE: Headquarters U.S. Air Force, Deputy Chief of Staff for Operations, written response to Heritage Foundation request for information on Air Force manning levels, July 24, 2020.

of aircraft within a particular fleet yields the actual operational capacity of that capability.

There are 186 F-22As in the Total Aircraft Inventory (TAI), but 28 are dedicated trainers, and 16 are primary development aircraft inventory (used for testing new equipment). In 2019, the F-22A had an MC rate of 50.57 percent, which means that there were just 71 F-22As that could be committed to combat at any given time.[53] The last time the United States was prepared to fight a peer competitor, the Air Force had more than 700 F-15C air superiority fighters with an MC rate of more than 80 percent for that fleet. If just 500 of them were combat coded, more than 400 mission-capable jets were ready to fight the Soviet Union. While the F-22A is an incredibly capable fighter and 71 F-22s would be a formidable capability against a regional threat, numbers are critical to winning a peer fight, particularly for offensive platforms, and 71 would not be sufficient for a peer-level fight.

There are 36 operational B-1s in the Lancer fleet,[54] and with an MC rate of 46 percent, 17 are available for combat at any given time during the year. The small size of the B-2 fleet, coupled with its 60 percent MC rate, means that, on average, just 12 are combat capable. If the B-52 operational fleet and its mission-capable rate of 66 percent are added, there were just 68 bombers in the Air Force inventory that were capable of executing combat missions on any given day in 2019.

Maintenance manning is now healthy across the board (see Table 7), but the pilot shortage shows no signs of abatement. In March 2017, Lieutenant General Gina M. Grosso, Air Force Deputy Chief of Staff for Manpower, Personnel, and Services, testified that at the end of FY 2016, the Air Force had a shortfall of 1,555 pilots across all mission areas (608 Active, 653 Air National Guard, and 294 Reserve). Of that total, the Air Force was short 1,211 fighter pilots (873 Active, 272 Air National Guard, and 66 Reserve).[55]

The numbers continued to fall, and at the end of FY 2017, the Air Force was short more than 2,000 pilots. Today, the total Air Force has a shortfall of 2,100 pilots (950 Active, 650 Air National Guard, and 500 Reserve) of a total requirement of 20,850 pilots.[56] The ability of the Air Force to recover from that shortfall will depend on how well the service addresses several major issues, especially the available number of pilot training slots, an area in which it appears that some progress is being made.

In FY 2018, the Air Force graduated 1,200 pilots; it added 1,279 in FY 2019 and projects that it will graduate 1,200 in 2020 (down from 1,480 because of the impact of COVID-19).

TABLE 8

Mission-Capable Combat-Coded Fighters in the Active-Duty Air Force

	Combat-Coded Fighters	Average Age	FY 2019 Mission-Capable Rate	Mission-Capable Combat-Coded Fighters
A-10C	116	37	0.71	82
F-15C	105	35	0.70	74
F-15E	158	27	0.71	112
F-16C	406	29	0.72	292
F-22A	133	13	0.51	68
F-35A	94	4	0.62	58
TOTALS	**1,011**			**679**

SOURCES: Headquarters U.S. Air Force, Deputy Chief of Staff for Operations, written response to Heritage Foundation request for information on Air Force manning levels, July 24, 2020; Brian W. Everstine, "Breaking Down USAF's 70-Percent Overall Mission Capable Rate," *Air Force Magazine*, May 19, 2020, https://www.airforcemag.com/breaking-down-usafs-70-percent-overall-mission-capable-rate/ (accessed August 2, 2020); and table, "Aircraft Total Active Inventory (TAI) (As of Sept. 30, 2019)," in "Air Force & Space Force Almanac," *Air Force Magazine*, Vol. 103, No. 6 (June 2020), p. 63, https://www.airforcemag.com/app/uploads/2020/06/June2020_Fullissue5.pdf (accessed August 2, 2020).

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Those projected numbers rely on a graduation rate of nearly 100 percent for every pilot training class, and the service is already close to that mark.

Near-perfect graduation rates imply one or more of three things:

- The course of instruction is sufficiently easy that all students are able to pass;
- All students are so good that they are able to pass even when the standards demanded by air combat in the modern age are very high; or
- Because the service needs pilots, some students are graduated even if they have not met standard.

In 2016, the graduation rate was 93 percent; in 2017, it was 98 percent; and in 2018, it was 97 percent.[57] The expectation of high graduation rates during years of significant pilot shortfalls runs the risk of compromising quality for quantity. It is hard to fathom how the pilot production pipeline is going to ensure that all of those who earn their wings will be as competent and capable as they need to be in the years ahead. The graduation rate fell to a "more healthy" 93.5 percent in 2019, but the rationale for that number was not released.[58]

Throughout the pilot shortage, the Air Force has done an excellent job of emphasizing operational manning instead of placing experienced fighter pilots at staffs and schools, but the currency and qualifications of the pilots in operational units are at least as important as manning levels. Although the quality of sorties is admittedly subjective, a healthy rate of three sorties a week and flying hours averaging more than 200 hours a year have been established as "sufficient" over more than six decades of fighter pilot training. In the words of General Bill Creech, "Higher sortie rates mean increased

proficiency for our combat aircrews,"[59] and given the right number of sorties and quality flight time, it takes seven years beyond mission qualification in a fighter for an individual to maximize his potential as a fighter pilot.[60]

As the Air Force recovers from an 18-year drought in training for combat with a near-peer competitor, it will take even highly experienced fighter pilots another year of training to master the skill sets required to dominate the air against a near-peer competitor in a high-threat environment. Because squadrons have a mix of experience and talent levels, it will take several more years of robust training for the roster of operational fighter squadrons to be fully ready for a high-end fight.

While the Air Force has made significant strides in sortie production since 2014, low fighter mission-capable rates still prevent pilots from meeting the thresholds of three sorties a week and 200 hours a year per pilot. Moreover, to the extent that the Air Force lacks available aircraft, it will remain unable to train pilots to those thresholds. (For a summary of the mission-capable rates for combat-coded (operational) aircraft of the five fighter weapons systems, see Table 8.)

As noted, the primary drivers for mission-capable rates are maintenance manning and O&M funding. Maintenance manning has been healthy for more than three years, and O&M funding has risen by 16 percent since 2017, but flying hours across the fleet of fighters have increased by just 9 percent over that same period. USAF leadership has not increased the flying hour budget for FY 2021 because of an assessment that the Air Force is flying at the maximum executable levels.[61] This calls into question how well maintenance is organized to generate those sorties.

The sortie production recovery that took place at the end of the hollow-force days of the Carter Administration happened while levels of maintenance experience and inventories of spare parts were still low and well before the Reagan Administration's increase in defense spending.[62] The maintenance organization that created that turnaround was changed in 1989 to "save money by reducing maintenance staffing, equipment and base level support,"[63] which may help to explain the lackluster performance. No matter what the rationale may be, even with robust manpower and funding, flying hours and sortie rates are still short of the levels required for a rapid increase in readiness levels across the fighter force.

Flying hours for the average Air Force fighter pilot have increased by 8 percent since 2017 even though overall funding has increased by over 30 percent. Fighter pilots received an average of 13.0 hours per month in 2017, 12.9 hours per month in 2018, and 14.1 hours per month in 2019.[64] (See Table 9.)

The average combat mission-ready (CMR) pilot assigned to a combat-coded (operational) unit received just 14.6 hours and 7.5 sorties a month in 2019,[65] which is down from 2018. While there have been no indications that COVID-19 adversely affected flying hours, sortie rates, or readiness during the first five months of 2020, many months of weathering this virus lie ahead. (See Table 10.)

Deployability. Because of limitations on support equipment and aircraft availability due to long-term inspections and depot-level work, it takes three active-duty squadrons to deploy two squadrons forward. For that reason, up until the end of the Cold War, the Air Force organizational structure was based on a three-squadron wing. On any given day, units have several aircraft that are not flyable because of long-term inspections, deep maintenance, or the need for spare parts. By using aircraft from one of the three squadrons to "plus up" the others, the wing could immediately deploy two full-strength units into combat. The handful of fully flyable jets and pilots left at the home station were then used to train new and inbound pilots up to mission-ready status so that, among other things, they could replace pilots that were lost during combat.[66]

Normal fighter squadron manning levels are based on a ratio of 1.25 aircrew members for every aircraft,[67] which means that a unit with 24 assigned aircraft should have 30 line pilots and five supervisor pilots who are

TABLE 9

Average Hours All Fighter Pilots Received a Month

FLYING HOUR AVERAGES INCLUDE LINE PILOTS AND SUPERVISORS IN ALL OPERATIONAL, TRAINING, AND TEST & EVALUATION SQUADRONS

	2017	2018	2019	Change, 2018 to 2019
F-22	10.8	10.8	10.7	–1%
F-35A	10.4	10.4	14.7	41%
F-15C	10.5	10.5	11.8	13%
F-16C	12.2	12.2	12.2	0%
F-15E	18.3	18.3	20.6	13%
A-10	15.1	15.1	16.5	9%
All Jets	13.0	12.9	14.1	10%
Average Hours/Year	155.4	154.6	169.4	10%

SOURCE: Headquarters U.S. Air Force, Deputy Chief of Staff for Operations, written response to Heritage Foundation request for information on Air Force manning levels, July 24, 2020.

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TABLE 10

Average Flying Hours All Fighter Line Pilots Received a Month

FLYING HOUR AVERAGES INCLUDE LINE PILOTS (ONLY) IN ALL OPERATIONAL, TRAINING, AND TEST & EVALUATION SQUADRONS

	2017	2018	2019	Change, 2018–2019
F-22	11.7	12.8	10.9	–15%
F-35A	10.6	12.4	15.0	21%
F-15C	10.5	13.1	11.8	–10%
F-16C	11.9	15.5	12.5	–19%
F-15E	19.1	20.3	21.3	5%
A-10	16.7	23.0	16.9	–27%
All Jets	13.2	16.1	14.6	–9%
Average Hours/Year	159	193	175	–9%

SOURCE: Headquarters U.S. Air Force, Deputy Chief of Staff for Operations, written response to Heritage Foundation request for information on Air Force manning levels, July 24, 2020.

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TABLE 11

Average Sorties All Fighter Pilots Received a Month

FOR LINE PILOTS AND SUPERVISORS IN ALL OPERATIONAL, TRAINING, AND TEST AND EVALUATION SQUADRONS

	2017	2018	2019	Change, 2018–2019
F-22	6.4	6.4	7.2	12%
F-35A	6.6	6.6	6.5	–1%
F-15C	7.0	7.0	6.7	–5%
F-16C	7.4	7.4	7.4	0%
F-15E	7.9	7.9	7.7	–3%
A-10	7.1	7.1	7.5	6%
All Jets	7.2	7.2	7.2	1%
Average Sorties/Year	86.5	86.2	87.0	1%

SOURCE: Headquarters U.S. Air Force, Deputy Chief of Staff for Operations, written response to Heritage Foundation request for information on Air Force manning levels, July 24, 2020.

TABLE 12

Average Flying Hours and Sorties Line Combat Mission Ready Fighter Pilots Received a Month in 2019

HOUR AND SORTIE AVERAGES INCLUDE LINE PILOTS (ONLY) IN OPERATIONAL SQUADRONS (ONLY)

	Hours	Sorties
F-22	11.0	7.4
F-35A	15.4	6.7
F-15C	11.9	6.8
F-16C	12.7	7.6
F-15E	21.7	8.0
A-10	16.9	7.7
All Jets	14.6	7.5
Average Sorties/Year	174.7	89.9

NOTE: This is the first year the Air Force has provided Line operational fighter pilot hours and sorties.
SOURCE: Headquarters U.S. Air Force, Deputy Chief of Staff for Operations, written response to Heritage Foundation request for information on Air Force manning levels, July 24, 2020.

TABLE 13

Average Sorties All Line Fighter Pilots Received a Month by Aircraft

	2017	2018	2019	Change, 2018–2019
F-22	6.3	4.5	7.3	62%
F-35A	6.5	7.5	6.6	–12%
F-15C	7.2	8.4	6.7	–20%
F-16C	7.3	9.3	7.5	–19%
F-15E	8.0	8.5	7.9	–7%
A-10	7.2	9.7	7.7	–21%
All Jets	7.2	8.3	7.4	–11%
Average Sorties/Year	86	100	89	–11%

SOURCE: Headquarters U.S. Air Force, Deputy Chief of Staff for Operations, written response to Heritage Foundation request for information on Air Force manning levels, July 24, 2020.

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combat mission ready.[68] Flight times, sortie rates, mission planning teams, and flight supervision requirements are significantly higher in combat, and to cover those requirements, the manning ratio normally increases to 1.50 pilots per aircraft, or 36 line pilots per squadron. In other words, every squadron deployed to fight requires six more pilots than it has on its roster.[69] Pilots from the "donor" squadron can fill those slots for the deploying units.

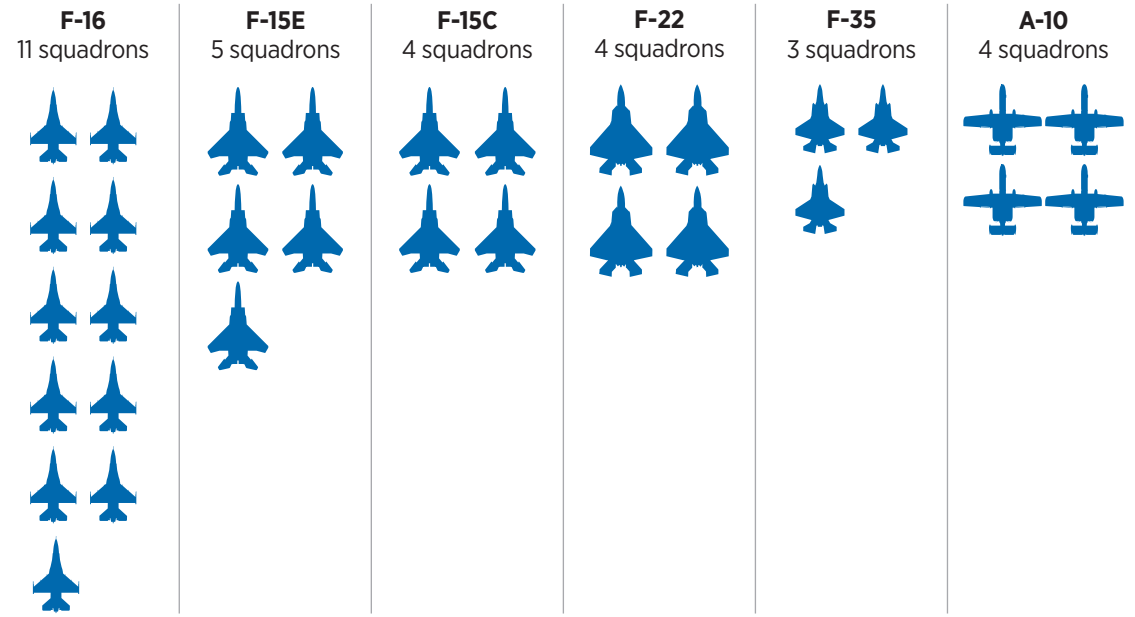
With the downsizing that has taken place since the end of the Cold War and the reduction in the number of fighter squadrons, the Air Force has reduced the number of fighter squadrons to two or even one in many wings, significantly complicating the math behind the number of deployable active-duty fighter squadrons. At best, the deployable and therefore employable capacity of the Air Force will likely be limited to just two out of every three combat-coded squadrons, equating to just 21 active-duty fighter squadrons.

Guard and Reserve units face the same challenges, except that the vast majority of those units have just one fighter squadron per wing, further straining their ability to muster the airframes and manning to meet an emergency deployment.[70] Planning for low-threat, low-intensity deployments to Operation Iraqi Freedom and Operation Enduring Freedom took this into consideration by mapping deployments out months (often years) in advance of the required movement. That allowed pilots to deconflict their civilian work schedules not just for the deployment, but also to get the training and time in the air that they needed to employ successfully in those low-threat combat operations.[71] Nevertheless, it was common for Guard units to pull pilots from other units in order to fulfill manning requirements for "rainbow" fighter squadrons.[72]

Calculating the number of deployable Guard and Reserve squadrons that could be made available to meet an order for emergency deployment to a high-threat environment is at best an exercise in guesswork, but given the readiness and manning issues that have been addressed, two Air National Guard (ANG) squadrons would likely enable one to deploy forward.[73] Of the 54 operational fighter

FIGURE 3

Air Force Active Duty Combat-Coded Fighter Squadrons (31 Total)



SOURCES: Headquarters U.S. Air Force, Deputy Chief of Staff for Operations, written response to Heritage Foundation request for information on Air Force manning levels, July 24, 2020; Brian W. Everstine, "Breaking Down USAF's 70-Percent Overall Mission Capable Rate," *Air Force Magazine*, May 19, 2020, https://www.airforcemag.com/breaking-down-usafs-70-percent-overall-mission-capable-rate/ (accessed August 2, 2020); and table, "Aircraft Total Active Inventory (TAI) (As of Sept. 30, 2019)," in "Air Force & Space Force Almanac," *Air Force Magazine*, Vol. 103, No. 6 (June 2020), p. 63, https://www.airforcemag.com/app/uploads/2020/06/June2020_Fullissue5.pdf (accessed August 2, 2020).

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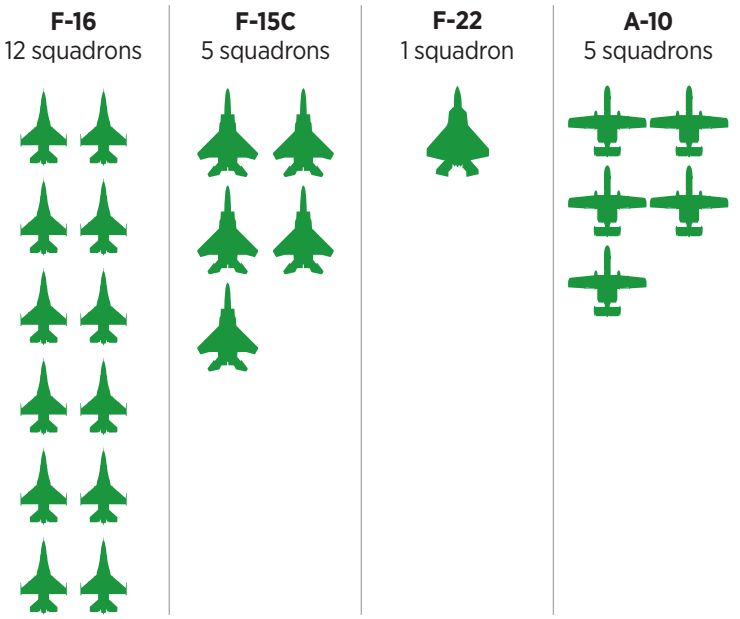
squadrons on the Air Force roster, 31 are active duty and 23 are Guard or Reserve Units. (See Figures 3 and 4, which present the number of active, Guard, and Reserve squadrons by type of platform.) By itself, the airframe disposition of each wing would allow just 20 active-duty fighter squadron equivalents (24 fighter aircraft each) to deploy to a fight, equating to 480 active-duty fighters that could deploy to meet a crisis situation—less than the fighter requirement for one full major regional contingency.

The average ANG and Reserve fighter squadron has one-third fewer jets than similar active-duty units. By rainbowing units with similar aircraft, they could muster 12 squadrons as a strategic reserve, equating to 288 fighters that could deploy sometime later. Those numbers are based on airframes alone, but other factors such as manning levels would also limit the number of sorties and the amount of combat power that those fighters could continually generate in a high-end confrontation with a peer competitor.

The declaration in Air Force posture statements for FY 2020 and FY 2021 that lead force packages within the service's 204 pacing squadrons are ready to fight also conveys the fact that only portions of its most capable squadrons have enough mission-capable aircraft and mission-ready aircrews to respond

FIGURE 4

Air National Guard and Air Force Reserve Combat-Coded Fighter Squadrons (23 Total)



SOURCES: Headquarters U.S. Air Force, Deputy Chief of Staff for Operations, written response to Heritage Foundation request for information on Air Force manning levels, July 24, 2020; Brian W. Everstine, "Breaking Down USAF's 70-Percent Overall Mission Capable Rate," *Air Force Magazine*, May 19, 2020, https://www.airforcemag.com/breaking-down-usafs-70-percent-overall-mission-capable-rate/ (accessed August 2, 2020); and table, "Aircraft Total Active Inventory (TAI) (As of Sept 30, 2019)," in "Air Force & Space Force Almanac," *Air Force Magazine*, Vol. 103, No. 6 (June 2020), p. 63, https://www.airforcemag.com/app/uploads/2020/06/June2020_Fullissue5.pdf (accessed August 2, 2020).

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readily to a crisis. Because of the pilot shortage, actual unit manning levels in fighter squadrons are below peacetime requirements (if only slightly), and those manning thresholds are not enough to meet the significantly increased tempo required for combat operations.

The service has already moved the majority of pilots who were in staff or other non-flying billets back to the cockpit in an effort to relieve the manning shortfall. This means that the only way units will meet wartime manning requirements is by pulling pilots from other "donor" squadrons. The complications that this involves are significant and call into question the idea that the portions of the 54 fighter squadrons that are unable to deploy immediately in a crisis could be combined to create more combat power. The vast majority of aircraft that are left would be used for homeland defense and to train replacement pilots or as replacement aircraft that are lost through combat attrition.

The current state of overall Air Force readiness includes many intangibles, but the factors that can be measured, such as mission-capable rates, aircrew training, and deployability, all point to a readiness level that did not visibly increase between 2018 and 2019.

Scoring the U.S. Air Force

Capacity Score: Marginal

One of the key elements of combat power in the U.S. Air Force is its fleet of fighter aircraft. In responding to major combat engagements since World War II, the Air Force has deployed an average of 28 fighter squadrons, based on an average of 18 aircraft per squadron. That equates to a requirement of 500 active component fighter aircraft to execute one MRC. Based on government force-sizing documents that count fighter aircraft, squadrons, or wings, an average of 55 squadrons (990 aircraft) is required to field a force capable of executing two MRCs (rounded up to 1,000 fighter aircraft to simplify the numbers).

As part of its overall assessment of capacity, the *2021 Index* looks for 1,200 active-duty fighter aircraft to account for the 20 percent reserve necessary when considering availability for deployment and the risk involved in employing 100 percent of fighters at any one time. It also incorporates the requirements stated in the 2018 TAFWN study.

- **Two-MRC Level:** 1,200 combat-coded fighter aircraft.

- **Actual 2019 Level:** 1,011 combat-coded fighter aircraft.

Based on a pure count of combat-coded fighter/attack platforms that have achieved initial operating capability (IOC), the USAF currently is at 84 percent of the capacity required to meet a two-MRC benchmark. However, the disposition of those assets (one to two squadrons for the majority of wings and Combat Air Force–wide manning levels) limits its ability to deploy rapidly to a crisis region and win a single MRC. While the active fighter and bomber assets available would likely prove adequate to fight and win a single regional conflict, when coupled with the low mission capability rates of those aircraft (see Table 8), the global sourcing needed to field the required combat fighter force assets would leave the rest of the world uncovered. Nevertheless, the capacity level is well within the methodology's range of "marginal." This score is now trending upward.

Capability Score: Marginal

The Air Force's capability score is "marginal," the result of being scored "strong" in "Size of Modernization Program," "marginal" for "Age of Equipment" and "Health of Modernization Programs," but "weak" for "Capability of Equipment." These assessments are the same as those in the *2020 Index*. However, new F-35 and KC-46 aircraft continue to roll off their respective production lines, this score is now trending upward.

Readiness Score: Marginal

The Air Force scores "marginal" in readiness in the *2021 Index*, the same grade it received in the *2020 Index*. The USAF's sustained pilot deficit and systemically low sortie rates and flying hours certainly contribute to this assessment, but its stagnant mission-capable rates and the lack of a systemic increase in operational fighter training reflect a service that is content with being ready to respond to a regional contingency rather than building the readiness levels required to meet the 2018 NDS.[74] The Air Force should be prepared to respond quickly to an emergent crisis not with a "task force" of four bombers, but with the speed and capacity required to stop a peer competitor in its tracks. With the significant curtailment of deployments in support of the global war on terrorism, the Air Force should be much farther along in its full-spectrum readiness than we have witnessed to date.

Fighter pilots should receive an average of three or more sorties a week and 200 hours per year to develop the skill sets needed to survive in combat. Even with greatly improved maintenance manning and experience levels and increased funding, average monthly sorties and flying hours have not reached those thresholds.

Whether they can or will be sustained for the length of time it will take to recover from the ongoing readiness shortfall is therefore open to question.

Overall U.S. Air Force Score: Marginal

This is an unweighted average of the USAF's capacity score of "marginal," capability score of "marginal," and readiness score of "marginal." The shortage of pilots and flying time for those pilots degrades the ability of the Air Force to generate the amount and quality of combat air power that would be needed to meet wartime requirements. Although it could eventually win a single major regional contingency in any theater, if the Air Force had to go to war today with a peer competitor, both the time needed to win that battle and the attendant rates of attrition would be much higher than they would be if the service had moved aggressively to increase high-end training and acquire the fifth-generation weapon systems required to dominate such a fight.

