



The 2020s Tri-Service Modernization Crunch

Mackenzie Eaglen

with Hallie Coyne

MARCH 2021

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Cover image shows a US Air Force B-1B Lancer. US Air Force photo by Staff Sgt. Peter Reft.

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Executive Summary

President Joe Biden's new administration and the 117th Congress must respond to a uniquely difficult political and fiscal environment; as part of this mandate, they will be charged with addressing the enduring mismatch of US defense strategy and resources, which contributes to ongoing supply and demand imbalances regarding requests for forces by combatant commanders. Since these challenges have been growing unchecked for years, the coming decade looms large as the US military is facing a massive spending spike to pay for modernization bills across the Navy, Marine Corps, Air Force, and Army that have been ignored, deferred, or inadequately considered. Although this was foreseen and forewarned, insufficient action has been taken. Resolution requires political courage, persistence, innovation, risk, and resources.

Fleets of ships, aircraft, vehicles, and other equipment are reaching the end of their service lives, hitting the edge of their upgrade limits, and losing combat relevance. As great-power competition accelerates, the United States is offering a free and open window of opportunity and advantage to its adversaries. Unless policymakers take concrete steps now, defense leaders will continue America's sleepwalk into strategic insolvency and its consequences. The aptly named "Terrible 20s" have arrived.

The intention of this report is not to propose ideal or preferred defense investments. Rather, it aims to deliver an unvarnished overview of the existing modernization bill before the Pentagon today, forcing an overdue confrontation with reality.

The 2020s Tri-Service Modernization Crunch undertakes three paths of analysis. The report initially reviews decades of defense investment decisions that resulted in the current composition of the US military. This history considers the ramifications of delayed equipment recapitalizations from the end of the Cold

War, the dominance of short-term spending priorities during the wars in Iraq and Afghanistan, the legacy of the 2011 Budget Control Act, and competing federal spending priorities and objectives. The results include climbing operations and maintenance costs for aging military platforms—which put still more pressure on modernization programs—and the entrenchment of inefficient modernization decision-making patterns.

This report also provides a comprehensive examination of the bills facing each service to modernize over the next decade. While the Department of Defense provides most modernization cost data for the next five years—or over the Future Years Defense Program—in its annual budget requests, this report projects costs for a 10-year time frame to demonstrate the scale of the challenges facing the armed forces. Although such cost data are inherently subject to change and variation, this analysis identifies the overarching trends shaping the modernization cost profiles of each service. Accordingly, while the total costs of specific modernization programs may evolve, many of the patterns discussed in this report will not. For example, the Navy has no choice but to continue replacing its old attack submarines, even though analysts may debate how many new ones should be built and how quickly.

Finally, the report lays out policy recommendations for how Congress, the White House, and the armed forces can begin developing and implementing a serious plan to meet the modernization crunch. Such options include taking immediate action to relieve pressure on procurement and accelerating the fielding of advanced technologies—in some cases using legacy platforms as playgrounds for innovation.

Unfortunately, as this report demonstrates, there is no easy way out of this fiscal bind for the US military. Rather, now is the time for effective mitigation strategies, urgent worst-case scenario planning, hard choices, and political leadership.

Introduction

As was long forewarned but easy to ignore to address more immediate problems, the United States military is now confronting a massive and underappreciated spending spike in paying for continuously delayed weapons modernization bills in the 2020s. Former Chairman of the Joint Chiefs of Staff Gen. Joseph Dunford testified in 2016 to Congress that “my most significant concern is the bow wave of modernization that has been deferred.”¹

It was postponed in the 1990s after the Ronald Reagan buildup and peace dividend, in the early 2000s for the wars, and then during the 2010s to pay down debt from the financial recession. Time is up, and many pieces of military equipment can no longer limp along—having aged chassis, hulls, and airframes that cannot be upgraded with today’s technology and cannot generate the kind of power needed to survive any fight. The solutions are simple, but they are far from easy. Chief among them are awareness, urgency, investment, and creativity.