U.S. Military Power: Air Force

	VERY WEAK	WEAK	MARGINAL	STRONG	VERY STRONG
Capacity			✓		
Capability			✓		
Readiness			✓		
OVERALL			✓		

AIR FORCE SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2020 ■ Pending

Strategic Bomber

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
B-52 Stratofortress Inventory: **76** Fleet age: **57.8** Date: **1961** The B-52, the oldest of the bombers, provides global strike capabilities with conventional or nuclear payloads. Programmed upgrades for B-52 include new communications, avionics, and Multi-Functional Color Displays. The Air Force plans to use this aircraft through the 2050s.	1	2	The B-21 is an advanced stealth bomber that will replace all B-1s and B-2s within the Air Force bomber fleet. Flight testing is scheduled for 2021. Procurement is expected to begin FY22.		
B-1 Lancer Inventory: **62** Fleet age: **32.4** Date: **1986** The B-1B is a supersonic all-weather conventional bomber. It was modified in the mid–1990s to disable its nuclear weapon delivery capability. Block 16 upgrades to be completed by 2020 include a fully integrated data link, navigation, radar, and diagnostic upgrades. B-1B phase-out is scheduled for 2032.	2				
B-2 Spirit Inventory: **20** Fleet age: **24.2** Date: **1997** The B-2 bomber provides the USAF with global strike capabilities for both nuclear and conventional payloads. The stealth bomber's communication suite is currently being upgraded. The current plan is to begin phasing out the B-2 in 2032.	3	4			

NOTE: See page 438 for details on dates, timelines, and procurement spending.

Ground Attack/Multi-Role Aircraft

PLATFORM	Age Score	Capability Score
A-10 Thunderbolt II Inventory: **281** Fleet age: **36.8** Date: **1977** The A-10 is the only USAF platform designed specifically for close-air support missions using both self-designated precision-guided munitions and an internal 30mm cannon. The retirement of the A-10 has been discussed for years, but it now appears it will keep flying through 2040.	2	2
F-16C Falcon Inventory: **783** Fleet age: **26.7** Date: **1980** The F-16 is a multirole aircraft capable of tactical nuclear delivery, all-weather strike, and Suppression of Enemy Air Defenses (SEAD). An ongoing Service Life Extension Program (SLEP) will keep this jet in the inventory through the late 2040s.		
F-35A Lightning Inventory: **203** Fleet age: **3.7** Date: **2016** The F-35 is a multirole stealth fighter that became operational in 2016. The Air Force has received more than 200 of a planned purchase of 1,763 aircraft.	5	5
F-15E Strike Eagle Inventory: **218** Fleet age: **27.4** Date: **1989** The F-15E is a multirole aircraft capable of all-weather, deep interdiction/attack, and tactical nuclear weapons delivery. Upgrades include an AESA radar, EPAWSS self-defense suite, a new central computer, and cockpit displays.	2	2

REPLACEMENT PROGRAM	Size Score	Health Score
F-35A Timeline: **2016–TBD** The F-35A "Lightning" is a multirole stealth fighter that became IOC on August 2, 2016. The Air Force plans to acquire 48 F-35As a year across the Future Years Defense Program, however the Senate markup of the 2021 NDAA contains funding for the acquisition of 12 more F-35As in FY 2021. **PROCUREMENT** 338 1,425 **SPENDING** *($ millions)* $45,485 $186,382	5	3

NOTE: See page 438 for details on dates, timelines, and procurement spending.

AIR FORCE SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2020 ■ Pending

Fighter Aircraft

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
F-15C/D Eagle Inventory: **234** Fleet age: **29.1** Date: **1975** The F-15C/D is an air-superiority fighter that has been in service since the late 1970s. The jet is receiving upgrades including a new AESA radar and self-defenses needed to survive and fight in contested airspace. Discussions are underway to retire the F-15C in late 2020s.	1	2	The F-15EX will be based on the two-seat F-15QA (Qatar) configuration upgraded with USAF-only capabilities, including the Eagle Passive Active Warning and Survivability System (EPAWSS) and advanced Operational Flight Program (OFP) software. The President's Budget for FY 2020 will acquire 8 F-15EXs in FY 2020 and a total of 80 over the Future Years Defense Program.		
F-22A Raptor Inventory: **186** Fleet age: **13.2** Date: **2005** The F-22 is the preeminent air superiority stealth fighter aircraft, modified to enable delivery of precision-guided weapons delivery. The jet is currently undergoing a modification called RAAMP that will improve reliability, maintainability, and performance.	4	5			

NOTE: See page 438 for details on dates, timelines, and procurement spending.

Tanker

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
KC-10 Extender Inventory: **59** Fleet age: **34.7** Date: **1981** The KC-10 is a multirole tanker and airlift platform that can refuel both boom- and drogue-compatible fighters on the same mission. Recent modifications have enabled a service life extension through 2045. The Air Force planned to retire the KC-10 by 2024, but with a shortfall of refueling platforms, and slow acquisition of the KC-46, that appears unlikely.	2	5	**KC-46** Timeline: **2019–2017** The KC-46 Pegasus will replace portions of the KC-135 tanker fleet. The program entered low-rate initial production in August 2016, and the Air Force accepted the first Pegasus on January 10, 2019. The tanker has had several deficiencies and is currently unable to refuel aircraft due to problems with its remote visual system. The Air Force is still accepting approximately 15 aircraft a year despite the Pegasus being unable to perform its primary mission.	3	3
KC-135 Stratotanker Inventory: **379** Fleet age: **58.7** Date: **1957** The KC-135 is a multirole tanker/airlift platform. The aircraft has undergone several modifications, mainly engine upgrades to improve performance and reliability. Part of the fleet will be replaced with the KC-46, with the remainder scheduled to be in service through 2040.	1				
KC-46 Pegasus Inventory: **21** Fleet age: **0.1** Date: **2020** This Pegasus is a multirole tanker/airlift platform that can refuel both boom- and drogue-compatible fighters on the same mission. The Air Force accepted the first of 179 programmed aircraft in 2019. The program has had significant problems, but deliveries will continue at a rate of 15 aircraft a year.	5	1			

PROCUREMENT

SPENDING *($ millions)*

NOTE: See page 438 for details on dates, timelines, and procurement spending.

AIR FORCE SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2020 ■ Pending

Heavy Lift

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
C–5M Galaxy Inventory: **52** Fleet age: **32.4** Date: **1970** The C-5 is the USAF's largest mobility aircraft. It can transport 270,000 pounds of cargo over intercontinental ranges and is air refuelable. The "M" models are heavily modified C-5A/Bs that have new engines, avionics, and structural/reliability fixes. Ongoing modifications include a new weather radar and mission computer, and improved Large Aircraft IR Countermeasures (LAIRCM).	2	5	None		
C-17 Globemaster III Inventory: **222** Fleet age: **17** Date: **1995** The C-17 is a large, air-refuellable transport aircraft that is capable of operating on small airfields (3,500 feet by 90 feet). Ongoing modifications include next-generation Large Aircraft Infrared Countermeasures (LAIRCM), and structural, safety, and sustainment modifications.	4				

Medium Lift

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
C-130J Super Hercules Inventory: **132** Fleet age: **9.3** Date: **2006** The C-130J is an improved tactical airlift platform that can operate from small, austere airfields, and provide inter-theater airlift and airdrop and humanitarian support. The Air Force active component completed transition to the C-130J in October 2017.	5	5	**C-130J** Timeline: **2006–2022** An upgraded medium-lift capability with multiple variants including the C-130J-30, AC-130J gunship, and HC-130 rescue/air refueling platform. The C-130J-30 can carry 92 airborne troops and lift over 40,000 pounds of cargo. The Air Force currently has two multi-year contracts underway with Lockheed Martin to procure 16 C-130Js per year through FY 2023, and to procure an additional 24 H/MC-130 aircraft from 2021 to 2025. **PROCUREMENT** 176 **SPENDING** *($ millions)* $14,016.4 $ 141.7	5	5

NOTE: See page 438 for details on dates, timelines, and procurement spending.

Intelligence, Surveillance, and Reconnaissance (ISR)

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
RQ-4 Global Hawk Inventory: **35** Fleet age: **9.5** Date: **2011** The RQ-4 is an unmanned aerial vehicle (UAV). Unlike the MQ-9, the RQ-4 is a high-altitude, long-endurance (HALE) UAV, which in addition to higher altitude has a longer range than medium-altitude, long-endurance (MALE) UAVs.	4	3	None		
MQ-9 A/B Reaper Inventory: **269** Fleet age: **5.5** Date: **2007** The MQ-9 is a hunter/killer Remotely Piloted Aircraft (RPA) with EO/IR and SAR targeting capabilities, and is capable of station times in excess of 24 hours. The Extended Range modification adds external fuel tanks, a four-bladed propeller, engine alcohol/water injection, heavyweight landing gear, longer wings, and tail surfaces.	5	2	**MQ-9** Timeline: **2007–2017** The MQ-9 "Reaper" is a proven hunter/killer unmanned Aerial Vehicle (UAV). The Air Force FY 2020 budget funds the procurement of 24 Reapers, but the proposed President's Budget for 2021 unexpectedly ends MQ-9 acquisition. However, both the House (16 aircraft) and Senate ($170.6m) markups of the 2021 NDAA contain funding for the acquisition of additional MQ-9 UAS. **PROCUREMENT** 48 / 16 **SPENDING** *($ millions)* $10,706 / $1,932	5	5
RC-135 Rivet Joint Inventory: **20** Fleet age: **55.8** Date: **1972** The RC-135 is a manned ISR platform that collects electronic and signals intelligence with real-time analysis and dissemination for tactical forces, combatant commanders, and National Command Authorities. Ongoing upgrades include new direction finding COMINT, precision ELINT/SIGINT system integration, wideband SATCOMS, enhanced near real-time data dissemination, and new steerable beam antenna.	1	4	None		
U-2 Dragon Lady Inventory: **27** Fleet age: **36.7** Date: **1956** The U-2 is a manned strategic high-altitude, long-endurance ISR platform. Capable of SIGINT, IMINT and MASINT collection, it can carry a variety of advanced optical, multispectral, EO/IR, SAR, SIGINT, and other payloads simultaneously. No other aircraft in the U.S. inventory has this capability, which will indefinitely delay the U-2's retirement.	1				

NOTE: See page 438 for details on dates, timelines, and procurement spending.

AIR FORCE SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2020 ■ Pending

Command and Control

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
E-3 AWACS Inventory: **31** Fleet age: **38.2** Date: **1977** The E-3 is an airborne warning and control system (AWACS) that delivers all-weather, air and maritime surveillance, command and control, battle management, target, threat, and emitter detection, classification, and tracking. Ongoing upgrades include an urgent operational requirement to shorten kill-chains on time-sensitive targets, modernizing airborne moving-target indication, and adding high-speed jam-resistant Link 16. The E-3 is scheduled to stay in service through the 2040s.	1	2	None		
E-8 JSTARS Inventory: **16** Fleet age: **17.8** Date: **2010** The E-8 is a ground moving-target indication (GMTI), airborne battlefield management/command and control platform. Its primary mission is providing theater commanders with ground surveillance data to support tactical operations. The Air Force plans to retire this platform in the mid-2020s.					

NOTES: See Methodology for descriptions of scores. The date is the year the platform reached initial operational capability. The timeline is from year the platform reached initial operational capability until its final procurement. Spending does not include advanced procurement or research, development, test, and evaluation (RDT&E).

U.S. Air Force Modernization Table Citations

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10. Appendix, "Department of the Air Force Total Aircraft Inventory (TAI)," in U.S. Department of Defense, Secretary of the Air Force, Office of Financial Management and Budget (SAF/FMB), *Department of the Air Force FY 2021 Budget Overview*, p. 42.
11. "The Air Force We Need" calls for one additional airlift squadron and five additional bomber, seven additional fighter, and 14 additional tanker squadrons. While the number of aircraft in any one of those categories varies from unit to unit, there are approximately 30 fighters, 10 bombers, 15 tankers, and 15 strategic airlift aircraft in each squadron. Mathematically, "The Air Force We Need" calls for 182 more fighters, 50 more bombers, 210 more refuelers, and 15 more airlift aircraft than the Air Force currently has in its inventory. U.S. Air Force, "The Air Force We Need: 386 Operational Squadrons."
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aircraft associated with Weapons Instructor Course Squadrons, Adversary Tactics, Test, OT&E, and other units are not standard/determinable and could not be assessed. The associated error is minimized by totaling all like fighter aircraft (F-16, F-15C, etc.); dividing them by the total number of squadrons flying those aircraft; and spreading the error equally across all combat-coded fighter and training units. The total number of fighters associated with non–Fighter Training Unit (FTU) squadrons was counted as "combat-coded."

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61. Telephone conversation with senior Air Force leader, April 24, 2020.
62. Slife, *Creech Blue*, pp. 92–95.
63. U.S. General Accounting Office, *Air Force Maintenance: Two Level Maintenance Program Assessment*, GAO/NSAID-96-86, March 1996, p. 1, https://www.gao.gov/assets/230/222350.pdf (accessed August 4, 2020).
64. Averages for sorties and hours are based on weighted fighter manning levels for each of the five major weapons systems provided in Headquarters U.S. Air Force, Deputy Chief of Staff for Operations, written response to Heritage Foundation request for information on Air Force manning levels, July 24, 2020. The numbers were weighted based on aircraft numbers as explained in note 22, *supra*, as well as standard aircrew ratios established in Figure A8.1, "Air Force Single Flying Hour Model F-16C Example," in U.S. Air Force, "Flying Operations: Flying Hour Program Management," Air Force Instruction 11-102, August 30, 2011, p 17, https://static.e-publishing.af.mil/production/1/af_a3_5/publication/afi11-102/afi11-102.pdf (accessed August 5, 2020).
65. See note 64.
66. Author's experience through 26 years of Air Force operations, coupled with senior leader engagements from 2018–2019.
67. Albert A. Robbert, Anthony D. Rosello, Clarence R. Anderegg, John A. Ausink, James H. Bigelow, William W. Taylor, and James Pita, *Reducing Air Force Fighter Pilot Shortages* (Santa Monica, CA: RAND Corporation, 2015), p. 33, https://www.rand.org/content/dam/rand/pubs/research_reports/RR1100/RR1113/RAND_RR1113.pdf (accessed August 4, 2020).
68. Even though active-duty fighter squadrons have an average of 30 aircraft per squadron, that number includes maintenance spares and attrition reserve platforms. Manning is based on Primary Assigned Aircraft (PAA), which is 24 aircraft for active-duty fighter squadrons.
69. Based on a squadron with 24 Primary Assigned Aircraft. For units with 18 PAA, four additional pilots are required.
70. The very premise of these units is that they are manned with citizen soldiers whose main source of income is full-time civilian jobs and who are committed to travel and temporary duty locations that make them unavailable for days or weeks at a time. Those units would likely require several days to assemble the manpower required to deploy, and once an assessment of their real mission currency was made, they would need some period of intense training before a responsible senior leader could employ them in a fight with a peer competitor.
71. "Deployments most suited to the ARC are those in which there is long lead time (six months or more), and in which the operation is of short duration (six days or less), requiring a small force package (12 aircraft or less), and in which the scheduling is flexible." John T. Correll, "Future Total Force," *Air Force Magazine*, Vol. 82, No. 7 (July 1999), p. 32, https://www.airforcemag.com/PDF/MagazineArchive/Documents/1999/July%201999/0799total.pdf (accessed August 4, 2020).
72. The author commanded the 349th Expeditionary Combat Group at Al Udeid, Qatar, from 2004–2005. During that time, he flew with seven different Air National Guard F-16 squadrons. Every one of those units had some level of rainbow manning, and each performed admirably.
73. Interview with senior Air National Guard leader, November 20, 2019.
74. See Venable, "Independent Capability Assessment of U.S. Air Force Reveals Readiness Level Below Carter Administration Hollow Force."

U.S. Marine Corps

Dakota L. Wood

The U.S. Marine Corps (USMC) is the nation's expeditionary armed force, positioned and ready to respond to crises around the world. Marine units assigned aboard ships ("soldiers of the sea") or at bases abroad stand ready to project U.S. power into crisis areas. Marines also serve in a range of unique missions, from combat defense of U.S. embassies under attack abroad to operating the President's helicopter fleet.

Although Marines have a wide variety of individual assignments, the focus of every Marine is on combat: Every Marine is first a rifleman. Over the past several decades, the Marine Corps has positioned itself for crisis response, but while sustaining its historical, institutional, and much of its doctrinal focus on its historical connection to operations in maritime environments, the majority of its operational experience over the past 20 years has been in sustained land operations. This has led to a dramatic decline in the familiarity of most Marines with conventional amphibious operations and other types of employment within a distinctly maritime setting. Recognizing this shortfall, the Corps' leadership has initiated efforts to reorient the service toward enabling and supporting the projection of naval power in heavily contested littoral environments with a particular focus on the Indo-Pacific region.

As reported in February 2020, the Corps had 36,100 Marines deployed to remain "engaged in joint, integrated operations around the globe, providing immediate response options, assuring allies and deterring our adversaries." This included approximately one-third of the Corps' operational forces deployed to 60 countries and 11,000 Marines serving aboard ships.[1] During the year preceding its fiscal year (FY) 2021 budget request, "[T]he Marine Corps executed 249 operations, nine amphibious operations, [and] 151 theater security cooperation events, and participated in 68 exercises." Among these involvements were support for operations Inherent Resolve (Iraq and Syria) and Freedom's Sentinel (Afghanistan); operations across Africa and Latin America; and major exercises with many partner countries in Asia and Europe.[2]

Pursuant to the National Defense Strategy (NDS),[3] maintaining the Corps' crisis-response capability is critical. Thus, given the fiscal constraints imposed by the budget environment of the past several years, the Marines have prioritized near-term readiness at the expense of other areas such as capacity, capability, modernization, home station readiness, and infrastructure. Over the past two to three years, however, additional funding provided by Congress has enabled the Corps to make advances in readiness and turn to modernization at what USMC Commandant General David H. Berger has called "a significant scale."[4] As stated in DOD's FY 2019 *Defense Budget Overview*, the service elevated modernization as a means to improve readiness for combat.[5] This is consistent with and central to its readiness-recovery efforts and represents a shift to a longer-term perspective. Recapitalization and repair of legacy systems are no longer sufficient to sustain

current operational requirements. New equipment is necessary.

In general for the Joint Force, this *Index* focuses on the forces required to win two major wars as the baseline force-sizing metric for the Army, Navy, and Air Force, but it adopts a different paradigm—one war plus crisis response—for the Marine Corps. While the three large services are sized for global action in more than one theater at a time, the Marines, by virtue of overall size and most recently by direction of the Commandant, focus on one major conflict while ensuring that all Fleet Marine Forces are globally deployable for short-notice, smaller-scale actions.

In previous editions of the *Index*, the capacity of the Marine Corps was assessed against a two-war requirement of 36 battalions: a historical average of 15 battalions for a major conflict (30 for two major conflicts) and a 20 percent buffer, bringing the total to 36. The Corps has consistently maintained that it is a one-war force and has no intention of growing to the size needed to fight two wars. Its annual budget requests and top-level planning documents reflect this position.

Having assessed that the Indo-Pacific region will continue to be of central importance to the U.S., and noting that China is a more worrisome "pacing threat" than any other competitor and that the Joint Force lacks the ability to operate within the range of intensely weaponized, layered defenses featuring large numbers of precision-guided munitions, the Corps is reshaping itself to optimize its capabilities and organizational structures for this challenge. This *Index* concurs with this effort but assesses that the Corps will still need greater capacity to succeed in war in the very circumstances for which the Marines believe they must prepare.

Capacity

The measures of Marine Corps capacity in this *Index* are similar to those used to assess the Army's: end strength and units (battalions for the Marines and brigades for the Army). The Marine Corps' basic combat unit is the infantry battalion, which is composed of approximately 900 Marines and includes three rifle companies, a weapons company, and a headquarters and service company.[6]

In 2011, the Marine Corps maintained 27 infantry battalions in its active component at an authorized end strength of 202,100.[7] As budgets declined, the Corps prioritized readiness through managed reductions in capacity, including a drawdown of forces, and delays or reductions in planned procurement levels. After the Marine Corps fell to a low of 23 active component infantry battalions in FY 2015,[8] Congress began to fund gradual increases in end strength, returning the Corps to 24 infantry battalions.

The Corps operated with 186,200 Marines in FY 2020,[9] perhaps a high point for the foreseeable future as the service plans to shrink to 184,100 in FY 2021 to free funding so that it can be reapplied to experimentation, retooling, and reorganization as described in "Force Design 2030."[10] The current size allows for 24 infantry battalions, but future plans will likely see the number shrink to 21 battalions.[11]

One impact of reduced capacity is a strain on Marines' dwell time. Cuts in capacity—the number of units and individual Marines—enabled the Corps to disperse the resources it did receive among fewer units, thus maintaining higher readiness levels throughout a smaller force. However, without a corresponding decrease in operational requirements, demand for Marine Corps units and assets has resulted in grueling deployment rates, a situation largely unchanged since 2018.[12] High deployment frequency exacerbates the degradation of readiness as people and equipment are used more frequently with less time to recover between deployments.

The stated ideal deployment-to-dwell (D2D) time ratio is 1:3 (seven months deployed for every 21 months at home).[13] This leaves more time available for training and recovery and provides support for a ready bench, without which readiness investments are immediately consumed. The Corps is currently sustaining a 1:2 D2D ratio while working toward the more desirable 1:3 ratio.[14]

Infantry battalions serve as a surrogate measure for the Corps' total force. As the first to respond to many contingencies, the Marine Corps requires a large degree of flexibility and self-sufficiency, and this drives its approach to organization and deployment of operational formations that, although typically centered on infantry units, are composed of ground, air, and logistics elements. Each of these assets and capabilities is critical to effective deployment of the force, and any one of them can be a limiting factor in the conduct of training and operations.

Aviation. Despite being stressed consistently by insufficient funding, the Marine Corps has made significant progress in achieving its objective of 80 percent aviation readiness in FY 2020.[15] However, even though operational requirements have not decreased, fewer Marine aircraft have been available for tasking or training. For example, according to its *2019 Marine Corps Aviation Plan*, the USMC currently fields 16 tactical fighter squadrons,[16] compared to 19 in 2017[17] and around 28 during Desert Storm.[18] Though availability of legacy aircraft has slowly improved—the result of increased funding for spare parts and implementation of recommendations from independent readiness reviews—the Marine Corps "is still challenged with low readiness rates in specific communities" such as F/A-18 squadrons.[19]

While the Corps is introducing the F-35 platform into the fleet, F/A-18 Hornets remain "the primary bridging platform to F-35B/C" and will remain in the force until 2030.[20] This primary TACAIR capability has to be carefully managed as it is no longer in production. The Navy completed its divestment of F/A-18 A-D models during FY 2019, making them available to the Marines and thereby enabling the Marine Corps to replace its older aircraft with planes that are less old.[21] To further mitigate the aging of its fleet until full transition to the F-35, the Corps is also looking to acquire F/A-18s from other countries as opportunities arise.[22] The Corps will maintain five squadrons of AV-8B Harriers, introduced in 1985, until FY 2022.[23]

In its heavy-lift rotary-wing fleet, the Corps began a reset of the CH-53E in 2016 to bridge the procurement gap to the CH-53K and aimed to "reset...the entire 143-aircraft fleet by FY20,"[24] but recent reporting indicates that the Corps is only one-third of the way through the process.[25] Even when the reset is complete, the service will still be 57 aircraft short of the stated heavy-lift requirement of 200 airframes and will not have enough helicopters to meet its heavy-lift requirement without the transition to the CH-53K.[26]

According to the *2019 Marine Corps Aviation Plan*, the Corps completed its transition from the CH-46E to the MV-22 Osprey in 2019, with 18 fully operational squadrons in the active component.[27] However, the procurement objective could increase to 380 aircraft pending the results of an ongoing requirements-based analysis.[28] The Osprey has been called "our most in-demand aircraft,"[29] which means the Marine Corps has to reconcile high operational tempos (OPTEMPOs) with the objective of maintaining the platform in inventory "for at least the next 40 years."[30] The Corps has committed to funding its Common Configuration–Readiness and Modernization (CC–RAM) and Nacelle Improvement (NI) programs to increase aircraft availability by 15 percent.[31]

Although amphibious ships are assessed as part of the Navy's fleet capacity, Marines operate and train aboard naval vessels, making "the shortage of amphibious ships...the quintessential challenge to amphibious training."[32] As of July 28, 2020, the Navy was operating only 33 amphibious ships,[33] and it is projected to continue operating short of the 38 ships the Marine Corps held as the minimum requirement for many years,[34] thus limiting what the Corps can do in operational, training, and experimentation settings.[35]

Because of this chronic shortfall in amphibious ships, the USMC has relied partially on land-based Special Purpose Marine Air-Ground Task Forces (SPMAGTFs), but while SPMAGTFs have enabled the Corps to meet Joint Force requirements, land-based

locations "lack the full capability, capacity and strategic and operational agility that results when Marine Air-Ground Task Forces (MAGTFs) are embarked aboard Navy amphibious ships."[36] The lack of variety in amphibious shipping, especially as the Corps considers the implications of evolving enemy capabilities, has combined with the service's concerns about the shortage of amphibious lift in general to increase its sense of urgency to explore alternatives with the Navy.[37]

The USMC continues to invest in the recapitalization of legacy platforms in order to extend platform service life and keep aircraft and amphibious vehicles in the fleet, but as these platforms age, they also become less relevant to the evolving modern operating environment. Thus, although they do help to maintain capacity, programs to extend service life do not provide the capability enhancements that modernization programs provide. The result is an older, less-capable fleet of equipment that costs more to maintain.

Capability

The nature of the Marine Corps' crisis-response role requires capabilities that span all domains. The USMC ship requirement is managed by the Navy and is covered in the Navy's section of the *Index*. The Marine Corps is focusing on modernization and emphasizing programs such as the Amphibious Combat Vehicle (ACV) and F-35 JSF programs, its top two priorities.[38] The Corps has doubled its investment in modernization as a percentage of its budget from 14 percent in FY 2019 to 30 percent for FY 2020.[39] That a focus on readiness and planning for future operations continues to be a priority is seen in the service's budget requests for FY 2021. The Department of the Navy decreased spending on procurement overall by 8.3 percent in order to increase funding for research and development and protect gains made in readiness over the past few years.[40]

Of the Marine Corps' current fleet of vehicles, its amphibious vehicles—specifically, the Assault Amphibious Vehicle (AAV-7A1) and Light Armored Vehicle (LAV)—are the oldest, with the AAV-7A1 averaging over 41 years old and the LAV averaging 27 years old.[41] The Corps had moved to extend the service life of the AAV but abandoned that program as progress with the ACV accelerated.[42] The Corps has stated that:

> We continue to make strategic choices in the divestiture of certain programs to reallocate funds toward building a more lethal, modern, multi-domain, expeditionary force. This has included accepting near-term capacity risk by reducing depot level maintenance for the legacy Amphibious Assault Vehicle (AAV) as we transition to the Amphibious Combat Vehicle (ACV).[43]

In addition, it decreased funding for maintenance of combat vehicles by 28 percent, or $56 million, in FY 2020 compared with the preceding year.[44]

Though it is not yet in development, service testimony notes that the Marine Corps is "beginning to look at a replacement" for the LAV, which will "help accelerate movement to the acquisition phase within the next four to five years."[45] As noted, the average age of the LAV is 27 years. Comparatively, the Corps' M1A1 Abrams inventory is 28 years old with an estimated 33-year life span,[46] and the newest High Mobility Multi-Purpose Wheeled Vehicle (HMMWV) variant has already consumed half of a projected 15-year service life.[47] In short, the Corps' fleet of vehicles is old.

All of the Corps' main combat vehicles entered service in the 1970s and 1980s, and while service life extensions, upgrades, and new generations of designs have allowed the platforms to remain in service, these vehicles are quickly becoming poorly suited to the changing threat environment.[48] The FY 2020 budget provided $2.99 billion for modernization of ground-related combat and combat-related systems that will extend the service utility of aging primary ground combat platforms.[49]

The age profiles of the Corps' aircraft are similar to those of the Navy's. In 2018, the

USMC had 251 F/A-18A-Ds (including one reserve squadron) and six EA-6Bs in its primary mission aircraft inventory,[50] and both aircraft had already surpassed their originally intended life spans. The Marine Corps completed retirement of its EA-6B squadrons in FY 2019.[51]

Unlike the Navy, the Corps did not acquire the newer F/A-18 E/F Super Hornets; thus, some of the older F/A-18 Hornets are going through a service life extension program to extend their life span to 10,000 flight hours from the original 6,000 hours.[52] This is intended to bridge the gap until the F-35Bs and F-35Cs enter service to replace the Harriers and most of the Hornets.

As the Navy accelerated its transition to the Super Hornet, it transferred its "best of breed" aircraft from its F/A-18A-D inventory to the Marine Corps and scrapped the remaining for parts to help maintain the Corps' legacy fleet through FY 2030.[53] The AV-8B Harrier, designed to take off from the LHA and LHD amphibious assault ships, will be retired from Marine Corps service by 2026.[54] The AV-8B received near-term capability upgrades in 2015, and they continued in 2017 in order to maintain its lethality and interoperability until the F-35 transition is completed in FY 2022.[55]

The Corps declared its first F-35B squadron operationally capable on July 31, 2015, after it passed an "Operational Readiness Inspection" test and has reported that the aircraft reached full operational capability in late 2018.[56] During FY 2019, VMFA-211, composed of F-35Bs, made the first full operational deployment with a Marine Expeditionary Unit (MEU) when it sailed with the 13th MEU from September 2018 to February 2019, supporting combat operations in Afghanistan, Iraq, and Syria.[57] To date, at least 174 aircraft (151 F-35Bs and at least 23 F-35Cs) have been procured.[58] In January 2020, Marine Fighter Attack Squadron 314 (VMFA-314) became the first USMC squadron to be equipped with the F-35C.[59]

The Marine Corps has two Major Defense Acquisition (MDAP) vehicle programs: the Joint Light Tactical Vehicle (JLTV) and Amphibious Combat Vehicle (ACV).[60] The JLTV is a joint program with the Army to acquire a more survivable light tactical vehicle, originally intended to replace a percentage of the older HMMWV fleet, introduced in 1985, although that objective changed in 2019. The Army retains overall responsibility for JLTV development through its Joint Program Office.[61]

Following FY 2015 plans for the JLTV, the program awarded a low-rate initial production contract, which included a future option of producing JLTVs for the Marine Corps, to defense contractor Oshkosh.[62] As of June 2017, despite a delay in the program's full-rate production decision and reduced procurement quantities in FY 2016 and FY 2017, the Corps expected to complete its prior acquisition objective of 5,500 by FY 2023.[63] In mid-August 2019, the Corps announced that it would increase its procurement of JLTVs to around 15,000, essentially enabling it to replace its HMMWV fleet of 15,390 vehicles.[64] In FY 2020, the Corps procured 1,264 vehicles at a cost of $556 million.[65]

After restructuring its ground modernization portfolio, the Marine Corps determined that it would combine its efforts by upgrading 392 of its legacy AAVs and continuing development of the ACV to replace part of the existing fleet and complement its AAVs.[66] This would help the Corps to meet its requirement of armored lift for 10 battalions of infantry.[67] In June 2018, BAE Systems won the contract award to build the ACV 1.1.[68] It delivered the first 30 vehicles during 2019. The Corps purchased 56 in FY 2020 and plans to buy another 72 in FY 2021.[69] The Marine Corps plans to field 204 vehicles in the first increment—enough to support lift requirements for two infantry battalions.[70]

The ACV 1.1 platform is notable because it is an amphibious wheeled vehicle instead of a tracked vehicle capable of traversing open water only with the assistance of Navy shore connectors (landing craft) such as Landing Craft, Air Cushion Vehicles (LCAC), that carry the ACV from ship to shore. Development and procurement of the ACV program are phased so that the new platforms are fielded

incrementally alongside a number of modernized AAVs.[71] Plans call for a 694-vehicle program of record (a combination of upgraded AAVs and ACVs), with the first battalion to reach initial operating capability (IOC) in FY 2020, and modernization of enough of the current AAV fleet to outfit six additional battalions, two in the first increment and four in the second. To this end, the Corps was allocated $301 million in its FY 2020 budget to fund the "first full-rate production lot of 72 [ACV] vehicles (16 more than FY 2020)."[72] This is significantly higher than the almost $167 million the Corps received for ACV in FY 2019, and substantially less than the almost $479 million it has requested for FY 2021 to purchase an additional 72 vehicles.[73]

With regard to aviation, Lieutenant General Brian Beaudreault, then Marine Corps Deputy Commandant for Plans, Policies, and Operations, testified in 2018 that "[t]he single most effective way to meet our NDS responsibilities, improve overall readiness, and gain the competitive advantage required for combat against state threats is through the modernization of our aviation platforms."[74] The F-35B remained the Marine Corps' largest investment program in FY 2020. Total procurement will consist of 420 F-35s (353 F-35Bs and 67 F-35Cs), of which at least 174 have been acquired.[75] AV-8Bs and F/A-18A-Ds continue to receive interoperability and lethality enhancements in order to extend their useful service lives during the transition to the F-35.

Today, the USMC MV-22 Osprey program is operating with few problems and nearing completion of the full acquisition objective of 360 aircraft.[76] The Marine Corps now has 16 fully operational MV-22 squadrons in the active component.[77] The MV-22's capabilities are in high demand from the Combatant Commanders (COCOMS), and the Corps is adding such capabilities as fuel delivery and use of precision-guided munitions to the MV-22 to enhance its value to the COCOMs.

The Corps has struggled with sustainment challenges in the Osprey fleet. In the years since procurement of the first MV-22 in 1999, the fleet has developed more than 70 different configurations.[78] This has resulted in increased logistical requirements as maintainers had to be trained to each configuration and spare parts were not all shared. The Marine Corps has developed its Common Configuration–Reliability and Modernization program to consolidate the inventory to a common configuration at a rate of "2–23 aircraft installs per year." The program was initiated in FY 2018.[79]

The USMC's heavy-lift replacement program, the CH-53K, conducted its first flight on October 27, 2015.[80] The CH-53K will replace the Corps' CH-53E, which is now 30 years old. Although "unexpected redesigns to critical components" delayed a low-rate initial production decision,[81] the program achieved Milestone C in April 2017. The Corps received $1 billion in 2019 to purchase seven aircraft and continued this effort by purchasing another six in FY 2020 for $848 million.[82] The helicopter is forecast to reach IOC in FY 2021.[83] This is of increasing concern because the Marine Corps maintains only 138 CH-53Es and will not have enough helicopters to meet its heavy-lift requirement of 220 aircraft without the transition to the CH-53K, which even when fully implemented will still fall short by 20 aircraft.[84]

Readiness

The Marine Corps' first priority is to be the crisis-response force for the military, which is why investment in immediate readiness has been prioritized over capacity and capability.[85] Although this is sustainable for a short time, issues about which concerns were expressed when the Budget Control Act was passed in 2011 have proved to be impediments to achieving and sustaining readiness at desired levels. That said, however, the Corps has reported notable increases in readiness over the past two to three years as a result of increased funding.

With respect to training, the Marine Corps continues to prioritize training for deploying and next-to-deploy units. Marine operating forces as a whole continue to average a 1:2 deployment-to-dwell ratio.[86]

Marine Corps guidance identifies multiple levels of readiness that can affect the ability to conduct operations:

> Readiness is the synthesis of two distinct but interrelated levels. a. unit readiness—The ability to provide capabilities required by the combatant commanders to execute their assigned missions. This is derived from the ability of each unit to deliver the outputs for which it was designed. b. joint readiness—The combatant commander's ability to integrate and synchronize ready combat and support forces to execute his or her assigned missions.[87]

As previously mentioned, the availability of amphibious ships, although funded through the Navy budget, has a direct impact on the Marine Corps' joint readiness. For example, while shore-based MAGTFs can maintain unit-level readiness and conduct training for local contingencies, a shortfall in amphibious lift capabilities leaves these units without "the strategic flexibility and responsiveness of afloat forces and...constrained by host nation permissions."[88]

In December 2017, a U.S. Government Accountability Office (GAO) official testified that while deploying units completed all necessary predeployment training for amphibious operations, the Marine Corps was "unable to fully accomplish...home-station unit training to support contingency requirements, service-level exercises, and experimentation and concept development for amphibious operations."[89] A shortage of available amphibious ships was identified as the primary factor in training limitations. Of the 32 amphibious ships currently in the U.S. fleet, only 16 were considered "available to support current or contingency operations" at that time.[90] Although infantry battalions can maintain unit-level readiness requirements, their utility depends equally on their ability to deploy in defense of U.S. interests.

Marine aviation in particular has experienced significant readiness shortfalls, but the Marines have reported better rates as a result of sustained funding for readiness in recent years. The *2018 Marine Aviation Plan* found that "[a]cross all of Marine aviation, readiness is below steady state requirements."[91] However, in testimony before the House Armed Services Committee, General Berger reported that readiness for fixed-wing aviation had met the 80 percent goal established by former Secretary of Defense James N. Mattis in 2018.[92]

The Marines Corps' Ground Equipment Reset Strategy, developed to recover from the strain of years of sustained operations in Iraq and Afghanistan, has had a positive impact after being delayed from the end of FY 2017 to FY 2019. During 2019, the Marine Corps reset approximately 99 percent of its ground equipment and "returned 72% of [its] ground equipment to the operating forces."[93] Reconstituting equipment and ensuring that the Corps' inventory can meet operational requirements are critical aspects of readiness.

Scoring the U.S. Marine Corps

Capacity Score: Marginal

Based on the deployment of Marines across major engagements since the Korean War, the Corps requires roughly 15 battalions for one major regional contingency (MRC).[94] This translates to a force of approximately 30 battalions to fight two MRCs simultaneously if we were to retain the metric used in previous *Indexes*. The government force-sizing documents that discuss Marine Corps composition support the larger measure. Though the documents that make such a recommendation count the Marines by divisions, not battalions, they are consistent in arguing for three Active Marine Corps divisions, which in turn requires roughly 30 battalions.

With a 20 percent strategic reserve, the ideal USMC capacity for a two-MRC force-sizing construct is 36 battalions. However, the Corps has repeatedly made the case that it is a one-war force that must also have the ability to serve as the nation's crisis-response force.[95] It has just as consistently resisted growing in end strength even during the years of high operational demand associated with peak activities in Operation Iraqi Freedom (Iraq) and Operation Enduring Freedom (Afghanistan). Most recently, General Berger has stated flatly that the Corps will trade manpower for modernization and that he intends to shrink the Corps from its current 24 infantry battalions to 21 battalions in order both to free resources so that they can be applied to new formations and to maintain capability investments in other areas such as Marine Special Operations Command.[96]

Manpower is by far the biggest expense for the Marines. As allocated for the Corps' FY 2020 budget, the military personnel account was approximately $14.2 billion,[97] dwarfing both the almost $9.4 billion allocated for operation and maintenance[98] and the $2.99 billion allocated for the procurement of new equipment.[99] Nevertheless, the historical record of the use of Marine Corps forces in a major contingency argues for the larger number. More than 33,000 Marines, for example, were deployed in Korea, and more than 44,000 were deployed in Vietnam. In the Persian Gulf, one of the largest Marine Corps missions in U.S. history, some 90,000 Marines were deployed, and approximately 66,000 were deployed for Operation Iraqi Freedom.

One could reasonably presume that in a war with China, the demand for forces would be similar to the demands in these historical instances of Marine Corps employment. China is the pacing threat for the Corps. It is developing new tools and operational concepts that will likely require that Marine Corps forces be distributed across a large, contested littoral battlespace. But because the Corps has not yet determined, much less revealed, what its envisioned formations will require, we can only assess the service's current status against historical demand. Consequently, even a one-major-war Marine Corps should possess a larger end strength and more tactical units (infantry battalions as the surrogate measure for the total Corps) than it currently has.

As a one-war force that also needs the ability to provide crisis-response forces, to sustain operations in the face of combat losses, and to sustain its support to efforts that are not USMC-specific such as its service component contribution to U.S. Special Operations Command, the Corps should have a minimum of 30 battalions.

- **One-MRC-Plus Level:** 30 battalions.
- **Actual 2020 Level:** 24 battalions.

The Corps is operating with 80 percent of the number of battalions it should have relative to the revised benchmark set by this *Index* and has stated its intent to shrink from its current 24 battalions to 21 battalions. Marine Corps capacity is therefore scored as "marginal," an improvement from its *2020 Index* score of "weak" but only because the bar has been lowered. Reducing operational strength by three battalions, or 12.5 percent, would drive the Corps' capacity score down to "weak" again.

Capability Score: Marginal

The Corps receives scores of "weak" for "Capability of Equipment," "marginal" for "Age of Equipment" and "Health of Modernization Programs," but "strong" for "Size of Modernization Program." Therefore, the aggregate score for Marine Corps capability is "marginal."

Readiness Score: Marginal

As in previous years, the Marine Corps again prioritized next-to-deploy units during FY 2020. As the nation's crisis-response force, the Corps requires that all units, whether deployed or non-deployed, must be ready. However, since most Marine Corps ground units are meeting readiness requirements only immediately before deployment and the Corps' "ready

bench" would "not be as capable as necessary" if deployed on short notice, USMC readiness is sufficient to meet ongoing commitments only at reported deployment-to-dwell ratios of 1:2. This means that only a third of the force—the deployed force—could be considered fully ready. In testimony provided to various committees of the House and Senate and in its publicly available program documents, the Marine Corps has made gains in aviation unit readiness, but even 80 percent means four out of five planes are ready for action on its best day.

Marine Corps officials have emphasized a positive upward trend in general force readiness as a consequence of additional funding provided by Congress since FY 2018. The lack of a "ready bench" in depth (too few units and shortages of personnel in key maintenance fields) and lingering challenges in readiness levels among the USMC aircraft fleet perhaps offset some of the gains made by increased effort, funding, and focus, but the *2021 Index* assesses Marine Corps readiness levels as "marginal," an improvement over the *2019* score of "weak" and a reflection of the fact that the gains acknowledged in the *2020 Index* have been preserved.

Overall U.S. Marine Corps Score: Marginal

Marine Corps congressional testimony during FY 2020 was generally optimistic. Continued funding for readiness and an emphasis on modernization give strong support to the Corps' readiness-recovery efforts, but it will take time for their effects to materialize across the force, especially in light of the Corps' plans to shift its organizational and operational posture. Hence the need for continued attention and support from the Administration and Congress. Gains have been made and maintained over the past few years, and as a result, the Marine Corps has maintained its overall score of "marginal" in the *2021 Index*, which is in line with its sister services and a welcome return from its overall assessment of "weak" in 2018 and 2019.

U.S. Military Power: Marine Corps

	VERY WEAK	WEAK	MARGINAL	STRONG	VERY STRONG
Capacity			✓		
Capability			✓		
Readiness			✓		
OVERALL			✓		

MARINE CORPS SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2020 ■ Pending

Main Battle Tank

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
M1A1 Abrams Inventory: **447** Fleet age: **17** Date: **1990** The M1A1 Abrams is the main battle tank and provides the Marine Corps with heavy-armor direct fire capabilities. It is expected to remain in service beyond 2028. In FY 2020, the Commandant of the Marine Corps directed the service to divest its tank capability. The Corps began disestablishing its tank units in July 2020. All main battle tanks will be retired from the service by the end of FY 2021, transferred to the U.S. Army for future use.	3	4	None		

Light Wheeled Vehicle

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
HMMWV Inventory: **15,390** Fleet age: **22** Date: **1983** The HMMWV is a light-wheeled vehicle used to transport troops with some protection against light arms, blast, and fragmentation. The expected life span of the HMMWV is 15 years. Some HMMWVs will be replaced by the Joint Light Tactical Vehicle (JLTV).	2	1	**Joint Light Tactical Vehicle (JLTV)** Timeline: **2017–2022** The JLTV is a vehicle program meant to replace all of the HMMWVs and improve reliability, survivability, and strategic and operational transportability. This is a joint program with the Army. Full-rate production is scheduled for early 2019. JLTVs should be at full operational capability in FY 2022. The first set of JLTVs were fielded in March 2019. IOC was achieved in mid-summer 2019 with fielding at Camp Lejeune, N.C. **PROCUREMENT** 3,779 11,221 **SPENDING** *($ millions)* $1,531 $5,586	5	5

NOTES: See page 457 for details on ages, dates, timelines, and procurement spending. JLTV spending figures reflect the full joint program spending.

MARINE CORPS SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2020 ■ Pending

Amphibious Assault Vehicle

PLATFORM	Age Score	Capability Score
AAV Inventory: **1,200** Fleet age: **42** Date: **1972** The Amphibious Assault Vehicle transports troops and cargo from ship to shore. In September 2018, the USMC cancelled a survivability upgrade for this platform.	1	1
LAV-25 Inventory: **695** Fleet age: **38** Date: **1983** The LAV is a wheeled light armor vehicle with modest amphibious capability used for armored reconnaissance and highly mobile fire support. It has undergone several service life extensions (most recently in 2012) and will be in service until 2035.	2	

REPLACEMENT PROGRAM	Size Score	Health Score
Amphibious Combat Vehicle (ACV) Timeline: **2018–2021** The ACV is intended to replace the aging AAV. The first ACVs are expected to be fielded in 2020. Full operational capability is scheduled for 2023.	3	5

PROCUREMENT
112 524

SPENDING *($ millions)*
$624 $3,034

Attack Helicopters

PLATFORM	Age Score	Capability Score
AH-1W Super Cobra Inventory: **20** Fleet age: **25** Date: **1986** The Super Cobra is an attack helicopter that provides the Marines with close air support and armed reconnaissance. The Super Cobra will remain in service until 2021. It is being replaced by the AH-1Z.	1	2
AH-1Z Viper Inventory: **125** Fleet age: **7** Date: **2010** The AH-1Z Viper is the follow-on to the AH-1W Cobra attack helicopter. The Viper has greater speed, payload, and range, as well as a more advanced cockpit. It is gradually replacing the Cobra-variant and should do so fully by 2021. The expected operational life span of the Viper is 30 years.	5	5

REPLACEMENT PROGRAM	Size Score	Health Score
AH-1Z Timeline: **2014–2022** The new AH-1Z Viper program is part of a larger modification program to the H-1 platform. Replacing the AH-1W, the Z-Variant will serve as the next generation of attack aircraft. The new H-1 rotorcraft will have upgraded avionics, rotor blades, transmissions, landing gear, and structural modifications to enhance speed, maneuverability, and payload. It is scheduled for full operational capability in 2021.	5	5

PROCUREMENT
189

SPENDING *($ millions)*
$6,012 $7

NOTE: See page 457 for details on ages, dates, timelines, and procurement spending.

Airborne Electronic Attack Aircraft/ Ground Attack Aircraft

PLATFORM	Age Score	Capability Score
AV-8B Inventory: **109** Fleet age: **29** Date: **1985** The Harrier is a vertical/short takeoff and landing aircraft designed to fly from LHA/LHDs. It provides strike and reconnaissance capabilities. The aircraft is being replaced by the F-35B and will be fully retired around 2024.	5	1
F-35B Inventory: **83** Fleet age: **4** Date: **2015** The F-35B is the Marine Corps' short takeoff and vertical landing variant replacing the AV-8B Harrier. Despite some development problems, the F-35B achieved IOC in July 2015.	5	5
F/A-18 A-D Inventory: **224** Fleet age: **30** Date: **1978** Many aircraft in the F/A-18 fleet have logged about 8,000 hours compared with the originally intended 6,000. However, the fleet life has been extended until 2030. This is necessary to bridge the gap to when the F-35Bs and F-35Cs are available.	2	2

REPLACEMENT PROGRAM	Size Score	Health Score
F-35B/C Timeline: **2007–2031** The Marine Corps is purchasing 353 F-35Bs and 67 F-35Cs. The F-35B is the USMC version of the Joint Strike Fighter program. It is meant to replace the AV-8B Harrier, completing transition by 2030. The B-Variant achieved initial operational capability in July 2015. Full operational capability for both variants is expected in the late 2020s. The F-35C is the version built for employment on aircraft carriers. It is primarily for the U.S. Navy, but the Marines augment carrier operations and will use the F-35C for this purpose. **PROCUREMENT** 124 245 **SPENDING** *($ millions)* $16,821 $27,853	4	4

NOTE: See page 457 for details on ages, dates, timelines, and procurement spending.

MARINE CORPS SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2020 ■ Pending

Medium Lift

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
MV-22 Inventory: **309** Fleet age: **14** Date: **2007** The Osprey is a vertical takeoff and landing tilt-rotor platform designed to support expeditionary assault, cargo lift, and raid operations. The program is still in production. The life expectancy of the MV-22 is 23 years.	4	5	**MV-22B** Timeline: **2007–2019** Fielding of the Osprey was completed in 2019 with the MV-22 replacing the CH-46E helicopter, and the platform is meeting performance requirements. The modernization program is not facing any serious issues. **PROCUREMENT** 349 11 **SPENDING** *($ millions)* $30,782 $3,087	5	5

Heavy Lift

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
CH-53E Super Stallion Inventory: **138** Fleet age: **29** Date: **1981** The CH-53E is a heavy-lift rotorcraft. The aircraft will be replaced by the CH-53K, which will have a greater lift capacity. The program life of the CH-53E is 41 years.	2	1	**CH-53K** Timeline: **2017–2029** The program is in development. It is meant to replace the CH-53E and provide increased range, survivability, and payload. The program still has not fully developed the critical technology necessary. The helicopter is scheduled to complete initial testing in 2021 and be fielded as early as 2023. **PROCUREMENT** 20 176 **SPENDING** *($ millions)* $3,030 $18,026	5	3

Tanker

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
KC-130J Inventory: **45** Fleet age: **9** Date: **2005** The KC-130J is both a tanker and transport aircraft. It can transport troops, provide imagery reconnaissance, and perform tactical aerial refueling. This platform is currently in production. The airframe is expected to last 38 years.	4	5	**KC-130J** Timeline: **2005–2031** The KC-130J is both a tanker and transport aircraft. The procurement program for the KC-130J is not facing acquisition problems. **PROCUREMENT** 68 43 **SPENDING** *($ millions)* $4,676 $5,111	4	4

NOTES: See Methodology for descriptions of scores. Fleet age is the average between the last year of procurement and the first year of initial operational capability. The date is when the platform reached initial operational capability. The timeline is from start of the platform's program to its budgetary conclusion. Spending does not include advanced procurement or research, development, test, and evaluation (RDT&E). The total program dollar value reflects the full F–35 joint program, including engine procurement. As part of the F–35 program, the Navy is purchasing 67 F-35Cs for the U.S. Marine Corps that are included here. The MV-22B program also includes some costs from U.S. Air Force procurement. AH–1Z costs include costs of UH–1 procurement.

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44. Figure 3.12, "Marine Corps Expeditionary Equipment Depot," in ibid., p. 3-15.
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U.S. Space Force

John Venable

The U.S. Space Force (USSF) was created with enactment of the fiscal year (FY) 2020 National Defense Authorization Act (NDAA) on December 20, 2019.[1] Established as the fifth uniformed service within the Department of Defense and the second service within the Department of the Air Force (DOAF), the service will reside under the direction and leadership of the Secretary of the Air Force. The Act specifies that a four-star general will serve as Chief of Space Operations (CSO) and a full member of the Joint Chiefs of Staff.

The mission of this newest service is to organize, train, and equip forces "to protect U.S. and allied interests in space and to provide space capabilities to the joint force." Its responsibilities include "developing military space professionals, acquiring military space systems, maturing the military doctrine for space power, and organizing space forces to present to our Combatant Commands."[2]

Background

More than any other nation, America has enjoyed the technological advantages of space, and we now rely on it for nearly every aspect of our lives. Banking, commerce, travel, entertainment, the functions of government, and our military all depend on our assets in space.[3]

The importance of space has been recognized by every U.S. President since Dwight Eisenhower in the mid-1950s. While no service had the lead for developing capabilities in this new domain, the Air Force "claimed" defense-support space missions such as communications, reconnaissance, and navigation as inherently part of airpower. It also saw real potential in on-orbit anti-satellite and anti-missile systems and wanted to pursue those capabilities. President Eisenhower fully embraced defense-support missions but moved to preserve the domain for commerce and exploration by establishing a policy of "space for peaceful purposes."[4]

In 1961, the Air Force was named executive agent for space research and development, but at that point, the Army and Navy already had well-established programs.[5] By the end of the Eisenhower Administration, the splintering of space command and control within the Defense Department had taken hold, as had the President's policy of "space for peaceful purposes." Those two predilections would be sustained by every Administration for the next six decades, shaping (often unwittingly) every aspect of space policy and effectively preventing DOD from even recognizing this critical arena as a warfighting domain.