Unfortunately, while the solutions are simple to conceive, they are more complicated to execute. Political willpower is needed from Congress. The services must make difficult choices about their future spending trade-offs and accurately represent the real costs of trying to address decades of postponed modernization bills, all while applying previous lessons learned and achieving efficiencies. Defense policymakers across Washington must confront the hard fact that our military will be forced to accept new levels of risk in three key theaters due to the unalterable consequences of previous investment decisions. The best and only way is through, but navigating such complex decisions will require sustained political attention and investment during a decade when both will be in high demand elsewhere.

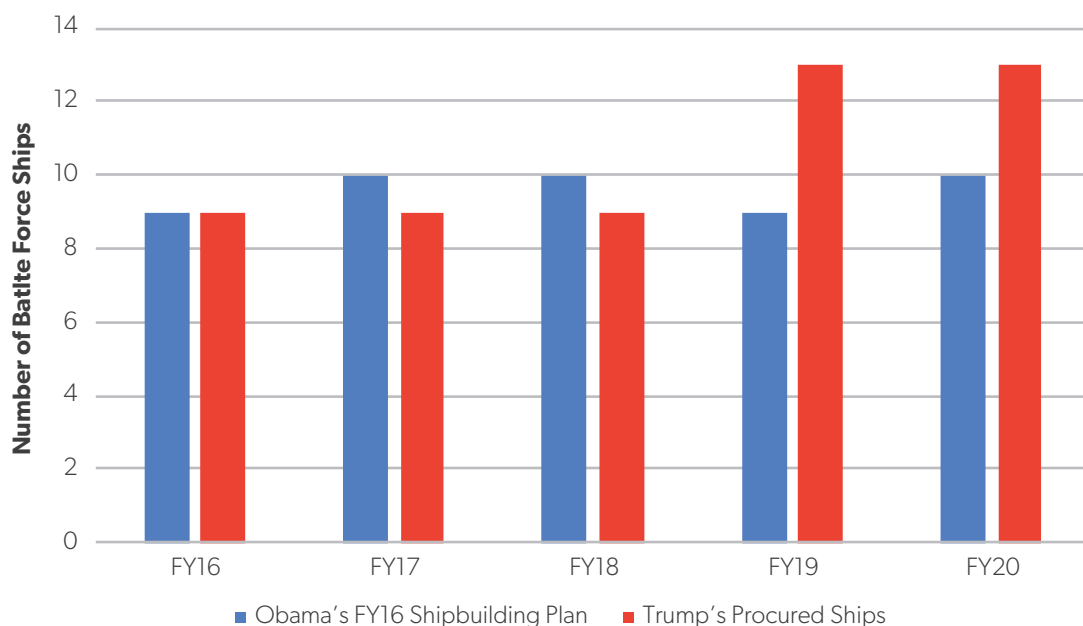
In 2016, popular military blogger and Navy Cmdr. CDR Salamander (ret.) coined the phrase

“Terrible 20s” to describe the modernization challenges before the US military this coming decade. He offered an ominous overview of the next 10 years as “that horrible mix of debt bombs, recapitalizing our SSBN [ballistic missile submarines] fleet, and the need to replace and modernize legacy aircraft, ships, and the concepts that designed them.”² It is a bracing and accurate summary of the following analysis. In this case, the first step in addressing the problem is reminding the policymakers that it exists. The second step—incumbent on leaders in Congress, at the Pentagon, and in the White House—is being honest about the consequences. The third is generating the willpower and spending the political capital to pay for it.

Addressing the Tri-Service Spending Spike

First things first: What is a spending spike? This phenomenon is known among analysts as the procurement or acquisition “bow wave,” a term derived from the wave created by the bow of a ship pushing water into a wave in front of it. At its most basic level, a bow wave—or modernization spending crunch, to be more exact—describes a period when an overwhelming amount of military purchases must be made nearly simultaneously. The term “modernization crunch” better captures the more complex nature of this moment. Modernization crunches are not merely about the magnitude of deferred spending but also about the speed at which the Pentagon can rebuild its equipment portfolio and the bandwidth and dollars available to do so.