The effectiveness of the DOD's space support missions was put on full display during Operation Desert Storm,[6] and adversary nations did much more than take note. They recognized the growing U.S. dependence on space and began to position themselves to move against it. As early as 2001, a congressionally mandated report warned of our growing dependence on space and the vulnerability of U.S. assets in that domain and ultimately recommended establishing a Space Corps within the DOAF.[7] Those recommendations were set aside following the terrorist attacks of

September 11, 2001, and by the mid-2010s, the command and control of space had fragmented across at least 60 different DOD offices.[8] All the while, U.S. reliance on GPS for air, land, and sea maneuver, targeting, and engagement has grown to the point of being nearly universal, exposing a critical vulnerability that our adversaries have moved to exploit.

Both China and Russia have developed doctrine, organizations, and capabilities to challenge U.S. access to and operations in the space domain. Concurrently, their use of space is expanding significantly. Both nations regard space access and denial as critical components of their national and military strategies[9] and are investing heavily in ground-based anti-satellite (ASAT) missiles and orbital ASAT programs that may deliver a kinetic strike capability,[10] as well as co-orbital robotic interference that can alter signals and mask denial efforts, or even pull adversary satellites necessary for surveillance, navigation, and targeting out of orbit.[11] These nations have demonstrated the capability to put American space assets at risk, and until very recently, the United States had not taken steps to protect those systems, much less to develop its own warfighting capability in that domain.

The 2017 NDAA mandated that DOD conduct a review of the organization and command and control of space assets within the department. Shortly after the passage of the NDAA, President Donald Trump directed that a Space Force be established within the DOAF.[12] The final report from the DOD study was issued in August of 2018 and recommended a two-phased approach to put DOD on the right path to dominate space. The first phase outlined three actions the Administration could take using its inherent authority:

- Establishing the Space Development Agency (SDA);
- Identifying the space professionals in each of the four armed services; and
- Creating a new combatant command for space.

Those elements were deemed critical to developing a credible warfighting capability and the uniformed service that would be formed to sustain it. The second phase required Congress to draft legislation creating the new service.

Space Development Agency (SDA). Equipping America's military for space operations has been a challenge for several decades because of the fragmentation and overlap in the organizations that define the requirements and control the acquisition process.[13] Six different organizations managed requirements, and eight others dealt with acquisition with no single entity or individual in charge of either process. The associated dysfunction contributed to program delays, cost increases, and even system cancellations.[14] The Administration established the SDA to deal with those issues.

The SDA's "charge is to create and sustain lethal, resilient, threat-driven, and affordable military space capabilities that provide persistent, resilient, global, low-latency surveillance to deter or defeat adversaries."[15] The SDA currently reports to the Under Secretary of Defense for Research and Engineering but will be realigned under the U.S. Space Force as the service gains more traction.[16]

Identifying the Pool of Space Personnel and Assets. As a key step in standing up the Space Force, the services were required to identify the uniformed and civilian personnel from which the new service could draw to build a space cadre capable of dominating that domain. The Administration directed each of the services, the National Guard, and Reserve to identify their military and civilian space professionals for placement in a pool known as the Space Operations Force. Although the forces will remain in their respective parent organizations, this directive required that they be managed as one community.

United States Space Command (USSPACECOM)

The President completed the third step of the first phase on December 18, 2019, by amending the Unified Command Plan (UCP) to reestablish U.S. Space Command as the 11th

combatant command within the Department of Defense.[17] As a geographic combatant command, USSPACECOM is now responsible for the region from 100 kilometers above sea level and beyond.[18]

USSPACECOM's mission is to conduct "operations in, from, and to space to deter conflict and, if necessary, defeat aggression." It will defend U.S. vital interests and integrate as seamlessly as possible with the other Combatant Commanders by delivering space combat power to the Joint Force and National Command Authorities. Currently headquartered at Peterson Air Force Base, Colorado, USSPACECOM is commanded by General Jay Raymond.[19]

USSPACECOM has two principal subordinate organizations: the Combined Force Space Component Command (CFSCC) and Joint Task Force–Space Defense (JTF–SD).

Combined Force Space Component Command. CFSCC is located at Vandenberg Air Force Base, California, and its mission is "to plan, integrate, conduct, and assess global space operations in order to deliver combat relevant space capabilities to Combatant Commanders, Coalition partners, the Joint Force, and the Nation." CFSCC plans and executes space operations through four operations centers:

- The Combined Space Operations Center (CSpOC) at Vandenberg Air Force Base, California;
- The Missile Warning Center (MWC) at Cheyenne Mountain Air Force Station, Colorado;
- The Joint Overhead Persistent Infrared Planning Center (JOPC) at Buckley Air Force Base, Colorado; and
- The Joint Navigation Warfare Center (JNWC) at Kirtland Air Force Base, New Mexico.

It also "executes tactical control over globally dispersed Air Force, Army, and Navy space units that command ground-based space capabilities and satellites in every orbital regime.[20]

Joint Task Force–Space Defense. In the words of its commander, Army Brigadier General Thomas James, JTF–SD's mission is "space superiority operations."[21] JTF–SD will protect and defend space assets from threats that are both terrestrial-based and in orbit. In that role, it is to organize and align the efforts of the Defense Department, the intelligence community, and the commercial sector to address threats in space and unify plans and efforts for related activities in orbit.[22] One of the many challenges associated with hostile actions or intent is to identify, characterize, and be able to attribute those threats or actions to specific entities, actors, and/or nation-states to enable decisive responses to deal with those threats. JTF–SD has that mission.

JTF–SD is comprised of "the National Space Defense Center [NSDC], space situational awareness units and emerging space defense units."[23] The NSDC was previously known as the Joint Interagency Combined Space Operations Center (JICSpOC) and is located at Schriever Air Force Base, Colorado.

The USSPACECOM commander executes his peacetime and wartime roles with equipment and personnel provided by the Army, Navy, Air Force, and Marines. Those four services were established within DOD by Title 10 of the U.S. Code to organize, train, and equip for missions in each of their respective domains, and all have developed their own standards, organizations, equipment, and personnel for their respective missions.

Despite the fact that the space mission has been ongoing for several decades, there has been no force provider to the space warfighting command specifically focused on doctrine, threats, strategy, tactics, or standards as there is for the other domains. The Air Force has maintained the preponderance of space systems and assets, but all four services have space professionals as well as assets, disparate units, and organizations that are critical enablers for the mission in the space domain.

By establishing Space Command, the SDA, and the Space Operational Force, the Administration set the stage for Congress to execute the second phase of the plan by reorganizing DOD's space assets into the Space Force. Congress included the legislation establishing the U.S. Space Force as the second service within the Department of the Air Force in the FY 2020 NDAA. The law formally amends Title 10 of the U.S. Code to include the Space Force as the sixth of the nation's armed forces.[24]

U.S. Space Force Organization

The USSF Headquarters and Office of the Chief of Space Operations (OCSO) are located in the Pentagon. During its first year of existence, the OCSO is focused on establishing a fully functioning headquarters; preparing to execute the full scope of its organize, train, and equip responsibilities; and, in conjunction with the U.S. Air Force, developing a detailed plan to transfer forces into the U.S. Space Force.

With the redesignation of Air Force Space Command (AFSPC) as U.S. Space Force, "about 16,000 Air Force active duty and civilian personnel" were assigned to support this new service,[25] but only a handful have officially transferred to the Space Force. Most are still wearing the same uniforms and holding the same seats in the same offices they occupied a year ago.[26]

In an effort to reduce cost and avoid duplication, the OCSO is leveraging the DOAF for the vast majority of its support functions. These functions include logistics, base operating support, civilian personnel management, business systems, information technology support, and audit agencies, adding up to approximately 75 percent of its support requirements.[27]

When Congress authorized the Space Force, it limited the scope of the new service to Air Force personnel and assets, equating to a total workforce of 27,300[28] comprised of personnel and organizations on five major installations:

- The 21st Space Wing at Peterson Air Force Base, Colorado;
- The 30th Space Wing at Vandenberg Air Force Base, California;
- The 45th Space Wing at Patrick Air Force Base, Florida;
- The 50th Space Wing at Schriever Air Force Base, Colorado; and
- The 460th Space Wing at Buckley Air Force Base, Colorado.[29]

Methodically expanding the Space Force to include all DOAF military and civilian personnel at those locations will likely take at least another full year.

But even when combined with the new geographic combatant command for space, a service formed just from Air Force assets will not remedy the dysfunctional oversight or command and control issues that the Space Force initiative was intended to resolve.[30] For that to happen, a significant portion of the remaining 21,200 space professionals in the Army and Navy[31] need to be incorporated into the Space Force. The Army Space and Missile Defense Headquarters at Redstone Arsenal, Alabama, should be considered for incorporation into the Space Force, at least in part.[32] The naval organizations and assets that should be considered for transfer include components of the Naval Warfare Systems Command, formerly the Space and Naval Warfare Systems Command (SPAWAR), San Diego, California,[33] and the Navy Satellite Operations Center (NAS), Point Mugu, California.[34]

The FY 2020 NDAA also included space acquisition reform. The act established an Assistant Secretary of the Air Force for Space Acquisition and Integration (ASAF/SP) to serve as the senior space architect within the DOAF and directed that the SDA, Space Rapid Capabilities Office, and Space and Missile Systems Center be consolidated under the ASAF/SP's control.

On May 20, 2020, the DOAF delivered a report to Congress on a new plan for space acquisition. The report proposes nine specific

actions to increase the speed of space acquisition capabilities, but the plan does not recommend establishing an additional service acquisition executive for space.[35]

Funding

The President's FY 2020 budget request included more than $72 million to get the new service up and running,[36] but by the time the Defense Department appropriations bill was signed in December, Congress had budgeted little more than half of that amount: Just $40 million was enacted.[37] While seemingly paltry on the surface, the $72 million was an estimate based on the assumption that Congress would establish a space force but with no certainty about when funding would arrive, how big the new service would become, or how fast it could grow to that level.

Of the approximately $72 million total, $53.8 million was budgeted for operations and maintenance (O&M) and for studies to determine, among other things, the new service's "future manpower and resource requirements."[38] That amount was based on a full year of spending, not a budget that would be approved three months into the fiscal year.[39] As it turns out, nine months of a 12-month $72 million budget equates to $39.75 million, and Congress actually appropriated $250,000 above that amount for O&M.[40]

In addition, $19 million of the President's FY 2020 budget was set aside to fund manning for the Space Force, including 160 new civilian billets to establish the service's headquarters.[41] With respect to compensation, several technical challenges arose within the DOAF military personnel system that would prevent the new service from readily paying its own personnel. For the time being, that task and its associated funding will remain with and be paid to Space Force personnel by the Air Force. Once an integrated DOAF pay system is fully operational, funding for personnel will be shifted directly to the new service.

The President's budget request for FY 2021 lays out a robust level of funding for every aspect of the new service's mission set. The budget for O&M is $2.5 billion; the budget for research, development, test, and evaluation (RDT&E) is $10.3 billion; and procurement adds another $2.4 billion for a total of $15.2 billion. Assuming that the President's budget is fully funded, Space Force end strength will be authorized up to 9,979 military and civilian personnel. The combination of robust funding and manpower levels will allow the OCSO to continue to focus on building a strong organizational foundation and filling critical billets with the right people.

Capacity and Capability

The classified nature of deployed space assets makes listing specific capacity levels within the Space Force portfolio—much less attempting to assess the service's capability to execute its mission—a challenging exercise. There is little question that the constellation of U.S. intelligence, surveillance, and reconnaissance (ISR), navigation, and communication satellites is unrivaled by that of any other nation-state. That array of assets allows the Space Force and its sister services to find, fix, and target virtually any terrestrial or sea-based threat anywhere on the surface of the Earth.

The capacity of the Space Force can be discussed in terms of the USSF's ability to meet persistent ISR, command and control, communications, weather forecasting, and navigation requirements through its satellite constellations and ground stations, as well as its capability to repair or expand that capacity with a robust and reliable launch capacity.

Satellite Constellations

The Space Force mission is conducted through a network of satellites, ground-based radar, ground stations, and situational awareness nodes. In 2018, the Secretary of the Air Force stated that "the Air Force operates 77 satellites vital to national security that provide communications, command and control, missile warning, nuclear detonation detection, weather and GPS for the world."[42] These satellite capabilities now reside within the Space Force.

Global Positioning System (31 Satellites). Perhaps the best-known constellation of satellites under Space Force control is the global positioning system (GPS). This system provides timing, velocity, and precise navigation for millions of simultaneous users around the world. It takes 24 of these satellites to provide seamless global coverage, and 31 (seven of which provide backup capability) are currently on station. GPS III is the latest upgrade to the platform and incorporates a more robust anti-jamming capability. In addition, its interoperability with other Global Navigation Satellite Systems (GNSS) such as the European Galileo network and the Japanese Quazi-Zenith Satellite System adds an impressive level of resiliency.[43]

Space-Based Infra-Red System (Six Satellites). The Space-based Infrared System (SBIRS) is an integrated constellation of satellites designed to deliver early missile warning and provide intercept cues for missile defenses. This surveillance network was designed to incorporate three satellites in high elliptical orbit (HEO) and eight others in geosynchronous orbit (GEO), each working in concert with ground-based data processing and command and control centers.

SBIRS HEO is a retaskable orbit, which means that these satellites can be moved to more optimum orbits/viewpoints as mission requirements dictate. These platforms include a scanning sensor array composed of short-wave and mid-wave infrared radars that can detect infrared activity close to the ground. Development began in 1996, and the first SBIRS HEO payload (HEO-1) was delivered in June 2006, followed in March 2008 by HEO-2,[44] putting sensor packages with sensitivity that exceeded the program's specifications on orbit.[45] HEO-3 and HEO-4 were put in orbit on December 13, 2014, and September 24, 2017, respectively.[46]

Sometime after the first HEO orbit was established, several cost, schedule, and performance issues arose, and the Air Force determined that it was better to stay on schedule and reduce the number of SIBRS GEO satellites in the constellation.[47] In 2017, the Air Force decided to remove funding for GEO vehicles 7 and 8, bringing an early end to SBIRS production. To date, four SBIRS GEO satellites have been placed in orbit, with the final two vehicles (GEO-5 and GEO-6), expected to launch in 2021 and 2022, respectively.[48]

The funding that was removed from SBIRS shifted to a new program, Next Generation Overhead Persistent Infrared (Next-Gen OPIR), which will include a new ground-control system. The objectives of the program are to deliver resilient detection and tracking capability through a contested environment that includes emerging advances in adversary rocket propulsion technology. It is expected that fielding of a strategically survivable constellation of satellites to provide missile warning will begin sometime in FY 2023.[49]

Defense Support Program (Five Satellites). Defense Support Program (DSP) satellites were designed to detect launches of intercontinental ballistic missiles or Submarine Launched Ballistic Missiles (SLBMs) against the U.S. and its allies. Its secondary missions include the detection of space launch missions or nuclear weapons testing/detonations. The DSP constellation is in GEO orbit and uses infrared sensors to pick up the heat from booster plumes against the Earth's background.

Phase 1 placed four satellites in orbit from 1970–1973[50] and was followed by Phase 2, which placed nine satellites in orbit from 1975–1987,[51] and Phase 3, which consisted of 10 DSP satellites launched from 1989–2007.[52] While Phase 3 DSP satellites have long exceeded their design lifetimes, reliability has exceeded expectations, and at least five[53] and as many as eight are still providing reliable data and are now integrated with or controlled by the SBIRS program ground station.[54]

Space Based Surveillance System (One Satellite). The Space Force maintains situational awareness of space objects through the space-based surveillance system (SBSS). The SBSS program began with a single Advanced Concept Technology Demonstration satellite known as the Midcourse Space Experiment

(MSX) satellite, which experimented with several systems including the Space Infrared Imaging Telescope (SPIRIT III); Ultraviolet and Visible Imagers and Spectrographic Imagers (UVISI); Space-Based Visible instrument (SBV); and On-board Signal and Data Processor (OSDP) systems. MSX ceased operations in June 2008 following the failure of the SBV.[55]

The follow-on satellite (SBSS 1) was launched on September 26, 2010.[56] SBSS 1 operates continually without the limitations of ground-based sensors that are constrained by weather, time of day, and atmosphere conditions in addition to tracking man-made orbiting objects and debris fields associated with those operations through a variety of sensors at an orbit altitude of 390 miles.[57]

Space Tracking and Surveillance System Advanced Technology Risk Reduction (One Satellite). The Space Tracking and Surveillance System Advanced Technology Risk Reduction (STSS-ATR) is an RDT&E program/satellite placed in orbit on May 5, 2009, by the Missile Defense Agency. This satellite was intended as a test platform to explore different capabilities and technology for missile defense.[58]

Geosynchronous Space Situational Awareness Program (Four Satellites). The Geosynchronous Space Situational Awareness Program (GSSAP) is a classified space surveillance constellation quietly developed by the Air Force and Orbital Sciences. Its mission is to deliver a Space Surveillance Network (SSN) for accurate tracking and characterization of man-made orbiting objects to U.S. Strategic Command.[59] GSSAP satellites employ electro-optical sensors to collect information on satellites and other objects in the GEO-belt region. This constellation of satellites is in near-geosynchronous orbit, and each satellite is maneuverable, which allows it to perform Rendezvous and Proximity Operations (RPO), or "maneuver near a resident space object of interest."[60]

Launched in pairs, the first two GSSAP spacecraft were put in orbit on July 28, 2014, followed by the second two on August 19, 2016. While these systems and their launch details are classified, a third pair is scheduled for launch during the second half of 2020, which would increase this constellation to six satellites before year's end.[61]

Weather (Two Satellites). Defense weather satellites have been collecting weather data and providing forecasts for U.S. military operations since 1962 through the Defense Meteorological Satellite Program (DMSP).[62]

Currently, two operational DMSP satellites are in Low Earth Orbit (LEO) at an altitude of approximately 450 nautical miles. The main sensors for these weather satellites are optical, and each provides continuous visual and infrared imagery of cloud cover over an area approximately 1,600 nautical miles wide. Complete global coverage of weather features is accomplished every 14 hours.[63] That program is now managed by the Space Force, but the National Oceanographic and Atmospheric Administration (NOAA) has managed maintenance and operational control since 1998.

The National Polar-orbiting Operational Environmental Satellite System (NPOESS) has advanced microwave imagery-sounding data products that deliver improved prediction of ocean surface wind speed and direction, a major factor in predicting weather. NPOES 1 was launched in 2013, and NPOES 2 was launched in 2016; NPOES 3 and NPOES 4 are scheduled to launch in 2023 and 2026, respectively. Eventually, three NPOESS satellites moving in three orbital planes will replace the two-satellite DMSP constellation.[64] Four Geostationary Operational Environmental Satellites (GOES) operated by NOAA also feed terrestrial and space weather data to the National Weather Service on North, Central, and South America as well as the Atlantic and Pacific Oceans.[65]

The Space Force will field the next-generation weather satellite, the Weather System Follow-on Microwave (WSF-M) Satellite, in 2021. WSF-M will be an LEO satellite with a passive microwave imaging capability to map terrestrial weather and another device to monitor space weather.[66] The WSF-M is designed to cover ocean surface vector winds, tropical cyclone intensity, and "energetic charged

TABLE 14

U.S. Satellites Under Control of the U.S. Space Force

System	Function	Satellites
GPS	Navigation	31
WGS	Communications	10
DSCS	Communications	7
SBIRS	Missile warning	6
AEHF	Communications	5
DSP	Missile warning	5
Milstar	Communications	5
GSSAP	Space object tracking	4
DMSP	Weather	2
SBSS	Space surveillance	1
STSS-ATR	Missile defense	1
Total in Orbit		**77**

SOURCES: GPS.gov, "Space Segment: Current and Future Satellite Generations," last modified June 30, 2020, https://www.gps.gov/systems/gps/space/ (accessed August 19, 2020); Fact Sheet, "GPS III," Los Angeles Air Force Base, current as of April 2018, https://www.losangeles.af.mil/About-Us/Fact-Sheets/Article/343728/gps-iii/ (accessed August 19, 2020); Gunter's Space Page, "WGS 1, 2, 3 (WGS Block 1)," last update March 19, 2020, https://space.skyrocket.de/doc_sdat/wgs-1.htm (accessed August 19, 2020); Gunter's Space Page, "WGS 4, 5, 6, 7 (WGS Block 2)," last update March 19, 2020, https://space.skyrocket.de/doc_sdat/wgs-4.htm (accessed August 19, 2020); Gunter's Space Page, "WGS 8, 9, 10 (WGS Block 2 Follow-On)," last update April 27, 2020, https://space.skyrocket.de/doc_sdat/wgs-8.htm (accessed August 19, 2020); Fact Sheet, "Defense Satellite Communications System," U.S. Air Force, current as of November 2015, https://www.af.mil/About-Us/Fact-Sheets/Display/Article/104555/defense-satellite-communications-system/ (accessed August 19, 2020); Gunter's Space Page, "Trumpet 4, 5 / SBIRS HEO-1, 2," last update August 14, 2020, https://space.skyrocket.de/doc_sdat/trumpet-fo.htm (accessed August 19, 2020); Gunter's Space Page, "Trumpet 6, 7 / SBIRS HEO-3, 4," last update August 14, 2020, https://space.skyrocket.de/doc_sdat/trumpet-fo-2.htm (accessed August 19, 2020); Center for Strategic and International Studies, Missile Defense Project, "Space Tracking and Surveillance System (STSS)," Missile Threat, last updated June 15, 2018, https://missilethreat.csis.org/defsys/stss/ (accessed August 19, 2020); Fact Sheet, "Advanced Extremely High Frequency System," U.S. Air Force Space Command, current as of July 2019, https://www.afspc.af.mil/About-Us/Fact-Sheets/Display/Article/249024/advanced-extremely-high-frequency-system/ (accessed August 19, 2020); Table, "Spacecraft in Service over Time," in "Air Force & Space Force Almanac 2020," Air Force Magazine, Vol. 103, No. 6 (June 2020), p. 67, https://www.airforcemag.com/app/uploads/2020/06/June2020_Fullissue5.pdf (accessed August 19, 2020); Fact Sheet, "Defense Satellite Communications System," U.S. Air Force, current as of November 2015, https://www.af.mil/About-Us/Fact-Sheets/Display/Article/104555/defense-satellite-communications-system/ (accessed August 19, 2020); Gunter's Space Page, "GSSAP 1, 2, 3, 4, 5, 6 (Hornet 1, 2, 3, 4, 5, 6)," last update March 19, 2020, https://space.skyrocket.de/doc_sdat/gssap-1.htm (accessed August 19, 2020); Fact Sheet, "Defense Meteorological Satellite Program," U.S. Air Force Space Command, current as of July 2019, https://www.afspc.af.mil/About-Us/Fact-Sheets/Article/249019/defense-meteorological-satellite-program/ (accessed August 19, 2020); Gunter's Space Page, "MSX," last update December 11, 2017, https://space.skyrocket.de/doc_sdat/msx.htm (accessed August 19, 2020); Gunter's Space Page, "SBSS 1," last update December 11, 2017, https://space.skyrocket.de/doc_sdat/sbss-1.htm (accessed August 19, 2020); and Gunter's Space Page, "STSS-ATRR," last update July 21, 2019, https://space.skyrocket.de/doc_sdat/stss-atrr.htm (accessed August 19, 2020).

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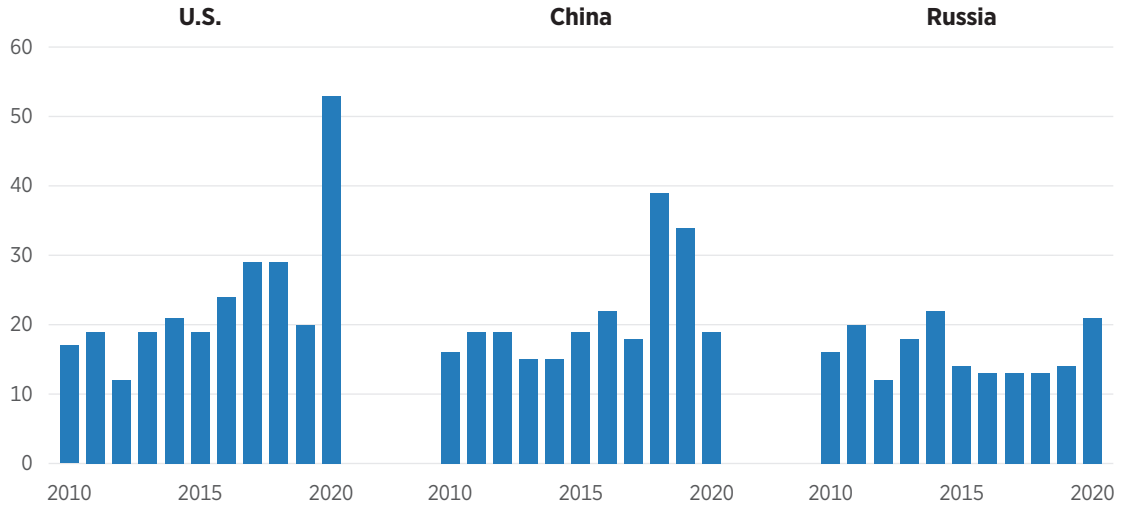
particles" in LEO—three gaps in DOD's current weather monitoring capability.[67] The number of satellites that will be included in this constellation has yet to be defined, but the first satellite is currently scheduled to launch in 2023 and will be operated by the Space Force.

Communications (20 Satellites). Milstar is a satellite communications (SATCOM)

CHART 8

U.S., Chinese, and Russian Space Launches



SOURCE: Rocket Launch Schedule, "Space Launch Schedule: Historic," https://www.spacelaunchschedule.com/launch-schedule/ (accessed August 19, 2020).

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system designed in the 1980s to provide the National Command Authorities assured, survivable global communications with a low probability of intercept or detection. The technology built into this five-satellite constellation was crafted to overcome enemy jamming and nuclear effects and was considered the most robust and reliable SATCOM system within the Defense department when it was fielded.

The follow-on to Milstar is the Advanced Extremely High Frequency System (AEHF). This system is a network of satellites operated by the Space Force for the Joint Force that allows the Defense Department to sustain secure, jam-resistant communications and command and control (C2) for high-priority military ground, sea, and air assets located anywhere in the world. The current AEHF Constellation includes five satellites in GEO, with a sixth scheduled to launch in 2020.[68]

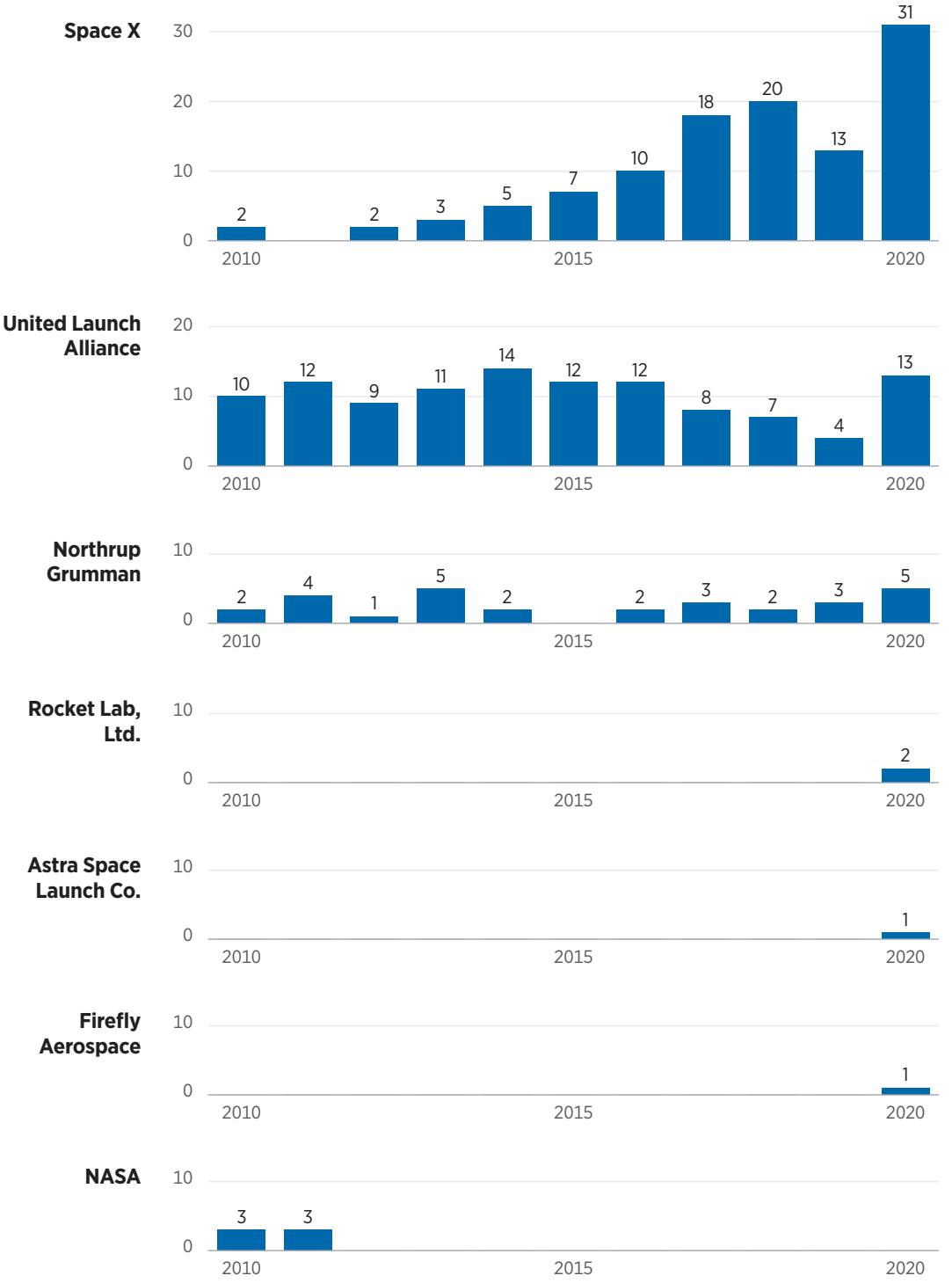
The Defense Satellite Communications System (DSCS) has seven operational satellites that provide nuclear-hardened, global communications to the Defense Department, the Department of State, and the National Command Authorities. The system is capable of high data rates and provides anti-jamming capabilities.

Wideband Global SATCOM (10 Satellites). Wideband Global SATCOM (WGS) is a joint-service program funded by the U.S. Air Force and U.S. Army, along with international partners Australia and Canada, and is used by all DOD services as well as National Command Authorities. Once known as the Wideband Gapfiller Satellite,[69] WGS provides Super High Frequency (SHF) wideband communications, which uses direct broadcast satellite technology to provide C2 for U.S. and allied forces. This system has solid capabilities that include phased array antennas and digital signal processing technology, delivering a flexible architecture with a satellite life span of up to 14 years.

Each WGS satellite is capable of covering 19 independent areas within its field of view, and the constellation as a whole can serve warfighters between 65 degrees North and 65

CHART 9

Total U.S. Launches by Organization



SOURCE: Rocket Launch Schedule, "Space Launch Schedule: Historic," https://www.spacelaunchschedule.com/launch-schedule/ (accessed August 19, 2020).

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degrees South latitude (within 90 miles of the Arctic and Antarctic Circles). Each satellite includes eight steerable and shapeable X-band beams formed by separate transmit-and-receive phased arrays, 10 steerable Ka band beams served by independently steerable dish antennas, and one X-band Earth coverage beam. The system allows any user to talk to any other user through nearly 1,900 independently routable subchannels.

The first WGS Block 1 satellite was placed in orbit on November 10, 2007, and was followed by a second and third on April 4, 2009, and June 12, 2009, respectively. Four more satellites were launched as part of WGS Block 2 from early 2012 through July 2015 and were followed by three more launches that took place in 2016, 2017, and 2019. Each of the 10 WGS satellites has an estimated life span of 14 years.[70]

Reconnaissance and Imagining (Unknown). While the history of the Air Force is steeped in these reconnaissance systems, the operational details of each constellation are classified. In the late 1990s and early 2000s, the Air Force moved to develop and field a constellation of Spaced Based Radar satellites. That program (known as Lacrosse/Onyx) launched five satellites, each carrying a synthetic aperture radar (SAR) as its prime imaging sensor. SAR systems can see through clouds with high resolution, offering the potential to provide a capability from which it is hard to hide.[71] The challenges that Lacrosse likely faced with computer processing speeds, data rates, and the ability to relay time-critical images have likely been resolved over the years, expanding both the capability and operational impact of such a system.

Radar imaging, coupled with space-borne Signals Intelligence (SIGINT); Electronic Intelligence (ELINT); and Measurement and Signature Intelligence (MASINT) and the ability to provide that real-time intelligence to warfighters anywhere in the world, gives the United States a significant competitive advantage. The number of satellites the Space Force has dedicated to those missions would exceed the 77 that the DOAF has publicly acknowledged. Although the capabilities associated with the satellites currently in orbit may not fully cover the capacity and capability requirements needed to support all combatant commands, it is complemented by a growing space launch capability that will enable the service to fill any shortfalls and has the potential to replace combat losses with a nearly on-demand capability.

Space Launch Capacity. The Space Force manages the National Security Space Launch (NSSL) program, which is a Major Defense Acquisition Program that acquires launch services from private companies to deliver national security satellites into orbit. Currently, the NSSL uses the Atlas V and Delta IV Heavy launch vehicles from United Launch Alliance and the Falcon 9 and Falcon Heavy from SpaceX to launch national security payloads. In 2018, the Air Force awarded three launch services agreements to space launch companies to develop their launch vehicles for a second phase of the NSSL. The Space Force will award two Launch Services Procurement contracts later in 2020, and the two vendors who win that competition will provide space launch services for the Space Force through 2027.[72]

In 2010, four organizations, including NASA, were involved in launching manned and unmanned systems into space. Collectively they conducted 17 launches, including three space shuttle missions, compared with the Russian and Chinese governments, each of which launched 16 missions into space.[73]

Today, six private corporations are actively engaged in placing satellites into orbit, twice the number that had launched systems into orbit in 2019.[74] In 2020, SpaceX alone will more than double the total number of scheduled launches into space from the United States in a single year with 31 Falcon 9 scheduled launches, including the first manned rocket that launched on May 30, 2020 (the first from U.S. soil since 2011).[75] In 2020, U.S. companies are scheduled to launch 53 missions into space, while China and Russia are scheduled to conduct 22 and 21 launches, respectively.[76]

America has turned the corner on this vital capability, and the access these private companies give the U.S. to space will be critical to dominating the great-power competition that lies ahead.

Offensive Systems

The United States faces a variety of threats, and the Space Force will have to deal with kinetic anti-satellite weapons (ASATs); high-powered lasers; laser dazzling or blinding; and high-powered microwave systems.[77] Defensive measures are being developed to ensure access to critical space resources through redundancy, interoperability with other nations' assets (GPS III), and maneuverability. However, no known U.S. ASAT programs of record are reported in open-source literature. The Space Force was established to regain the upper hand in this domain.

Assessment

The Space Force was established at the end of 2019, and significant progress was made in organizing America's space capabilities more effectively in the relatively brief period before publication of this *Index*. However, it is not at all clear how one would assess the Space Force's role in contributing to the projection of "hard combat power," which is the focus of this publication. There are as yet no viable metrics by which to measure the service's capacity, capability, or readiness. Consequently, this edition of the *Index* does not assess the U.S. Space Force.

U.S. Military Power: Space (not assessed this year)

	VERY WEAK	WEAK	MARGINAL	STRONG	VERY STRONG
Capacity					
Capability			n/a		
Readiness					
OVERALL			n/a		

Endnotes

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U.S. Nuclear Weapons Capability

Patty-Jane Geller

Assessing the state of U.S. nuclear weapons capabilities presents at least three serious challenges.

First, the United States is not taking full advantage of technologically available developments to field modern warheads (often incorrectly termed "new" warheads) that could be designed to be safer, more secure, and more effective and could give the United States better options for strengthening a credible deterrent. Instead, the U.S. has largely elected to maintain aging nuclear warheads based on designs from the 1960s, 1970s, and 1980s that were in the stockpile when the Cold War ended.

Second, the lack of detailed publicly available data about the readiness of nuclear forces, their capabilities, and the reliability of their weapons makes analysis difficult.

Third, the U.S. nuclear enterprise has many components, some of which are also involved in supporting other military (e.g., conventional) and extended deterrence missions. For example, dual-capable bombers do not fly airborne alert with nuclear weapons today, although they did so routinely during the 1960s and technically could do so again if necessary.

Additionally, the three key national security laboratories no longer focus solely on the nuclear weapons mission (although this remains their primary mission); they also focus extensively on nuclear nonproliferation and counterproliferation, intelligence, biological/medical research, threat reduction, and countering nuclear terrorism, which includes a variety of nuclear-related detection activities. The Nuclear Command, Control, and Communications System performs five essential functions: "detection, warning, and attack characterization; adaptive nuclear planning; decision-making conferencing; receiving Presidential orders; and enabling the management and direction of forces."[1]

Thus, it is hard to assess whether any one piece of the nuclear enterprise is sufficiently funded, focused, and/or effective with regard to the nuclear mission.

In today's rapidly changing world, the U.S. nuclear weapons enterprise must be, as described in the 2018 Nuclear Posture Review (NPR), *"modern, robust, flexible, resilient, ready and appropriately tailored"* to underpin the U.S. nuclear deterrent.[2] If the U.S. detects a game-changing nuclear weapons development in another country, the U.S. nuclear weapons complex must be able to provide a timely response. However, maintaining a capable U.S. nuclear enterprise presents many challenges.

To provide assurance against unexpected failures in the U.S. stockpile or changes in a geopolitical situation, the U.S. maintains an inactive stockpile that includes near-term hedge warheads that "can serve as active ready warheads within prescribed activation timelines" and reserve warheads that can provide "a long-term response to risk mitigation for technical failures in the stockpile."[3] The U.S. preserves upload capability on its strategic delivery vehicles, which means that, if necessary, the nation could increase the number of nuclear warheads on each type of its delivery

vehicles. For example, the U.S. Minuteman III intercontinental ballistic missile (ICBM) can carry up to three nuclear warheads, although it is currently deployed with only one.[4] While the United States preserves these capabilities, doing so in practice would take time and be both difficult and potentially costly. Certain modernization decisions (e.g., 12 versus 14 *Columbia*-class ballistic missile submarines with 16 versus 24 missile tubes per submarine) will limit upload capacity on the strategic submarine force. U.S. heavy bombers will continue to retain a robust upload capability.

Moreover, the United States has not designed or built a new nuclear warhead since the end of the Cold War. Instead, the National Nuclear Security Administration (NNSA) uses life-extension programs (LEPs) to extend the service life of existing weapons in the stockpile. Not all of the existing inactive stockpile, however, will go through the life-extension program. Hence, our ability to respond to contingencies by uploading weapons kept in an inactive status will decline with the passage of time. In other words, LEPs by themselves cannot be relied upon to sustain needed levels of reliability.

Presidential Decision Directive-15 (PDD-15) requires the U.S. to maintain the ability "to conduct a nuclear test within 24-to-36 months of direction by the President to do so."[5] However, successive government reports have noted the continued deterioration of technical and diagnostics equipment and the inability to fill technical positions that support nuclear testing readiness.[6] A lack of congressional support for improvements in technical readiness further undermines efforts by the NNSA to comply with the directive.

The nuclear weapons labs also face demographic challenges. Most scientists and engineers with practical "hands-on" experience in nuclear weapons design and/or testing are retired. This means that the certification of weapons designed and tested more than 30 years ago depends on the scientific judgment of designers and engineers who have never been involved in either the testing or the design and development of nuclear weapons. According to NNSA Administrator Lisa Gordon-Hagerty, more than 40 percent of the NNSA workforce will be eligible for retirement over the next five years, further adding to the loss of legacy nuclear weapons knowledge.[7]

The shift in emphasis away from the nuclear mission after the end of the Cold War led to a diminished ability to conduct key activities at the nuclear laboratories. According to Administrator Gordon-Hagerty:

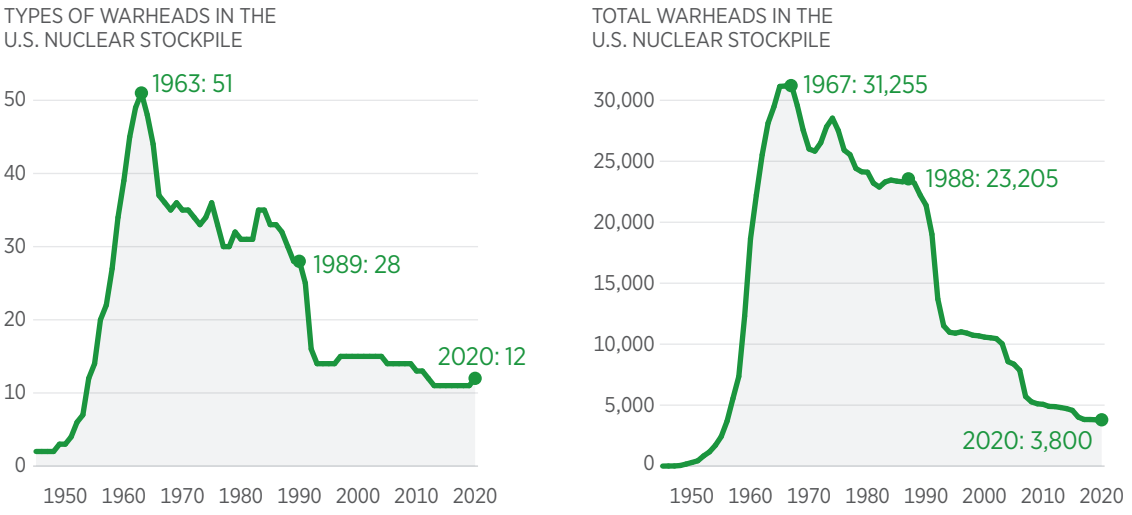
> While the U.S. nuclear weapons stockpile and its supporting infrastructure are safe, secure, effective, and reliable, they are aging. Competing interests over the past thirty years postponed weapon and infrastructure modernization programs, which directly contributed to erosion of our critical capabilities, infrastructure, and capacity to ensure the deterrent's viability into the future. The need to modernize our nuclear weapons stockpile and recapitalize its supporting infrastructure has reached a tipping point.[8]

As a result of this neglect, at the same time the nation faces an urgent need to modernize its aging nuclear warheads, "NNSA is undertaking a risk informed, complex, and time-constrained modernization and recapitalization effort."[9]

Another important indication of the health of the overall force is the readiness of the forces that operate U.S. nuclear systems. Following reports of misconduct in 2014, the Air Force had to make a number of changes to improve the performance, professionalism, and morale of the ICBM force.[10] Today, the COVID-19 pandemic presents another potential obstacle to the readiness of nuclear operators. In April 2020, the Pentagon announced its plans to maintain the readiness of the nuclear enterprise during the pandemic, to include a tiered testing system with forces involved "in critical national capabilities such as strategic deterrence or nuclear deterrence" in the first tier.[11] The Air Force and Navy have also isolated

CHART 10

A Smaller and Less Diverse Nuclear Arsenal



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those preparing for deployment to minimize risk to the force.[12]

Over time, fiscal uncertainty and a steady decline in resources for the nuclear weapons enterprise have adversely affected the nuclear deterrence mission. Despite America's continued commitment to nonproliferation and reductions in the number of the world's nuclear weapons, adversaries have increased both their nuclear forces and the role of nuclear weapons in their strategies. As Admiral Charles Richard, Commander, U.S. Strategic Command, testified before the Senate Armed Services Committee in February 2020:

> The contemporary security environment is the most challenging since the Cold War. In the nuclear dimension, we face a range of potential adversaries, each with different interests, objectives, and capabilities. To maintain a credible deterrent in this environment requires us to modernize and recapitalize our strategic forces to ensure our Nation has the capability to deter any actor, at any level. Doing so requires we remain committed to modernizing and recapitalizing our strategic forces and supporting infrastructure, and that we continue to pursue

the supplemental nuclear capabilities intended to address new challenges in the security environment.[13]

In recent years, bipartisan congressional support for the nuclear mission has been strong, and nuclear modernization has received additional funding. Preservation of that bipartisan consensus will be critical as these programs mature and begin to introduce modern nuclear systems to the force.

The Trump Administration has made significant progress in funding a comprehensive modernization program for nuclear forces that includes warheads, delivery systems, and command and control. Despite attempts to pull back from nuclear modernization, Congress has consistently funded the Trump Administration's budget request for these programs. Because such modernization activities require consistent, stable long-term funding commitments, it is essential that Congress continue to invest in this cornerstone of our security.

The Trump Administration's 2018 NPR, recognizing the reality of a worsening security environment that includes the rise of competition with a revisionist and resurgent Russia, an increasingly threatening China, and other growing strategic threats "including major conventional, chemical, biological, nuclear, space, and cyber threats, and violent nonstate actors," called for "tailored deterrence strategies" and reaffirmed that "aggression against the United States, allies, and partners will fail and result in intolerable costs for [the aggressors]."[14] Accordingly, the NPR called for modernization of nuclear weapons and the nuclear weapons complex, as well as significant reinvestments in the nuclear triad.[15]

The NNSA received $16.7 billion in fiscal year (FY) 2020, almost 10 percent more than the $15.2 billion it received in FY 2019, which included full funding for major efforts like modernization of plutonium pit production and five warhead modernization programs.[16] Modernization programs to replace the triad—including the Ground Based Strategic Deterrent (GBSD), Long Range Stand Off Weapon (LRSO), *Columbia*-class nuclear submarine, and B-21 bomber—also continue to progress in 2020. The NPR proposed two supplements to nuclear capabilities: a low-yield warhead for strategic submarine-launched ballistic missiles (SLBMs) in the near term, which was deployed in 2020, and a low-yield nuclear-armed sea-launched cruise missile, for which an analysis of alternatives is currently underway.[17]

Implications for U.S. National Security

U.S. nuclear forces are designed both to deter large-scale attacks that threaten America's sovereignty, allies, and forward-deployed troops and to assure our allies and partners. They are not designed to shield the nation from all types of attacks from all adversaries.

U.S. nuclear forces play an essential role in underpinning the broad nonproliferation regime by providing U.S. security guaranties that assure allies including NATO, Japan, and South Korea that they can forgo development of nuclear capabilities. In part, U.S. deterrence capabilities also enable the United Kingdom and France to limit their numbers of nuclear weapons to levels they might not otherwise agree to accept.

North Korea has demonstrated that a country with limited intellectual and financial resources can develop a nuclear weapon if it decides to do so. Iran appears to continue on a path that largely retains its ability to develop a nuclear weapon capability, despite U.S. and international pressure to not do so. Such a reality only adds to the importance of U.S. nuclear assurances to allies and partners. Further erosion of the credibility of American nuclear forces could lead countries like Japan or South Korea to pursue an independent nuclear option, encouraging instability across the region.

Several negative trends, if not addressed, could undermine the overall effectiveness of U.S. nuclear deterrence. The United States must account for adversaries that are modernizing their nuclear forces, particularly Russia and China. Additional challenges include increasingly aged nuclear warheads; an aging and crumbling nuclear weapons infrastructure; an

aging workforce; and the need to fully recapitalize all three legs (land, air, and sea) of the nuclear triad including the systems for nuclear command and control while also conducting timely and cost-efficient life-extension programs—all while maintaining the nation's commitment to a testing moratorium under the Comprehensive Test Ban Treaty, which was signed but rejected by the Senate.

The 2018 NPR noted a rapid deterioration of the threat environment since 2010 and identified four enduring roles for U.S. nuclear capabilities:

- Deterrence of nuclear and non-nuclear attack;
- Assurance of allies and partners;
- Achievement of U.S. objectives if deterrence fails; and
- Capacity to hedge against an uncertain future.[18]

Because the capabilities of U.S. adversaries can vary, the 2018 NPR emphasized the need for tailored deterrence strategies. For example, Russia is engaged in an aggressive nuclear buildup, having added several new modern nuclear systems to its arsenal since 2010. In his February 2020 testimony before the Senate Armed Services Committee, Admiral Richard warned that:

> Russia's aggressive and robust military and nuclear modernization campaign across its strategic triad and dual-use systems is close to completion. To date, Russia has recapitalized 76 percent of its strategic nuclear forces with modern weapons and equipment, strengthening its overall combat potential....
>
> Russia's nuclear forces include a range of strategic weapons, some not captured by existing arms control structures, and theater and tactical nuclear weapons entirely outside the arms control framework.... Russia's overall nuclear stockpile is likely to grow significantly over the next decade—growth driven primarily by a projected increase in Russia's non-strategic nuclear weapons. Russia's determined pursuit of "non-strategic" nuclear weapons, together with their recent theory of nuclear rhetoric, indicates a troubling readiness to resort to nuclear weapons early in a crisis.[19]

Concurrently, Russia is using its dual-capable (nuclear/conventional capable) platforms to threaten the sovereignty of U.S. allies in Eastern Europe and the Baltics. It also is developing "novel technologies" such as a nuclear-powered cruise missile and nuclear-capable unmanned underwater vehicle.[20]

China is engaging in a similarly provocative nuclear buildup as it attempts to project power into the South China Sea, partly through illegally created islands on which China has installed offensive capabilities. Defense Intelligence Agency Director Lieutenant General Robert Ashley recently reported that China will likely at least double its nuclear stockpile within the next decade.[21] North Korea "has accelerated its provocative pursuit of nuclear weapons and missile capabilities."[22] And Iran, in addition to being the world's principal state sponsor of terrorism, retains "the technological capability and much of the capacity necessary to develop a nuclear weapon within one year of a decision to do so."[23]

Deterrence is an intricate interaction between U.S. conventional and nuclear forces, and the psychological perceptions of both allies and adversaries with respect to America's willingness to use such forces to defend its interests, as well as its allies and partners, are of the greatest importance. Nuclear deterrence must reflect and be attuned to the mindset of any particular adversary the U.S. seeks to deter. If an adversary believes that he can fight and win a limited nuclear war, the task for U.S. leaders is to convince that adversary otherwise. The U.S. nuclear portfolio must be structured

in terms of capacity, capability, variety, flexibility, and readiness to achieve these objectives. In addition, military roles and requirements for nuclear weapons will be inherently different depending on who is being deterred, what he values, and what the U.S. seeks to deter him from doing.

Due to the complex interplay among strategy, policy, and actions that any given state may take, as well as other actors' perceptions of the world around them, one will never know whether or when a nuclear deterrent or conventional forces provided by the U.S. might be perceived as insufficient. Nuclear weapon capabilities take years or decades to develop, as does the infrastructure supporting them—an infrastructure that the U.S. has neglected for decades. We can be reasonably certain, however, that a robust, well-resourced, focused, and reliable nuclear enterprise is much more likely to sustain the value of the U.S. deterrent than is one that is outdated and/or questionable.