In an ordinary American’s life, we could think of a modernization crunch as that one month when your staggered bills all end up due on the same date. You come home from work, and in the mail you find that your mortgage payment, child’s college tuition, health

Figure 1. Obama’s FY 2016 Shipbuilding Plan vs. Trump’s Procured Ships, FY 2016–FY 2020

Source: Ronald O'Rourke, "Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress," Congressional Research Service, January 2021, 45, <https://fas.org/sgp/crs/weapons/RL32665.pdf>; and Office of the Chief of Naval Operations, "Report to Congress on the Annual Long-Range Plan for Construction of Naval Vessels for Fiscal Year 2016," March 2015, 6, <https://documentcloud.adobe.com/link/review?uri=urn:aaid:scds:US:033dffe4-1fd3-4201-b810-b532ed256377>.

care expenses, and new car down payment have somehow lined up, and now you have to pay them all at once. Pentagon modernization crunches follow the same logic. Part of the reason is that many of the systems were bought in the same short period decades ago, so they are aging out together, more or less.

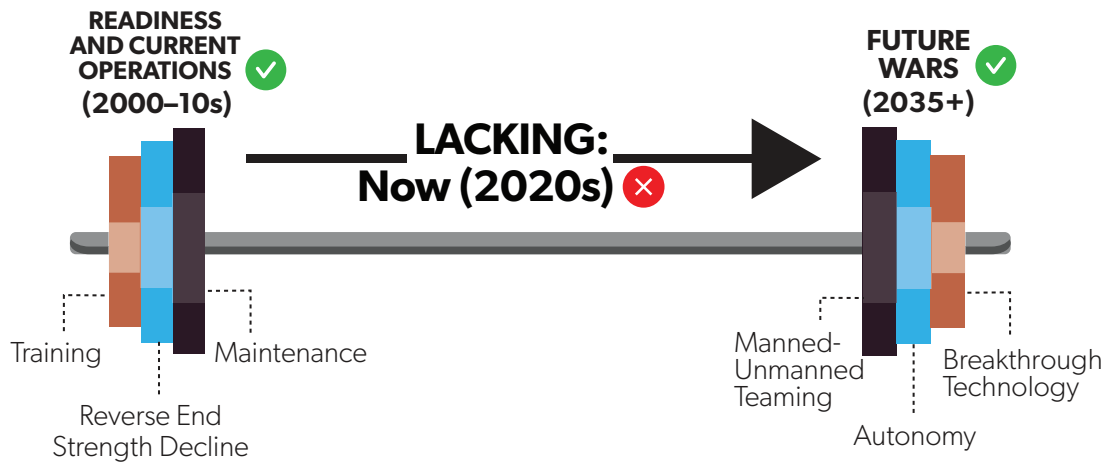
This report not only details the defense modernization squeeze but also highlights how this shortfall is merely the tip of a massive iceberg of deferred modernization investment across the military services and not present in official Pentagon documents. If unaddressed, this challenge—in both its current and further afield iterations—will have immediate and severe consequences for America's armed forces.

Why Does It Matter?

Washington has delayed sweeping military modernization for over two decades for various reasons that seemed justifiable at the time but only worsened the

problem. In the 1990s and 2000s, the US got away with not recapitalizing the fleets and inventories of the services because of the Reagan buildup. During the first outbreak of the wars in Iraq and Afghanistan, the US military was effective with fewer advanced weapons systems partly because of the nature of the conflict.³ For example, the US had vastly superior air power when compared to the Iraqi military and Taliban forces from the outset. The quality of US service members and their training and leadership allowed the armed forces to cope until help could arrive in the form of up-armored vehicles, more drones, and better munitions.⁴

Yet after the intensity of the initial invasions, the following years were characterized by US forces carrying out grueling, manpower-intensive, and protracted counterinsurgency operations against adversaries that used a varying mix of "conventional combat, insurgency, terrorism, information operations, and criminal activity to achieve their objectives" as the conflicts evolved.⁵ Lost American blood and treasure

Figure 2. Barbell Military Investment Strategy Was Unbalanced: We Are in the “Lacking 2020s”

Source: Author.

escalated as the military was forced to confront drastically different challenges simultaneously, and both wars have yet to come to a satisfactory conclusion. Yet, in the 2010s, the United States began to confront new challenges in its threat environment beyond the immediate conflicts in the Middle East. The “pivot to Asia” initiated by Barack Obama during his administration culminated in the recognition of China as the clear pacing threat for the United States by Donald Trump’s White House (Figure 1).