The U.S. has demonstrated that it is capable of incredible mobilization when danger materializes, and today's nuclear threat environment is evolving, dynamic, and proliferating in unpredictable ways, with new and resurgent old actors developing new capabilities. Meanwhile, despite the promise of additional funding, the U.S. nuclear enterprise remains largely static, leaving the United States at what could well be a technological disadvantage. Such a posture puts both the security of the United States and the security of its allies and the entire free world at risk.

Scoring U.S. Nuclear Weapons Capabilities

The U.S. nuclear weapons enterprise is composed of several key elements that include warheads; delivery systems; and the physical infrastructure that designs, manufactures, and maintains U.S. nuclear weapons. The nuclear enterprise also includes and must sustain the talent of our people: the nuclear designers, engineers, manufacturing personnel, planners, maintainers, and operators who help to ensure a nuclear deterrent that is second to none. The nuclear weapons enterprise entails additional elements like nuclear command and control; intelligence, surveillance, and reconnaissance (ISR); and aerial refueling, all of which also play a major role in conventional operations.

The factors selected below are the most important elements of the nuclear weapons complex. They are judged on a five-grade scale that ranges from "very strong," defined as having a sustainable, viable, and funded plan in place, to "very weak," defined as a situation in which the U.S. is not meeting its security requirements and has no program in place to redress the shortfall. The other three possible scores are "strong," "marginal," and "weak."

Current U.S. Nuclear Stockpile
Score: Strong

U.S. warheads must be safe, secure, effective, and reliable. The Department of Energy (DOE) defines reliability as "the probability that a weapon will perform in accordance with its design intent or military requirements."[24] Since the cessation of nuclear testing in 1992, reliability has been determined through the NNSA's Stockpile Stewardship Program, which consists of an intensive warhead surveillance program; non-nuclear experiments (i.e., experiments that do not produce a nuclear yield); sophisticated calculations using high-performance computing; and related annual assessments and evaluations.

The reliability of nuclear warheads and delivery systems becomes even more important as the number and diversity of nuclear weapons in the stockpile decrease. Fewer types of nuclear weapons means a smaller margin of error if all of one type are affected by a technical problem that might cause a weapon type and/or its delivery system to be decommissioned. Further, with less diversity, the risk that a problem might affect multiple systems

increases. America and its allies must have high confidence that U.S. nuclear warheads will perform as expected.

As warheads age, uncertainty about their ability to perform their mission as expected could increase and significantly complicate military planning. Despite creating impressive amounts of knowledge about nuclear weapons physics and materials chemistry, the U.S. could find itself surprised by unanticipated long-term effects on aging components that comprise a nuclear weapon. "The scientific foundation of assessments of the nuclear performance of US weapons is eroding as a result of the moratorium on nuclear testing," argue John Hopkins, nuclear physicist and a former leader of the Los Alamos National Laboratory's nuclear weapons program, and David Sharp, former Laboratory Fellow and a guest scientist at Los Alamos National Laboratory.[25]

The United States currently has the world's safest and most secure stockpile, but concerns about overseas storage sites, potential problems introduced by improper handling, or unanticipated aging effects could compromise the integrity and/or reliability of U.S. warheads. The nuclear warheads themselves contain security measures that are designed to make it difficult, if not impossible, to detonate a weapon absent a proper authorization. While some U.S. warheads have modern safety features that provide additional protection against accidental detonation, others do not.

Grade: The Department of Energy and Department of Defense are required to assess the reliability of the nuclear stockpile annually. Each of the three nuclear weapons labs (Los Alamos National Laboratory, Lawrence Livermore National Laboratory, and Sandia National Laboratory) reports its findings with respect to the safety, security, and reliability of the nation's nuclear warheads to the Secretaries of Energy and Defense, who then brief the President. Detailed classified reports are also provided to Congress. While these assessments do not include the nuclear weapons delivery systems, the Commander of U.S. Strategic Command does assess overall nuclear weapons system reliability, including the reliability of both warhead and delivery platforms.

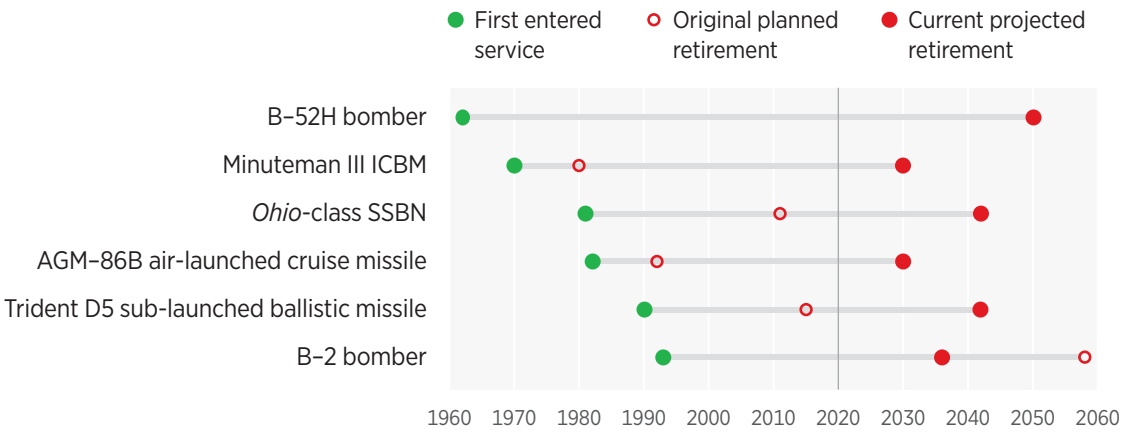
Absent nuclear weapons testing, the national laboratories' assessment of weapons reliability, based on the full range of surveillance, scientific, and technical activities carried out in NNSA's Stockpile Stewardship Program, depends on the expert judgment of the laboratories' directors. This judgment, albeit based on experience, non-nuclear experimentation, and extensive modeling and simulation, is nevertheless inherently subjective and no substitute for objective data obtained through direct nuclear testing. Nuclear testing was used in the past to diagnose potential problems with warheads and to certify the effectiveness of fixes to those problems. It was also used to certify current nuclear warheads, as well as to detect potential problems and confirm the effectiveness of fixes to those problems. Given that modern simulation is based on nuclear tests that were conducted primarily in the 1950s and 1960s with testing equipment of that era, there is a great deal more that today's nuclear testing and detection equipment could teach us about nuclear weapons physics.

By 2005, a consensus emerged in the NNSA, informed by the nuclear weapons labs, that "indefinite refurbishment" of the nuclear stockpile would be "extremely difficult to execute (because many warhead components can not [*sic*] be replicated as originally built), and would result in modifications on top of other modifications that [would] be increasingly difficult to certify without nuclear testing." Two major studies had "concluded that the Reliable Replacement Warhead (RRW) concept, if feasible, would be a preferred alternative to the indefinite refurbishment strategy."[26] When the U.S. did conduct nuclear tests, it frequently found that small changes in a weapon's tested configuration had a dramatic impact on weapons performance. In fact, the 1958–1961 testing moratorium caused weapons with serious problems to be introduced into the U.S. stockpile.[27] These problems were discovered only after the resumption of U.S. nuclear weapons testing following the Soviet

FIGURE 5

U.S. Nuclear Delivery Systems Outdated

Current U.S. nuclear delivery systems are between 27 and 58 years old, and some are expected to be retired within a decade.



NOTES: The original retirement date for the B-2 was set at 2058, but in the FY 2019 budget, the Air Force moved up the retirement date by 22 years to 2036. That move could have been caused by projected threats, the cost of sustainment, or both. The original programmed retirement date for the B-52H is not known, but the Air Force has recently stated it plans to continue flying this jet into the 2050s. The average B-52H bomber has logged approximately 20,300 hours, and based on airframe component lifetime estimates and flying 350 hours each year, it could continue flying until 2067.
SOURCES: Heritage Foundation research.

heritage.org

Union's unannounced breakout from the 1962 agreed moratorium.

The United States is committed to sustaining its nuclear stockpile without nuclear testing, and this creates some inherent uncertainty concerning the adequacy of fixes to the stockpile when problems are found. These growing numbers of additional uncertainties include updates made to correct problems that were found in the weapons or changes in the weapons resulting from life-extension programs. It is simply impossible to duplicate exactly weapons that were designed and built many decades ago. According to Sandia National Laboratories Director Dr. Stephen Younger, we have had to fix "a number of problems that were never anticipated" by using "similar but not quite identical parts."[28]

One of the costs of having to certify weapons without nuclear testing, at least to date, has been fewer types of weapons (i.e., reduced diversity in the stockpile) and, consequently, a greater potential impact across the inventory of warheads should an unknown or misidentified error emerge in the certification process. Loss of diversity in the stockpile also increases the risk of "common-mode" failure that could affect multiple systems simultaneously, making the push for commonality with potential single points of failure in U.S. warheads worrisome. "To be blunt," warned then-Secretary of Defense Robert Gates in October 2008, "there

is absolutely no way we can maintain a credible deterrent and reduce the number of weapons in our stockpile without either resorting to testing our stockpile or pursuing a modernization program."[29]

The U.S. pursues warhead LEPs that replace aging components before they can cause reliability problems. The number and scope of LEPs being carried out over the next two decades will stress NNSA's warhead design and production complex and remains a concern, particularly given uncertainties regarding the congressional budget process. In spite of these concerns, in FY 2019 and FY 2020, the NNSA continued to assess that the stockpile is "safe, secure, and effective."[30]

In light of our overall assessment, we grade the U.S. stockpile conditionally as "strong" based on the results of the existing method used to certify the stockpile's effectiveness. This grade, however, will depend on whether support for an adequate stockpile, both in Congress and in the Administration, remains strong.

Reliability of U.S. Delivery Platforms Score: Strong

Reliability encompasses not only the warhead, but strategic delivery vehicles as well. For ICBMs and SLBMs, in addition to a successful missile launch, this includes the separation of missile boost stages, performance of the missile guidance system, separation of the reentry vehicles from the missile post-boost vehicle, and accuracy of the final reentry vehicle in reaching its target.[31]

The U.S. conducts flight tests of ICBMs and SLBMs every year to ensure the reliability of its delivery systems with high-fidelity "mock" warheads. Anything from faulty electrical wiring to booster separations could degrade the reliability and safety of the U.S. strategic deterrent. U.S. strategic, long-range bombers also regularly conduct Continental United States and intercontinental exercises and receive upgrades to sustain a demonstrated high level of combat readiness. The Air Force most recently tested the AGM-86B air-launched cruise missile launched from the B52-H bomber in 2017.[32] Platforms have to be modernized and replaced simultaneously, and already diminished capabilities make this even more difficult.

Grade: In July 2018, the Air Force suffered its first unsuccessful ICBM test since 2011,[33] but it has conducted four successful tests since then. These successes include one developmental test in February 2020, the first test hosted by Vandenberg Air Force Base since it became part of the U.S. Space Force.[34] The next ICBM test, scheduled for August 2020, reportedly remained on schedule despite the ongoing COVID-19 pandemic.[35] The SLBM tests were successful in 2019 and 2020.[36]

To the extent that data from these tests are publicly available, they provide objective evidence of the delivery systems' reliability and send a message to U.S. allies and adversaries alike that the U.S. system works and the U.S. nuclear deterrent is ready if needed. The aged systems, however, occasionally have reliability problems, as evidenced by the July 2018 failed Minuteman III launch. Moreover, because of its obsolescence against Russian air defense systems, the B52H bomber can no longer officially carry gravity bombs.[37]Aging will continue to affect delivery platform reliability until platforms are replaced, but two years of successful missile tests and bomber flights indicate that, at least for now, delivery platforms will likely continue to perform reliably.

Until significant evidence tells us otherwise, this factor receives a grade of "strong."

Nuclear Warhead Modernization Score: Marginal

During the Cold War, the United States focused on designing and developing new nuclear warhead designs in order to counter Soviet advances and modernization efforts and to leverage advances in understanding the physics, chemistry, and design of nuclear weapons. Today, the United States is focused on sustaining its aging stockpile rather than on fielding new nuclear warheads, but it also seeks to retain the skills and capabilities required to design, develop, and produce new warheads.

Relying only on sustaining our aging stockpile could increase the risk of failure caused by aging components and signal to adversaries that the United States is less committed to nuclear deterrence. In FY 2016, the United States established the Stockpile Responsiveness Program (SRP) "to exercise all capabilities to conceptualize, study, design, develop, engineer, certify, produce, and deploy nuclear weapons."[38] Congress doubled funding for the SRP from $34 million in FY 2019 to $70 million in FY 2020. The Administration requested $70 million for the program in FY 2021.[39]

Modern or new weapon designs could allow American engineers and scientists to improve previous designs and devise more effective means by which to address existing military requirements (e.g., the need to destroy deeply buried and hardened targets) that have emerged in recent years. Future warheads could improve reliability (i.e., remedying some ongoing aging concerns such as replacement of aged nuclear components) while also enhancing the safety and security of American weapons.

The ability to work on future/new weapon design options would help to ensure that today's American experts and those of the next-generation remain engaged and knowledgeable, would help to attract the best talent to the nuclear enterprise, and would help the nation to gain additional insights into foreign nations' (i.e., adversaries) nuclear weapon programs. As the Panel to Assess the Reliability, Safety, and Security of the United States Nuclear Stockpile noted, "Only through work on advanced designs will it be possible to train the next generation of weapon designers and producers. Such efforts are also needed to exercise the DoD/NNSA weapon development interface."[40]

Meanwhile, potential U.S. adversaries and current and future proliferants are not limited to updating only Cold War designs and can seek designs outside U.S. experiences. Other nations maintain their levels of proficiency by having their scientists work on new nuclear warheads.[41] As recently reported by the Department of State, "Russia has conducted nuclear weapons experiments that have created nuclear yield and are not consistent with the U.S. 'zero-yield' standard," and evidence points to China's possibly having done so as well.[42]

Grade: The nuclear enterprise was able to display improved flexibility when it produced a low-yield version of the W76 warhead, which was designed to counter Russia's perception of an exploitable gap in the U.S. nuclear force posture, within a year despite continued nuclear policy restrictions and a preference for life-extension programs. Such efforts to produce the W76-2 in 2019 warranted an improvement in this score last year.

The NNSA continues to improve in this category in 2020. As part of the SRP, the NNSA plans to conduct feasibility studies of the next Navy warhead, dubbed the W93 in the budget request for FY 2021.[43] Also, as part of its effort to restore the ability to produce plutonium pits, the NNSA produced five pits in 2019.[44] This continued effort in 2020 will help the NNSA to regain the capabilities needed to produce new warheads. The score for this category remains at "marginal," but it will improve when the NNSA, through the SRP in particular, begins to produce tangible advancements in pit production and W93 development.

Nuclear Delivery Systems Modernization Score: Strong

Today, the United States fields a triad of nuclear forces with delivery systems that are safe and reliable, but as these systems age, there is increased risk of significantly negative impact on operational capabilities. Any margins allowing delay of platform replacement have been significantly diminished. The older weapons systems are, the more likely it is that faulty components, malfunctioning equipment, or technological developments will limit their reliability in the operating environment.

Age degrades reliability by increasing the potential for systems to break down or fail to respond correctly. Corrupted systems, defective electronics, or performance degradation caused by long-term storage defects (including

for nuclear warheads) can have serious implications for American deterrence and assurance. Because it cannot be assumed (especially for systems approaching end of life) that a strategic delivery vehicle will operate in a reliable manner indefinitely, that vehicle's deterrence and assurance value may be significantly reduced with consequent effects on perceptions of deterrence among both allies and adversaries.

The U.S. Air Force and Navy plan to modernize or replace each leg of the nuclear triad in the next few decades, but fiscal constraints and inconsistent funding levels (including issues related to "continuing resolutions") will make such efforts difficult at best. Sustained leadership focus is imperative if the modernization program is to succeed.

The Navy is fully funding its programs to replace the *Ohio*-class submarine with the *Columbia*-class submarine, but issues involving cost estimates and potential industrial base impacts caused by the COVID-19 pandemic could make it harder to achieve the goal of deploying the first submarine in 2031.[45] The Air Force is funding the B-21 Raider Long-Range bomber, which will replace conventionally armed bombers before they become nuclear certified, and the Long Range Standoff Weapon, which will replace the aging air-launched cruise missile. Existing Minuteman III ICBMs are expected to remain in service until 2032, 50 years after their intended lifetime, when they will be replaced by the GBSD missiles. Existing Trident II D5 SLBMs have been life-extended to remain in service until 2042 through the end of the last *Ohio*-class submarine's lifetime.[46]

Remanufacturing some weapon parts is difficult and expensive either because the manufacturers are no longer in business or because the materials that constituted the original weapons are no longer available (e.g., because of environmental restrictions). U.S. triad modernization is a requirement validated by all four of the NPRs since the end of the Cold War and remains a "must" in all future deterrence scenarios. U.S. nuclear weapon modernization plans benefited from predictability associated with the FY 2018–FY 2019 budget deal, but the economic downturn caused by the COVID-19 pandemic and the prospect of future defense budget cuts threaten such progress.

Grade: U.S. nuclear platforms are in dire need of recapitalization. Plans for modernization of the nuclear triad are in place, and Congress and the services have largely sustained funding for these programs. Moreover, some aspects of these programs have progressed in 2020. For instance, the Air Force awarded sole source contracts for both the LRSO and GBSD programs.[47] It is also setting up a joint developmental and operational test force to support the GBSD program.[48] In FY 2020, the Administration's budget request for nuclear modernization received full funding from Congress, despite an initial House-passed spending bill that included significant cuts in these programs. Potential modernization delays and congressional funding cuts could cause this score to be downgraded in the future, but this year, both Congress and the Administration have demonstrated a commitment to nuclear weapons modernization that again earns this indicator a grade of "strong."

Nuclear Weapons Complex
Score: Marginal

Maintaining a reliable and effective nuclear stockpile depends in large part on the facilities where U.S. devices and components are developed, tested, and produced. These facilities constitute the foundation of our strategic arsenal and include the:

- Los Alamos National Laboratories,
- Lawrence Livermore National Laboratories,
- Sandia National Laboratory,
- Nevada National Security Site,
- Pantex Plant,

- Kansas City Plant,
- Savannah River Site, and
- Y-12 National Security Complex.

In addition to these government sites, the defense industrial base supports the development and maintenance of American delivery platforms.

These complexes design, develop, test, and produce the weapons in the U.S. nuclear arsenal, and their maintenance is of critical importance. As the 2018 NPR stated:

> An effective, responsive, and resilient nuclear weapons infrastructure is essential to the U.S. capacity to adapt flexibly to shifting requirements. Such an infrastructure offers tangible evidence to both allies and potential adversaries of U.S. nuclear weapons capabilities and thus contributes to deterrence, assurance, and hedging against adverse developments. It also discourages adversary interest in arms competition.[49]

Maintaining a safe, secure, effective, and reliable nuclear stockpile requires modern facilities, technical expertise, and tools both to repair any malfunctions quickly, safely, and securely and to produce new nuclear weapons if required. The existing nuclear weapons complex, however, is not fully functional. The U.S. cannot produce the nuclear components needed to replace nuclear weapons in the stockpile.[50] For instance, the United States has not had a substantial plutonium pit production capability since 1993. A plutonium pit is the heart of a nuclear weapon that contains the nuclear material. The NNSA currently plans to produce no fewer than 80 plutonium pits a year by the 2030 time frame—a challenging timeline by the agency's own admission.[51]

If the facilities are not properly funded, the U.S. will gradually lose the ability to conduct the high-quality experiments that are needed to ensure the reliability of the stockpile without nuclear testing. In addition to demoralizing the workforce and hampering recruitment, old and/or obsolete facilities and poor working environments make maintaining a safe, secure, reliable, and militarily effective nuclear stockpile difficult. The NNSA's facilities are old: Nearly 60 percent are more than 40 years old, nearly 30 percent date to the Manhattan Project of the 1940s, and 10 percent are considered excess or no longer needed.[52] As a consequence, the NNSA had accumulated about $4.8 billion in deferred maintenance as of March 2020.[53] Aging facilities have also become a safety hazard: In some buildings, for example, chunks of concrete have fallen from the ceiling.[54]

The U.S. currently retains more than 5,000 old plutonium pits in strategic reserve in addition to pits for use in future LEPs. There are disagreements as to the effect of aging on plutonium pits and how long the U.S. will be able to depend on them before replacement. Because our laboratories estimated the life span of warhead plutonium to be between 45 and 60 years in 2006, it may not be long before the United States has to start replacing core components of its nuclear warheads.[55] Current capacities to do so are insufficient because the U.S. has only demonstrated an ability to produce about 10 plutonium pits a year at the Los Alamos PF-4 facility. If executed as planned, infrastructure modernization of PF-4, as mandated by the 2018 NPR, will boost that number to about 30 by 2026.

A second plutonium pit production facility is being planned to exploit the Mixed Oxide Fuel (MOX) facility that until last year was under construction at the Savannah River Site in South Carolina. The MOX building is being repurposed for plutonium pit production with production of no fewer than 50 pits per year to be achieved by 2030 for an overall requirement of no fewer than 80 plutonium pits a year. Achievement of this timeline is made more difficult by the fact that the NNSA is embarking on the most ambitious warhead sustainment program since the end of the Cold War, overhauling some five warhead types and stressing the demands on both workforce and facilities.

Manufacturing non-nuclear components can be extremely challenging either because some materials may no longer exist or because manufacturing processes have been forgotten and must be retrieved. There is a certain element of art to building a nuclear weapon, and such a skill can be acquired and maintained only through hands-on experience.

Grade: On one hand, the U.S. maintains some of the world's most advanced nuclear facilities. On the other, some parts of the complex—importantly, the plutonium and highly enriched uranium component manufacturing infrastructure—have not been modernized since the 1950s. Plans for long-term infrastructure recapitalization remain essential even as the NNSA is embarking on an aggressive warhead life-extension effort. Sustaining and/or increasing critically essential but always decaying tritium gas is likewise essential; delays only increase production needs because the more tritium decays because of our inability to replenish it, the more tritium gas we will need to cover our baseline needs.[56]

Significant progress has been made over the past year, however, in recapitalizing uranium infrastructure and in getting funded plans in place to recapitalize plutonium pit production capacity. With these projects only beginning and still at risk of major funding cuts or cancellations, the infrastructure's grade will likely remain at "marginal" until demonstrable progress has been made.

Personnel Challenges Within the National Nuclear Laboratories Score: Marginal

Combined with nuclear facilities, U.S. nuclear weapons scientists and engineers are critical to the health of the complex and the stockpile. The 2018 NPR emphasizes that:

> The nuclear weapons infrastructure depends on a highly skilled, world-class workforce from a broad array of disciplines, including engineering, physical sciences, mathematics, and computer science. Maintaining the necessary critical skills and retaining personnel with the needed expertise requires sufficient opportunities to exercise those skills. Should a technical or geopolitical development demand a new nuclear weapon, it is crucial that the nuclear weapons workforce possess the skills and the knowledge needed to design, develop, and manufacture warheads of different design in a timely manner.[57]

The ability to maintain and attract a high-quality workforce is critical to assuring the future of the American nuclear deterrent, especially when a strong employment atmosphere adds to the challenge of hiring the best and brightest. Today's weapons designers and engineers are first-rate, but they also are aging and retiring, and their knowledge must be passed on to the next generation of experts. This means that young designers need meaningful and challenging warhead design and development programs to hone their skills, and the SRP offers one visible means by which to address such concerns. The NNSA and its weapons labs understand this problem and with the support of Congress are beginning to take the necessary steps through SRP and foreign weapon assessment to mentor the next generation. To continue this progress, SRP funding should be maintained at least at its current rate of about $70 million per year.

The U.S. currently relies on non-yield-producing laboratory experiments, flight tests, and the judgment of experienced nuclear scientists and engineers, using robust modeling and simulation, to ensure continued confidence in the safety, security, effectiveness, and reliability of its nuclear deterrent. Without their experience, the nuclear weapons complex could not function. Few of today's remaining scientists or engineers at the NNSA weapons labs have had the experience of taking a warhead from initial concept to a "clean sheet" design, engineering development, production, and fielding. The SRP is remedying some of these shortfalls by having its workforce exercise most of the nuclear weapons design and engineering skills that are needed.

The average age of the NNSA's workforce decreased slightly to 46.9 years as of July 2019.[58] Still worrisome, however, is that NNSA sites are reporting rates of retirement eligibility from 15 percent to 44 percent, which will likely increase over the next five years.[59] Given the distribution of workforce by age, these retirements will create a significant knowledge and experience gap.

Grade: In addition to employing world-class experts, the NNSA labs have had some success in attracting and retaining talent (e.g., through improved college graduate recruitment efforts). As many scientists and engineers with practical nuclear weapon design and testing experience are retired, continued nuclear warhead annual assessments and certifications will rely increasingly on the judgments of people who have never tested or designed a nuclear weapon. In light of these issues, the NNSA workforce earns a score of "marginal," albeit with signs of improvement.

Readiness of Forces Score: Strong

The readiness of forces that operate U.S. delivery platforms is a vital component of America's strategic forces. The military personnel operating the three legs of the nuclear triad must be properly trained and equipped. It is also essential that the crews responsible for the nuclear mission are maintained in an appropriate state of readiness.

During FY 2020, the services have continued to align resources in order to preserve strategic capabilities in the short term. Nevertheless, the long-term possible effects of a continued flat defense budget could have major negative implications for the timely execution of programs. The economic downturn caused by the COVID-19 pandemic could also lead to programmatic delays or further defense budget cuts.

U.S. general-purpose forces are critical to ensuring the overall effectiveness of our nuclear forces (e.g., by providing a pool of qualified candidates to operate nuclear weapon delivery systems). Changes prompted in part by the 2014 Navy and Air Force cheating scandals have addressed most morale issues and have recast the role of forces supporting the nuclear deterrent by, for example, providing additional funding for equipment purchases, creating more mid-career billets to help career-field continuity, focusing leadership attention, and changing training to focus on mission in the field rather than on a theoretical ideal.[60] Sustained attention to the situation in the nuclear enterprise is critical.

Grade: Despite uncertainties regarding the future impacts of budgetary shortfalls, the young men and women who secure, maintain, plan for, and operate U.S. nuclear forces are of an extremely high caliber. Nuclear force commanders have provided assurance that the COVID-19 pandemic has had no impact on force readiness and the ability to launch nuclear weapons.[61] Force readiness thus receives a grade of "strong."

Allied Assurance Score: Strong

The credibility of U.S. nuclear deterrence is one of the most important components of allied assurances. U.S. allies that already have nuclear weapons can coordinate actions with the United States or act independently. During the Cold War, the U.S. and the U.K. cooperated to the point where joint targeting was included. France maintains its own independent nuclear arsenal. The U.S. also deploys nuclear gravity bombs in Europe as a visible manifestation of its commitment to its NATO allies.

The U.S. also has an enduring extended deterrence role with its Asian allies. The United States provides nuclear assurances to Japan and South Korea, both of which are technologically advanced industrial economies facing aggressive nuclear-armed regional adversaries (i.e., China, Russia, and North Korea). Continued U.S. nuclear deterrence assurances and guarantees are critical and must be perceived as credible. Both Japan and South Korea have the capability and basic know-how to build their own nuclear weapons quickly should they chose to do so. That would be a major setback for U.S. nonproliferation policies.

The 2018 NPR took a positive step when it placed "[a]ssurance of allies and partners" second on its list of four "critical roles" that nuclear forces play in America's national security strategy. The 2018 NPR proposed two supplements to existing capabilities—a low-yield SLBM warhead and a new nuclear sea-launched cruise missile—as important initiatives to strengthen assurance along with the Obama and Trump Administrations' initiatives to bolster conventional forces in NATO.[62] The recent successful deployment of the W76-2 low-yield warhead will be an important component of America's ability to deter aggression against its Asian and NATO allies.

Grade: At this time, most U.S. allies are not seriously considering developing their own nuclear weapons. European members of NATO continue to express their commitment to and appreciation of NATO as a nuclear alliance even as they worry about the impact of Russia's intermediate-range ground-launched missile capabilities and the fate of the New Strategic Arms Reduction Treaty, set to expire in February 2021. Uncertainties surround the purchase and modernization of NATO's dual-capable aircraft and the replacement of existing U.S. nuclear weapons with the B61-12, which is now facing a delay of one to two years.[63] Recent controversy within the German government over continuing to deploy U.S. gravity bombs in Germany adds to this uncertainty. Nevertheless, both Germany and NATO Secretary General Jens Stoltenberg have recently affirmed their commitment to NATO's nuclear sharing.[64] The score for allied assurance therefore remains "strong."

Nuclear Test Readiness Score: Weak

In the past, nuclear testing was one of the key elements of a safe, secure, effective, and reliable nuclear deterrent. While the U.S. is currently under a self-imposed nuclear testing moratorium, it is still required to maintain a low level of nuclear test readiness at the Nevada National Security Site (formerly Nevada Test Site).

"Test readiness" refers to a single test or a very short series of tests, not a sustained nuclear testing program, reestablishment of which would require significant additional resources. Specifically, under the 1993 PDD-15, "DOE [now NNSA] will maintain the readiness and capability to conduct nuclear tests within 2 to 3 years."[65] Because of a shortage of resources, the NNSA has been unable to achieve this goal. Test readiness has not been funded as a separate program since FY 2010 and is instead supported by the Stockpile Stewardship Program that exercises testing elements at the Nevada National Security Site and conducts subcritical nuclear laboratory experiments.[66]

However, whether this approach can assure that the U.S. has the timely ability to conduct yield-producing experiments to correct a flaw in one or more types of its nuclear weapons is open to question. The U.S. might need to test to assure certain weapon characteristics that could possibly be validated only by nuclear testing and to verify render-safe procedures. The ability to conduct yield-producing experiments rapidly is likewise important, especially if the U.S. needs to react strongly to another nation's nuclear weapons tests and/or communicate its unquestioned resolve.

Current law requires that the U.S. must maintain a capability to conduct a nuclear test within 24 to 36 months of a presidential decision to do so.[67] However, the FY 2020 Stockpile Stewardship and Management Plan (SSMP) states that fully complying with domestic regulations, agreements, and laws would "significantly extend the time required for execution of a nuclear test."[68] The time needed to conduct not just a test to address a need within the existing stockpile, but a test to develop a new capability was most recently reported in the FY 2018 SSMP as 60 months.[69] Because the United States is rapidly losing its remaining practical nuclear testing experience, including instrumentation of very sensitive equipment, the process would likely have to be reinvented from scratch.[70]

Grade: The Trump Administration has recently discussed whether to conduct a nuclear test as a demonstration for U.S. adversaries that allegedly have been conducting nuclear

explosive tests of their own.[71] As noted, however, the U.S. through NNSA can meet the legally required readiness requirement only if certain domestic regulations, agreements, and laws are waived. In addition, the U.S. is not prepared to sustain testing activities beyond a few limited experiments because it no longer retains the deep drilling technology in Nevada and has only a few "holes" that are able to contain a nuclear test. Thus, testing readiness earns a grade of "weak."

Overall U.S. Nuclear Weapons Capability Score: "Marginal" Trending Toward "Strong"

It should be emphasized that "trending toward strong" assumes that the U.S. maintains its commitment to modernization of the entire nuclear enterprise—from warheads to platforms to personnel to infrastructure—and allocates needed resources accordingly. Without this commitment, this overall score will degrade rapidly to "weak." Continued attention to this mission is therefore critical.

Although a bipartisan commitment has led to continued progress on U.S. nuclear forces modernization and warhead sustainment, these programs remain seriously threatened by potential future fiscal uncertainties. The infrastructure that supports nuclear programs is very aged, and nuclear test readiness has revealed troubling problems within the forces.

On the positive side, the 2018 NPR strongly articulates a core nuclear weapons policy solidly grounded in the realities of today's threats and growing international concerns. The 2018 NPR clearly and strongly articulates a continued commitment to extended deterrence. The commitment to warhead life-extension programs, the exercise of skills that are critical for the development of new nuclear warheads (under the SRP), and the just-in-time modernization of nuclear delivery platforms represent a positive trend that must be maintained. Averaging the subscores across the nuclear enterprise in light of our concerns about the future results in an overall score of "marginal."

U.S. Military Power: Nuclear

	VERY WEAK	WEAK	MARGINAL	STRONG	VERY STRONG
Nuclear Stockpile				✓	
Delivery Platform Reliability				✓	
Warhead Modernization			✓		
Delivery Systems Modernization				✓	
Nuclear Weapons Complex			✓		
National Labs Talent			✓		
Force Readiness				✓	
Allied Assurance				✓	
Nuclear Test Readiness		✓			
OVERALL			✓		

Endnotes

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Ballistic Missile Defense

Patty-Jane Geller

Missile defense is a critical component of the national security architecture that enables U.S. military efforts and can protect national critical infrastructure, from population and industrial centers to politically and historically important sites. It can strengthen U.S. diplomatic and deterrence efforts and provide both time and options to senior decision-makers amid crises involving missiles flying on both ballistic and non-ballistic trajectories (e.g., cruise missiles and hypersonic weapons).

The Growing Missile Threat

Missiles remain a weapon of choice for many U.S. adversaries because they possess important attributes like extraordinarily high speed (against which the U.S. has a limited ability to defend) and relative cost-effectiveness compared to other types of conventional attack weapons.[1] The number of states that possess missiles will continue to increase, as will the sophistication of these weapons, as modern technologies become cheaper and more widely available.

Despite U.S. diplomatic efforts, North Korea continues its aggressive development of a nuclear ICBM program that will allow it to strike the United States. It also has recently tested ground-based and sea-based ballistic missiles. Iran continues to modernize and proliferate its regional missile systems. Its recent successful rocket launch demonstrates that Iran has the ability to build and launch sophisticated missiles, which implies that it either has or is developing the know-how to advance to the ICBM-level of capability.[2] According to Dr. Robert Soofer, Deputy Assistant Secretary of Defense for Nuclear and Missile Defense Policy:

> As adversary missile technology matures and proliferates, the threat to the U.S. homeland, allies, partners, and our forces in the field becomes increasingly dynamic and difficult to predict. While traditional fixed and mobile ballistic missile threats continue to grow, adversaries are also investing in ground-, air-, and sea-launched cruise missiles with diverse ranges. China and Russia are also developing and testing hypersonic missile technology, with Russia recently deploying the world's first operational intercontinental-range hypersonic glide vehicle (HGV). These missile technologies are being incorporated into adversary strategies meant to coerce and intimidate the United States and its allies by threatening critical targets in our homelands.[3]

An additional concern is ballistic missile cooperation between state and non-state actors, which furthers the spread of sophisticated technologies and compounds challenges to U.S. defense planning.[4]

The Strategic Role of Missile Defense

Because they are designed to defeat incoming missile attacks, missile defense systems can

save lives and protect civilian infrastructure from damage or destruction. More important, missile defense plays a critical role in strategic deterrence. The ability to deter an enemy from attacking depends on convincing him that his attack will fail, that the cost of carrying out a successful attack is prohibitively high, or that the consequences of an attack will be so painful that they will outweigh the perceived benefit of attacking.

A U.S. missile defense system strengthens deterrence by offering a degree of protection to the American people and the economic base on which their well-being depends, as well as forward-deployed troops and allies, making it harder for an adversary to threaten them with ballistic missiles. By raising the threshold for missile attack, missile defense limits the option for a "cheap shot" against the United States. A missile defense system also gives a decision-maker a significant political advantage: By protecting key elements of U.S. well-being, it mitigates an adversary's ability to intimidate the United States into conceding important security, diplomatic, or economic interests.

Missile defense systems also enable U.S. and allied conventional operations. Adversaries want to deny the United States the ability to conduct offensive operations during a regional conflict, which they can attempt to do by targeting U.S. and allied forward deployed personnel or military assets. In addition, they might try to decouple the United States from defense of its allies by threatening to strike the U.S. homeland or forces abroad if the United States intervenes in a regional conflict. Missile defenses in place make it easier for the U.S. military to introduce reinforcements that can move more freely through a region and can therefore strengthen the credibility of U.S. extended deterrence.

Finally, a missile defense system gives decision-makers more time to choose the most de-escalatory course of action. Without the ability to defend against an attack, U.S. authorities would be limited to an unappealing set of responses that could range from preemptively attacking an adversary to attacking his ballistic missiles on launch pads or even conceding to his demands or actions. With a missile defense system, however, decision-makers would have additional options and more time to consider their implications and arrive at the one that best serves U.S. security interests. In other words, missile defense systems could be profoundly stabilizing.

The U.S. Missile Defense System

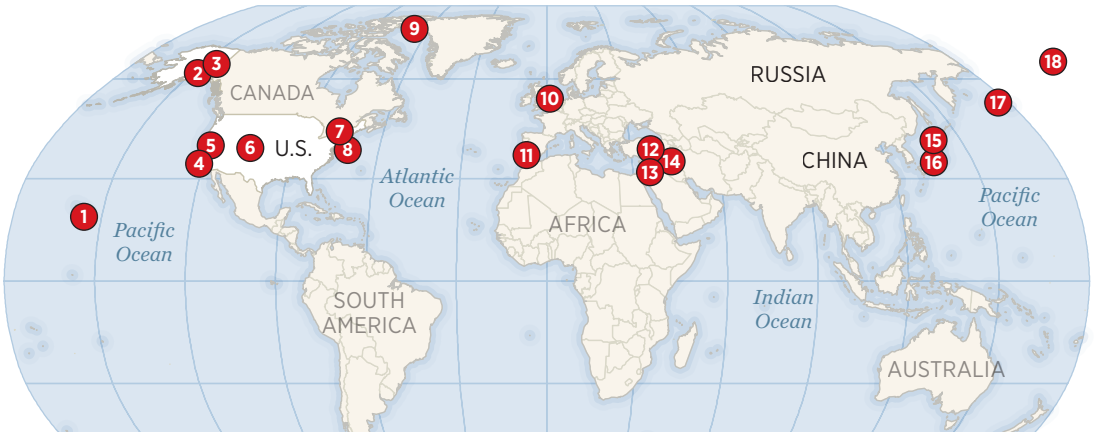
The U.S. missile defense system has three critical components: sensors, interceptors, and a command and control infrastructure that provides data from sensors to interceptors. Of these, interceptors receive much of the public's attention because of their visible and kinetic nature. Different physical components of a ballistic missile defense system are designed with the phase of flight in which an intercept occurs in mind, although some of them—for example, the command and control infrastructure or radars—can support intercepts in various phases of flight. Interceptors can shoot down an adversarial missile in the boost, ascent, midcourse, or terminal phase of its flight.

Another way to consider ballistic missile defense systems is by the range of an incoming ballistic missile (short-range, medium-range, intermediate-range, or intercontinental-range) that an interceptor is designed to shoot down, since the length of the interceptor's flight time determines how much time is available to conduct an intercept and where the various components of a defense system must be placed to improve the probability of such an intercept. With intercontinental-range ballistic missiles, the United States has "about 30 minutes" to detect the missile, track it, provide the information to the missile defense system, come up with the most optimal firing solution, launch an interceptor, and shoot down an incoming missile, ideally with enough time to fire another interceptor if the first attempt fails.[5] The time frame is shorter when it comes to medium-range and short-range ballistic missiles.

Missile defense can also be framed by origin of interceptor launch. At present, U.S. interceptors are launched from the ground or from

MAP 10

U.S. Missile Defense Assets



GBI—Ground based interceptors
GFC—Fire control center
GMD—Ground-based midcourse defense
IDT—In-Flight Interceptor Communications System (IFICS) Data Terminal
TPY-2—Transportable Radar Surveillance and Control Model 2
UEWR—Upgraded early warning radar

1. **Pearl Harbor, HI (base)**
   - Sea-based X-Band radar
2. **Clear, AK**
   - UEWR
3. **Ft. Greely, AK**
   - 40 GBIs
   - GMD
   - GFC
   - IDT
4. **Vandenberg AFB, CA**
   - 4 GBIs
   - 2 IDTs
5. **Beale AFB, CA**
   - UEWR
6. **Scriever AFB, CO**
   - GFC
7. **Ft. Drum, NY**
   - IDT
8. **Cape Cod, MA**
   - UEWR
9. **Thule, Greenland**
   - UEWR
10. **Fylingdales, UK**
    - UEWR
11. **Rota, Spain (base)**
    - Sea-based Aegis BMD SPY-1 radar
12. **Kurecik AFB, Turkey**
    - TPY-2 radar
13. **Israel**
    - TPY-2 radar
14. **CENTCOM-Middle East**
    - TPY-2 radar
15. **Shariki, Japan**
    - TPY-2 radar
16. **Kyogamisaki, Japan**
    - TPY-2 radar
17. **Shemya, AK**
    - Cobra Dane radar
    - IDT
18. **Outer space**
    - Defense support program satellites
    - Space-based infrared system satellites
    - Space tracking and surveillance system-demonstrator

NOTE: Locations are approximate.

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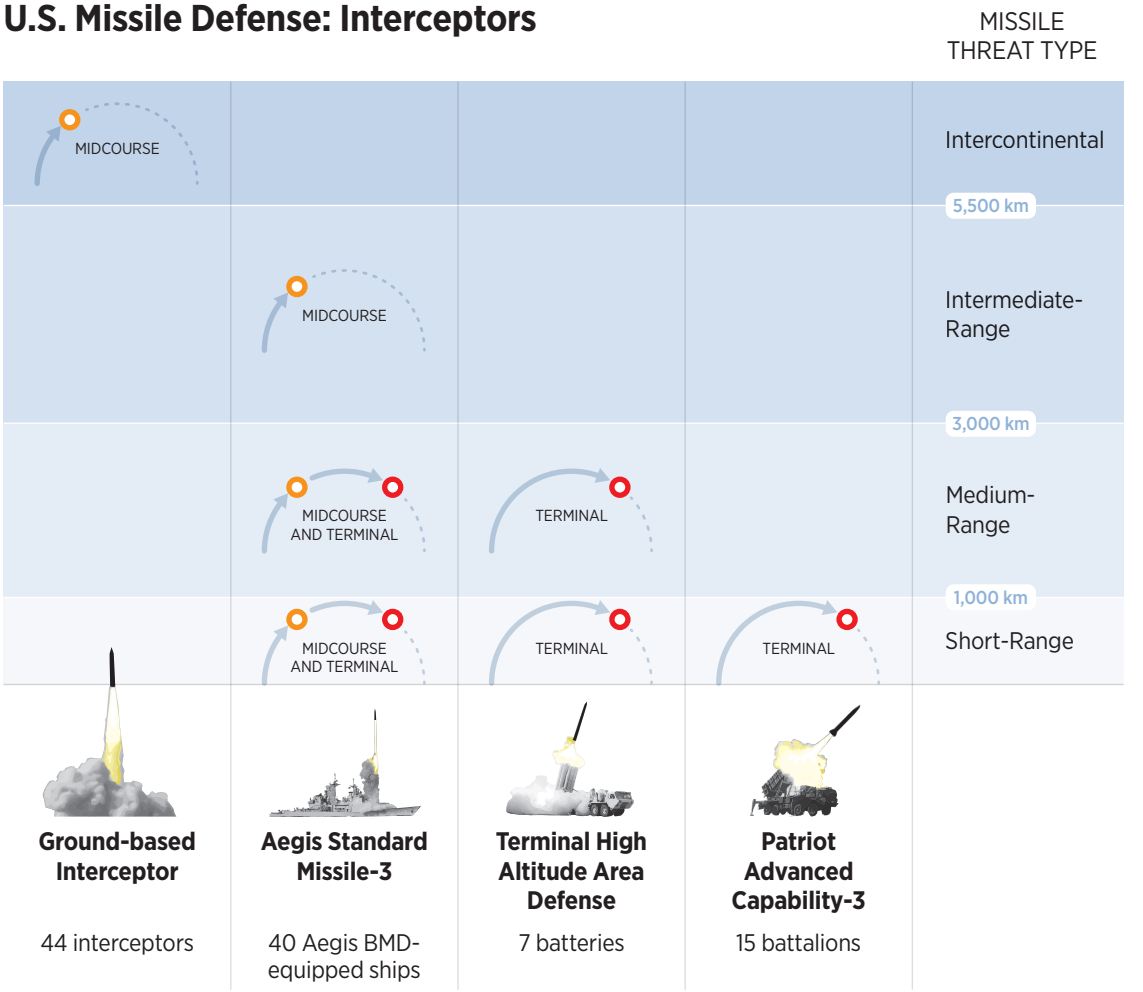
FIGURE 6

U.S. Missile Defense: Interceptors



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the sea. In the past, the United States explored concepts to launch interceptors from the air or from space, but only limited efforts have been made since the U.S.'s withdrawal from the Anti-Ballistic Missile Treaty in 2002.[6] There is renewed interest in boost-phase missile defense concepts within the Trump Administration, but the fiscal year (FY) 2021 budget

submission for the Missile Defense Agency (MDA), a U.S. Department of Defense agency charged with "develop[ing] and deploy[ing] a layered Missile Defense System to defend the United States, its deployed forces, allies, and friends from missile attacks in all phases of flight,"[7] does not include funding to explore space-based or air-based missile interceptors.

The current U.S. missile defense system is a result of investments made by successive U.S. Administrations. President Ronald Reagan envisioned the program as having a layered ballistic missile defense system, including ballistic missile defense interceptors in space, that would render nuclear weapons "impotent and obsolete."[8] These layers would include boost, ascent, midcourse, and terminal interceptors, including directed-energy interceptors, so that the United States would have more than one opportunity to shoot down an incoming missile.

The United States stopped far short of this goal, even though the Strategic Defense Initiative program resulted in tremendous technological advances and benefits.[9] Instead of a comprehensive layered system, the U.S. has no boost-phase ballistic missile defense systems and is unable to handle the advanced ballistic missile threats from China or Russia.

The volatility and inconsistency of priority and funding for ballistic missile defense by successive Administrations and Congresses—Administrations and Congresses, it should be noted, controlled by both major political parties—have led to the current system, which is numerically and technologically limited and cannot address more sophisticated or more numerous long-range ballistic missile attacks. Historically, U.S. policy has been one of protecting the homeland only from a "limited" ballistic missile attack.[10] The National Defense Authorization Act (NDAA) for Fiscal Year 2017 dropped the word "limited" that had been a fixture of policy since the National Missile Defense Act of 1999 even as it continued to focus on ballistic missiles. The 2020 NDAA made it a matter of policy to rely on nuclear deterrence to defend against "near-peer intercontinental threats" and focus on improving missile defense against "rogue states."[11]

In the future, as technological trends progress and modern technologies become cheaper and more widely available, North Korean or Iranian ballistic missiles may rival, in sophistication if not numbers, those of Russia or China. Consequently, the U.S. must remain aware of how such threats are evolving and alter its missile defense posture accordingly.

In January 2019, the Trump Administration published its congressionally mandated Missile Defense Review (MDR), a statement of policy intended to guide the Administration's missile defense programs. The MDR addresses the dangerous threat environment that has evolved since the last MDR in 2010 and advocates a comprehensive approach to all missile threats that integrates offensive capabilities, active defenses, and passive defenses. It also acknowledges that the United States is no longer vulnerable only to ballistic missiles and recognizes the need to defend against cruise and hypersonic missiles as well.[12] For FY 2021, the Trump Administration requested $20.3 billion for missile defeat and defense (MDD), including $9.2 billion for the MDA (a decrease of $1.2 billion from the FY 2020 enacted budget); $7.9 billion in missile defense capabilities outside of the MDA, such as the Space Development Agency (SDA) and the services; and $3.2 billion for "missile defeat or left-of-launch activities."[13]

Interceptors

Interceptors comprise one major component of the U.S. missile defense system. Different types of interceptors that respond to different missile threats have been emphasized over the years, and these choices are reflected in the composition of today's U.S. missile defense.

Ballistic missile defense interceptors are designed to intercept ballistic missiles in three different phases of their flight.

- **The boost phase** is from the launch of a missile from its platform until its engines stop thrusting.

- **The midcourse phase** is the longest and thus offers a unique opportunity to intercept an incoming threat and, depending on other circumstances like the trajectory of the incoming threat and quality of U.S. tracking data, even a second shot at it should the first intercept attempt fail.

- **The terminal phase** is less than one minute long, occurring as the missile plummets through the atmosphere toward the target, and offers a very limited opportunity to intercept a ballistic missile threat.

Boost-Phase Interceptors. The United States currently has no capability to shoot down ballistic missiles in their boost phase. Boost-phase intercept is the most challenging option technologically because of the very short time frame in which a missile is boosting, the missile's extraordinary rate of acceleration during this brief window of time, and the need to have the interceptor close to the launch site.[14] It is, however, also the most beneficial time to strike. A boosting ballistic missile is at its slowest speed compared to other phases; it is therefore not yet able to maneuver evasively and has not yet deployed decoys that complicate the targeting and intercept problem.

In the past, the United States pursued several boost-phase programs, including the Airborne Laser, the Network Centric Air Defense Element, the Kinetic Energy Interceptor, and the Air Launched Hit-to-Kill missile. Each of these programs was eventually cancelled because of insurmountable technical challenges, unworkable operational concepts, or unaffordable costs. As stated in the MDR, the Trump Administration is considering an option that would incorporate the F-35 initially as a sensor platform and later potentially as an interceptor platform for boost-phase intercepts. However, the current budget does not include funding for MDA development of a boost-phase interceptor program.

Midcourse-Phase Interceptors. The United States deploys two systems that can shoot down incoming ballistic missiles in the midcourse phase of flight. This phase offers more predictability as to where the missile is headed than is possible in the boost phase, but it also allows the missile time to deploy decoys and countermeasures designed to complicate interception by confusing sensors and radars.

The Ground-Based Midcourse Defense (GMD) system is the only system capable of shooting down a long-range ballistic missile headed for the U.S. homeland. It consists of 40 Ground-Based Interceptors (GBIs) in Alaska and four in California. In 2017, Congress approved a White House reprogramming request to increase the number of GBIs from 44 to 64 to keep up with the advancing ballistic missile threat, but this project has yet to be completed.[15] At about $70 million apiece, GBIs are rather expensive—but they are also a lot cheaper than the damage that would be caused by a successful ballistic missile attack. In March 2019, the MDA conducted a groundbreaking and successful "salvo" GMD test against an ICBM target in which one GBI intercepted the target and a second intercepted the biggest piece of debris from the exploded target.[16]

In order to increase the probability of an intercept, the United States has to shoot multiple interceptors at each incoming ballistic missile. At present, because its inventory of ballistic missile defense interceptors is limited, the United States can shoot down only a handful of ballistic missiles that have relatively unsophisticated countermeasures.[17]

The Aegis defense system is a sea-based component of the U.S. missile defense system. It is designed to address the threat of short-range, medium-range (1,000–3,000 kilometers), and intermediate-range (3,000–5,500 kilometers) ballistic missiles. It utilizes different versions of the Standard Missile-3 (SM-3) depending on the threat and other considerations like ship location and quality of tracking data. The U.S. Navy is planning to increase the number of BMD-capable ships from 48 at the end of FY 2021 to 65 at the end of FY 2025.[18] The increase reflects an increase in demands for these assets.

The Aegis Ashore system in Romania and one being deployed to Poland will relieve some of the stress on the fleet because missile defense–capable cruisers and destroyers are multi-mission and are used for other purposes, such as wartime fleet operations and even anti-piracy operations, when released from ballistic missile missions by the shore-based systems. These Aegis Ashore sites will help to protect U.S. allies and forces in Europe from the Iranian ballistic missile threat. Two Aegis Ashore batteries were sold recently to Japan to help protect U.S. allies and forces in the Indo-Pacific from the North Korean and Chinese threats, but this project has since been suspended.[19]

In February 2020, the MDA "confirmed it would conduct an ICBM intercept test with the SM-3 Block IIA missile in the third quarter of 2020." The test would be "the first ICBM-class intercept attempt for the SM-3 Block IIA missile."[20] The Pentagon hopes to use SM-3 Block IIAs as an "underlay" to the GMD system to defend the homeland, with GBIs taking the first shot at an incoming target and SM-3 interceptors taking a second shot if GBIs missed.[21] Deploying such an underlay would require the Pentagon to develop a concept of operations that includes deployment of SM-3 interceptors on Aegis ships or Aegis Ashore sites across the United States.

Terminal-Phase Interceptors. The United States currently deploys three terminal-phase missile defense systems: Terminal High Altitude Area Defense (THAAD); Patriot Advanced Capability-3 (PAC-3); and Aegis BMD.

A THAAD battery is capable of shooting down short-range and intermediate-range ballistic missiles inside and just outside of the atmosphere.[22] It consists of a launcher, interceptors, the Army Navy/Transportable Radar Surveillance and Control Model 2 (AN/TPY-2) radar, and fire control.[23] The system is transportable and rapidly deployable. THAAD batteries have been deployed to such countries as Japan, South Korea, Israel, and the United Arab Emirates. The United States deployed a THAAD battery to Romania in support of NATO ballistic missile defense in summer 2019 and signed a deal this year to deliver THAAD to Saudi Arabia.[24] This year's budget also included funding "to prove the technologies to enable expansion of engagement options and coverage areas for the THAAD weapon system."[25]

The PAC-3 is an air-defense and short-range ballistic missile defense system. A battery includes a launcher, interceptors, AN/MPQ-53/65 radar, an engagement control station, and diesel-powered generator units. The system is transportable, and the United States currently deploys it in several theaters around the world.[26] The system is the most mature of the U.S. missile defense systems.

The PAC-3's predecessor system, the Patriot, played a critical role in allied assurance during the First Gulf War when it was deployed to Israel. The purpose was to assure Israeli citizens by protecting them from Iraqi missiles, thereby decreasing the pressure on Israel's government to enter the war against Iraq. In so doing, the U.S. sought to prevent Israel from joining the U.S. coalition against Saddam Hussein's forces in Iraq, which would have fractured the Arab coalition.

The Aegis defense system also provides terminal capability against short-range and medium-range ballistic missiles, aerial threats, and cruise missiles, among others.[27]

Assessment: Interceptor strength is difficult to assess because deploying more interceptors to increase capacity or defend more targets would always be better than simply relying on the number currently deployed. To strengthen regional interceptor capability in the Middle East, for instance, after the January 2020 Iranian ballistic missile attack on al-Asad Air Base, which had no missile defenses, the Pentagon moved a Patriot battery to al-Asad to provide a short-term solution to the Iranian threat.[28] Nevertheless, deployment of more short-range to medium-range interceptors to more unprotected locations *ad infinitum* is clearly not sustainable.

The budget for FY 2021 includes funding to procure additional PAC-3, SM-3, and THAAD

interceptors, but DOD can also improve the effectiveness of interceptors more creatively.[29] For instance, the Pentagon is developing a THAAD remote launch capability, which can enable a commander to spread out THAAD interceptors to expand a defended area.[30] In addition, the Army recently increased its THAAD battery requirement from seven (the existing number) to eight.[31] This eighth THAAD battery was not included in the FY 2021 budget request; instead, it appeared as the number two priority on the MDA's Unfunded Priorities List.[32]

In terms of GBI capacity and capability to defend the homeland, Air Force General Terrence J. O'Shaughnessy, Commander, U.S. Northern Command (NORTHCOM), recently stated that he "retains confidence in the current ground-based interceptor fleet" but that it will need to improve to remain ahead of emerging threats.[33] After a series of North Korean provocations in 2017, the Trump Administration and Congress agreed on the need to expand interceptor capacity from 44 to 64 to keep pace with the growing North Korean threat. Twenty new silos are under construction in Alaska, but they will remain empty because DOD does not have enough interceptors available to fill them.

Existing GBIs carry Exoatmospheric Kill Vehicles (EKVs) to intercept the target with kinetic kill technology, but EKVs are no longer manufactured. The MDA intended to produce a Redesigned Kill Vehicle (RKV) to top the 20 new interceptors, but this program was canceled in 2019. The MDA instead initiated the Next Generation Interceptor (NGI) program to develop advanced kill vehicles to fill the 20 new silos and replace the 44 existing GBIs, but fielding of NGIs will not begin until 2028 at the earliest.

In addition to a delay in capacity, the GMD system will lose capability as the existing EKVs face aging and obsolescence issues. RKV would have begun to replace EKVs as early as 2021, but with NGI not expected until the end of the decade, the 44 deployed interceptors may be at heightened risk. In fact, senior defense leaders estimate that the problems of North Korean ICBM advancement and aging EKVs will converge around 2025.[34]

General O'Shaughnessy recently expressed his concerns to the Senate Armed Services Committee:

> I want to make it clear that I am deeply concerned with the resulting delay in adding to our ground-based interceptor capability and capacity. As we progress toward a next-generation interceptor (NGI) capability, USNORTHCOM remains responsible for defending the homeland from missile attacks. It is therefore necessary to swiftly develop and field a lower-tier missile defense capability as a complement to NGI to intercept current and emerging missile threats. Given the nature of the ballistic missile threat, I am a strong advocate for bringing a layered capability on board for the warfighter well before NGI is fielded.[35]

Another way to improve interceptor capability is by fielding an interceptor as part of the Army's Indirect Fire Protection Capability (IFPC) Increment 2 to defend against short-range rockets, artillery, and mortars, as well as cruise missiles, against which the United States lacks sufficient defense capability.[36] As a system, IFPC would fill the gap between short-range tactical air defense and ballistic missile defense like PAC-3 and THAAD.

In response to a congressional requirement to field an interim cruise missile defense capability to meet the increasing cruise missile threat, the Army purchased two Iron Dome batteries manufactured by the Israeli company Rafael. While Iron Dome has successfully defended Israel from short-range attacks, particularly on the Israeli border with the Gaza Strip,[37] the Army has identified problems with integration of Iron Dome as part of an enduring IFPC solution.[38] The Army is working to find the best option for a long-term IFPC solution, but until it finds that option, it will lack a strong capability in the area of cruise missile defense.

Overall, the United States has multiple capable interceptors, but there is much room for improvement. The Pentagon has viable plans in place to improve the capability of Aegis and PAC-3 assets and to acquire additional systems of each, but it will need to focus on stabilizing the homeland missile defense system in particular in the near future.

Sensors

The sensor component of the U.S. missile defense system is distributed across the land, sea, and space domains and provides the United States and its allies with the earliest possible warning of a launch of enemy missiles in addition to missile tracking and discrimination. The sensors do this by detecting the heat generated by a missile's engine, or booster. They can detect a missile launch, acquire and track a missile in flight, and even classify the type of projectile, its speed, and the target against which the missile has been directed. The sensors relay this information to the command and control stations that operate interceptor systems, like Aegis (primarily a sea-based system) or THAAD (a land-based system).

On land, the major sensor installations are the upgraded early warning radars (UEWRs), which are concentrated along the North Atlantic and Pacific corridors that present the most direct flight path for a missile aimed at the United States. These include the phased array early warning radars based in California, the United Kingdom, and Greenland that scan objects up to 3,000 miles away.[39] These sensors focus on threats that can be detected starting in the missile's boost or launch phase when the release of exhaust gases creates a heat trail that is "relatively easy for sensors to detect and track."[40]

A shorter-range (2,000-mile) radar is based in Shemya, Alaska. Two additional sites, one in Cape Cod, Massachusetts, and the other in Clear, Alaska, are being modernized for use in the layered ballistic missile defense system.[41]

The other land-based sensors are mobile. These AN/TPY-2 sensors can be forward-deployed for early threat detection or retained closer to the homeland to track missiles in their terminal phase.[42] Of the United States' 12 AN/TPY-2 systems, five are forward-deployed with U.S. allies.[43]

In March 2017, in cooperation with the Republic of Korea, the United States deployed a THAAD missile system to the Korean Peninsula; in April, it was accompanied by an AN/TPY-2. The THAAD deployment was heavily criticized by China for allegedly destabilizing China's nuclear deterrence credibility because the system would be able to improve U.S. early warning, and therefore interception, of any Chinese nuclear-tipped missiles and undermine China's second-strike capability.[44] However, the THAAD system deployed in South Korea for the purposes of intercepting North Korean missiles is not set up in a way that could track or shoot down Chinese ICBMs directed toward the United States, so why China would be so opposed to it is unclear.[45]

There are two types of sea-based sensors. The first is the Sea-Based X-band (SBX) radar that is mounted on an oil-drilling platform and can be relocated to different parts of the globe as threats evolve.[46] SBX is used primarily in the Pacific. The second radar is the SPY-1 radar system that is mounted on all 84 U.S. Navy vessels equipped with the Aegis Combat System, which means they can provide data that can be utilized for ballistic missile missions. Of these 84 ships, 40 are BMD-capable vessels that carry missile defense interceptors.[47]

Finally, U.S. missile defense sensors operate in space. Control of the space BMD system is divided among the MDA, the U.S. Space Force, and the SDA.

The oldest system that contributes to the missile defense mission is the Defense Support Program (DSP) constellation of satellites, which use infrared sensors to identify heat from booster and missile plumes. The DSP satellite system has gradually been replaced by the Space-Based Infrared Radar System (SBIRS) to improve the delivery of missile defense and battlefield intelligence.[48] For instance, SBIRS can scan a wide swath of territory while simultaneously tracking a specific

target, making it a good scanner for observing tactical, or short-range, ballistic missiles.[49]

However, congressional funding delays have left SBIRS underfunded and have hampered the system's full development and deployment.[50] In 2017, the Air Force decided to end production of SBIRS early and move on to developing its replacement, the Next-Generation Overhead Persistent Infrared (Next-Gen OPIR) satellites. The first of these satellites, which are designed to be more survivable against cyber and electronic attacks, are scheduled for delivery in 2025.[51]

The MDA also operates the Space Tracking and Surveillance System-Demonstrators (STSS-D) satellite system. Two STSS-D satellites were launched into orbit in 2009 to track ballistic missiles that exit and reenter the Earth's atmosphere during the midcourse phase.[52] Although still considered an experimental system, STSS-D satellites provide operational surveillance and tracking capabilities and have the advantage of a variable waveband infrared system to maximize their detection capabilities. Data obtained by STSS-D have been used in ballistic missile defense tests.

From as far back as President Reagan's Strategic Defense Initiative, successive presidential Administrations have called for a layer of sensing satellites in space to track a missile's flight from birth to death. From the ultimate high ground, space-based sensors can detect missile launches from almost any location from boost phase to terminal phase, compared to ground-based radars that are limited in their tracking range.[53] In particular, space-based sensors can help track hypersonic vehicles, which fly at lower altitudes than ballistic missiles and can maneuver during their trajectories.

Since many new threats are not flying on ballistic trajectories, the Trump Administration has paid close attention to developing this space sensor layer as endorsed by the MDR. In FY 2020, Congress provided slightly more than $140.5 million to the MDA to develop the Hypersonic and Ballistic Tracking Space Sensor (HBTSS) to fulfill this need.[54] This year, the President requested $99.6 million for the SDA to integrate the MDA's HBTSS payload into a future architecture of sensing and tracking satellites proliferated in Low Earth Orbit (LEO).[55]

Assessment: Senior defense leaders have stated repeatedly that the most important way to advance sensor capability is to deploy sensor satellites to space in order to track missiles throughout their entire flight from the high ground. Today's deployed radars and sensors are both vulnerable to adversary attack and limited in tracking range. As Admiral Charles Richard, Commander of U.S. Strategic Command, has explained:

> Future space-based sensors may be able to provide birth-to-death detection, tracking, and discrimination of hypersonic glide vehicle, cruise missile, and ballistic missile threats globally. These abilities cannot be fully achieved with the current or future terrestrial-based radar architecture due to the constraints of geography and characteristics of future missile threats.[56]

Similarly, General O'Shaughnessy recently stated that given the emerging threat, "the urgency of taking steps now to develop and field a future space-based sensing layer as soon as technology allows cannot be overstated."[57]

But the space sensor layer program has been unnecessarily plagued by bureaucratic infighting and insufficient funding requests. In FY 2019 and FY 2020, the Administration did not request funds for a space sensor layer, so Congress unilaterally provided funding to the MDA for HBTSS. In FY 2020 and FY 2021, the Administration tried to move the program to the SDA, even though Congress expressed its desire that HBTSS remain in MDA. Moreover, a decrease in research and development funding as requested in FY 2021 would increase the difficulty of demonstrating this space sensor layer quickly, especially because of the technological challenges associated with developing a sensor that can perform in LEO.[58]

In addition to space sensors, there is a gap in missile discrimination capability over the Pacific for tracking North Korean missiles. The MDA's Long Range Discrimination Radar (LRDR) being built in northern Alaska will improve coverage in the northern Pacific but will leave a tracking and discrimination gap over Hawaii and elsewhere in the Pacific. In the FY 2021 budget, the MDA omitted plans to build a Homeland Defense Radar (HDR)-Hawaii and another HDR-Pacific due to budgetary restraints. DOD plans to use deployed AN/TYP-2 radars, the SBX radar, and radars on Aegis ships while these homeland defense radars remain delayed.[59] Eventual deployment of the space sensor layer will also improve this capability, but it is no substitute for a long-term solution that completely closes this Pacific midcourse discrimination gap.[60]

Some progress in sensor capability has been made over the past year. Congress reprogrammed funds for Next-Gen OPIR last year after the requirement for the program moved up in schedule. If implemented by Congress, the budget for FY 2021 should fully fund the program.[61] Additionally, the Army recently awarded a contract for the Lower-Tier Air and Missile Defense System radars that will provide 360-degree threat coverage for PAC-3 and other regional missile defense batteries; for comparison, the current Patriot radar can only scan the sky one slice at a time.[62]

Despite this progress, achievement of an advanced sensor capability requires stabilization of the space sensor layer program. Due to their ability to track and characterize missiles throughout the entirety of their flight, space sensors are essential to development of an interceptor capability against advancing threats like hypersonic vehicles.

Command and Control

The command and control architecture established for the U.S. ballistic missile defense system brings together data from U.S. sensors and relays them to interceptor operators to enable them to destroy incoming missile threats against the U.S. and its allies. The operational hub of missile defense command and control is assigned to the Joint Functional Component Command for Integrated Missile Defense (JFCC IMD), which is housed at Schriever Air Force Base, Colorado.

Under the jurisdiction of U.S. Strategic Command, JFCC IMD brings together Army, Navy, Marine Corps, and Air Force personnel. It is co-located at Schriever with the MDA's Missile Defense Integration and Operation Center (MDIOC). This concentration of leadership from across the various agencies helps to streamline decision-making for those who command and operate the U.S. missile defense system.[63]

Command and control operates through a series of data collection and communication relay nodes among military operators, sensors, radars, and missile interceptors. To command and control the GMD system to defend the homeland, the first step is the Ground-based Midcourse Defense Fire Control (GFC) process, which involves assimilating data on missile movement from the United States' global network of sensors.

Missile tracking data travel through the Defense Satellite Communications System (DSCS), which is operated from Fort Greely, Alaska, and Vandenberg Air Force Base, California, or ground-based redundant communication lines to the Command Launch Equipment (CLE) software that develops fire response options, telling interceptors where and when to fire. Once the NORTHCOM Commander (who becomes the supported commander during GMD execution) in consultation with the President has determined the most effective response to a missile threat, the CLE fire response option is relayed to the appropriate GBIs in the field.[64] When the selected missiles have been fired, they maintain contact with an In-Flight Interceptor Communications System (IFICS) Data Terminal (IDT) to receive updated flight correction guidance to ensure that they hit their target.[65]

Overlaying the Command and Control operation is the Command and Control, Battle Management and Communication (C2BMC)

program. Through its software and network systems, C2BMC feeds information to and synchronizes coordination among the multiple layers of the ballistic missile defense system.[66] More than 70 C2BMC workstations are distributed throughout the world at U.S. military bases.[67] C2BMC has undergone multiple technical upgrades, called "spirals," since 2004 to bring more missile defense elements into the network. Last year, the MDA completed an upgrade that will help to expand Aegis missile defense coverage by enabling Aegis Weapons Systems to engage on remote. In FY 2021, the MDA plans to complete another upgrade to incorporate the LRDR into C2BMC.

Regional missile defense systems like THAAD, PAC-3, and Aegis are equipped with their own individual fire control systems to command and control the launch of their interceptors. The C2BMC system can also provide tracking information to individual missile defense batteries from other regional sensors. Aegis BMD systems have onboard command and control governed by the Aegis Combat System, but they can also provide their sensor data to the GMD system through C2BMC.[68]

C2BMC connects sensors and shooters around the world to a global network, but there is no comparable system to link sensors and shooters in a single region. The Army is developing the Integrated Air and Missile Defense (IAMD) Battle Command System (IBCS) to provide this capability. Once fielded, IBCS would connect all sensors and shooters in a region to a single fire control network, as opposed to having each missile defense battery operate its own collocated sensor and launcher as is done today.[69] IBCS would also link defenses against smaller threats, like IFPC, with ballistic missile defense.

Assessment: The United States has maintained a global command and control system that it continues to improve and update. In 2018, the MDA completed updates to the aging GFC system to improve efficiency.[70] Recent spiral upgrades to C2BMC have improved capability, and future spirals that are planned will continue to increase the integration of ballistic missile defense elements across the world. As global missile threats advance to include not just ballistic missiles, but cruise and hypersonic missiles as well, the United States will need a more advanced command and control capability to address this increasingly vast range of threats.

DOD is currently developing a Joint All Domain C2 (JADC2) system so that it can integrate non-compatible sensors across all domains into a single network to respond more efficiently to this complex threat, and missile defense command and control will strengthen as the services begin to field JADC2 capabilities. IBCS will also provide an important improvement to regional missile defenses and must remain on schedule. IBCS was originally scheduled to reach initial operating capability in FY 2019 but has already been delayed to FY 2022 because of technical issues.[71] Although the current missile defense command and control architecture can address today's threat, advancements that are underway will become increasingly necessary to strengthen command and control for the future.

Conclusion

By choice of successive post–Cold War Administrations and Congresses, the United States does not have in place a comprehensive set of missile defense systems that would be capable of defending the homeland and allies from robust ballistic missile threats. U.S. efforts have focused on a limited architecture protecting the homeland and on deploying and advancing regional missile defense systems.

While the United States has in place multiple types of capable interceptors, a vast sensor network, and a command and control system, many elements of the missile defense system need to improve to defend more effectively against today's threat. At the same time, the development of missile threats, both qualitative and quantitative, outpaces the speed of missile defense research, development, and deployment to address the future threat.

The United States has not invested enough in future ballistic missile defense technologies,

has canceled future missile defense programs like the Airborne Laser and the Multiple Kill Vehicle, and has never invested in space-based interceptors that would make U.S. defenses more robust and comprehensive. This Administration has stressed the importance of U.S. missile defense, but Congress also needs to recognize its importance and provide sufficient funding for struggling programs like GMD and space sensors if we are to reap the strategic benefits that it provides.

Endnotes

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8. Ronald Reagan, "Address to the Nation on National Security," March 23, 1983, https://millercenter.org/the-presidency/presidential-speeches/march-23-1983-address-nation-national-security (accessed June 19, 2020).
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Conclusion: U.S. Military Power

The Active Component of the U.S. military is two-thirds the size it should be, operates equipment that is older than should be the case, and is burdened by readiness levels that are problematic. Some progress has been made, but it has been made at the expense of both capacity and modernization. Accordingly, this *Index* assesses the:

- **Army as "Marginal."** The Army's score remains "marginal" in the *2021 Index*. The Army has fully committed to modernizing its forces for great-power competition, but its programs are still in their development phase, and it will be a few years before they are ready for acquisition and fielding. It remains "weak" in capacity with 70 percent of the force it should have but has significantly increased the readiness of the force, scoring the highest level of "very strong" in 2020. The Army has a better sense of what it needs for war against a peer, but funding uncertainties could threaten its ability to realize its goals.

- **Navy as "Marginal."** The Navy's overall score remains "marginal" in the *2021 Index* but is trending toward "weak" in capability and readiness and remains "weak" in capacity. The technology gap between the Navy and its peer competitors is narrowing in favor of competitors, and the Navy's ships are aging faster than they are being replaced. The Navy sustained its focus on improving readiness in 2020, but it has a very large hole to fill, its fleet is too small relative to workload, and supporting shipyards are overwhelmed by the amount of repair work needed to make more ships available.

- **Air Force as "Marginal."** The USAF scores "marginal" in all three measures but is trending upward in capability and capacity. The shortage of pilots and flying time for those pilots degrades the ability of the Air Force to generate the amount and quality of combat air power that would be needed to meet wartime requirements. Although it could eventually win a single major regional contingency (MRC), the time needed to win that battle and the attendant rates of attrition would be much higher than they would be if the service had moved aggressively to increase high-end training and acquire the fifth-generation weapon systems required to dominate such a fight.

- **Marine Corps as "Marginal."** The score for the Corps' capacity was raised to "marginal" from "weak" but only because this *Index* has changed the threshold, lowering it from 36 infantry battalions to 30 battalions in acknowledgment of the Corps' argument that it is a one-war force that also stands ready for a broad range of smaller crisis-response tasks. However, the Corps intends to reduce the number of its battalions further from 24 to 21, which would return it to a score of "weak." The service is moving ahead aggressively with a redesign of its operating forces, but it remains hampered by old equipment, and

U.S. Military Power: Army

	VERY WEAK	WEAK	MARGINAL	STRONG	VERY STRONG
Capacity		✓			
Capability			✓		
Readiness					✓
OVERALL			✓		

U.S. Military Power: Navy

	VERY WEAK	WEAK	MARGINAL	STRONG	VERY STRONG
Capacity		✓			
Capability			✓		
Readiness			✓		
OVERALL			✓		

U.S. Military Power: Air Force

	VERY WEAK	WEAK	MARGINAL	STRONG	VERY STRONG
Capacity			✓		
Capability			✓		
Readiness			✓		
OVERALL			✓		

U.S. Military Power: Marine Corps

	VERY WEAK	WEAK	MARGINAL	STRONG	VERY STRONG
Capacity			✓		
Capability			✓		
Readiness			✓		
OVERALL			✓		

problematic funding continues to constrain its deployment-to-dwell ratio to 1:2 (too few units for its workload), forcing it to prioritize readiness for deployed and next-to-deploy units at the expense of other units across the force.

- **Space Force as "Not Assessed."** The Space Force was formally established on December 20, 2019, as a result of an earlier proposal by President Trump and legislation passed by Congress. As of mid-2020, the Space Force is still in the process of

U.S. Military Power: Space (not assessed this year)

	VERY WEAK	WEAK	MARGINAL	STRONG	VERY STRONG
Capacity					
Capability			n/a		
Readiness					
OVERALL			n/a		

U.S. Military Power: Nuclear

	VERY WEAK	WEAK	MARGINAL	STRONG	VERY STRONG
Nuclear Stockpile				✓	
Delivery Platform Reliability				✓	
Warhead Modernization			✓		
Delivery Systems Modernization				✓	
Nuclear Weapons Complex			✓		
National Labs Talent			✓		
Force Readiness				✓	
Allied Assurance				✓	
Nuclear Test Readiness		✓			
OVERALL			✓		

being established, and personnel numbers are very small. Given the nascent state of the Space Force, we do not render an assessment of it in the *2021 Index*. We hope to assess its strength in future editions of the *Index*, but this will be complicated by the classified nature of the force.

- **Nuclear Capability as "Marginal."** This score is trending toward "strong," but it should be emphasized that this assumes that the U.S. maintains its commitment to modernization of the entire nuclear enterprise—from warheads to platforms to personnel to infrastructure—and allocates needed resources accordingly. Without this commitment, this overall score will degrade rapidly to "weak." Continued attention to this mission is therefore critical. Although a bipartisan commitment has led to continued progress on U.S. nuclear forces modernization and warhead sustainment, these programs remain seriously threatened by potential future fiscal uncertainties. The infrastructure that supports nuclear programs is very aged, and nuclear test readiness has revealed troubling problems within the forces.

In the aggregate, the United States' military posture is rated "marginal." The *2021 Index* concludes that the current U.S. military force is likely capable of meeting the demands of a single major regional conflict

U.S. Military Power

	VERY WEAK	WEAK	MARGINAL	STRONG	VERY STRONG
Army			✓		
Navy			✓		
Air Force			✓		
Marine Corps			✓		
Nuclear			✓		
Space					
OVERALL			✓		

while also attending to various presence and engagement activities but that it would be very hard-pressed to do more and certainly would be ill-equipped to handle two nearly simultaneous major regional contingencies.

The military services have continued to prioritize readiness and have seen improvement over the past couple of years, but modernization programs continue to suffer as resources are redirected toward current operations and sustainment of readiness levels. The services have also normalized the reduction in size and number of military units, and the forces remain well below the level they need to meet the two-MRC benchmark.

Congress and the Administration took positive steps to stabilize funding for fiscal years 2018, 2019, and 2020 through the Bipartisan Budget Agreement of 2018, and the Bipartisan Budget Act of 2019 sustained support for funding above the caps imposed by the Budget Control Act of 2011 (BCA). While this allays the most serious concerns about a return to the damaging levels of the BCA, more will be needed in the years to come to ensure that America's armed services are properly sized, equipped, trained, and ready to meet the missions they are called upon to fulfill.