The 2018 National Defense Strategy stated, “We cannot expect success fighting tomorrow’s conflicts with yesterday’s weapons or equipment.”⁶ The strategy further established, “To address the scope and pace of our competitors’ and adversaries’ ambition and capabilities, we must invest in modernization of key capabilities through sustained, predictable budgets.”⁷

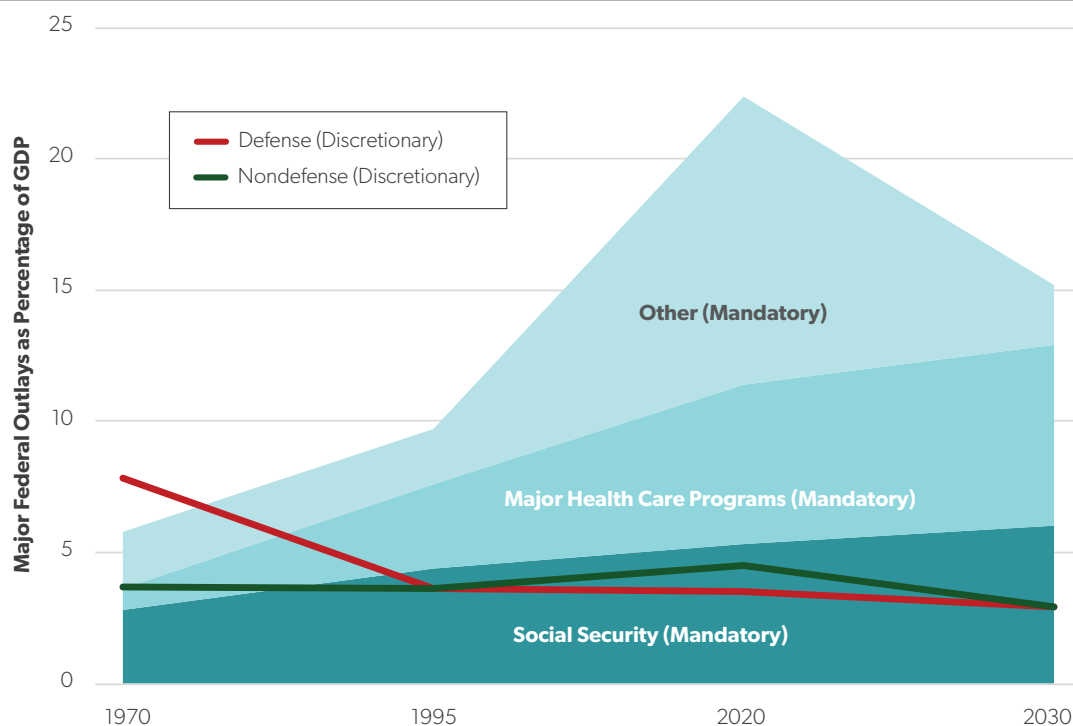
In an AEI report, *Repair and Rebuild: Balancing New Military Spending for a Three-Theater Strategy*, I argued that in the 2000s, Pentagon leaders focused understandably on the wars but did so while planning too optimistically in realizing ambitious technology transformations that would take decades to materialize.⁸ As a result, not enough investment was made in the conventional platforms required to maintain a ready force and strong conventional deterrent through the 2020s (Figure 2). In fact, rosy assumptions about

revolutions in military affairs and the promises of technology solutions tomorrow became a justification to drastically slash those same aging fleets and inventories of ships, aircraft, and vehicles the troops use every day to sail, fly, and drive to accomplish their missions. Now the military is facing a decade of staggering modernization costs.

Despite the clear need for sustained defense topline, the Trump administration’s dedication to rebuilding the military turned out to be an unfulfilled promise. Although the Department of Defense (DOD) did receive real budget topline increases in 2017 and 2018, by 2019 the budget began to flatline again (or stop growing above annual inflation rates).⁹ The latest presidential budget request for fiscal year (FY) 2021 at \$716 billion, including discretionary, mandatory, and Overseas Contingency Operation (OCO) funding, represents a decline in real terms of 4.1 percent from the previous year.

Moreover, President Trump released his administration’s final defense budget request for FY21 in February 2020. Since then, the COVID-19 pandemic has resulted in the deaths of over 500,000 Americans at the time of writing, more than twice the number of American soldiers who died in World War I. COVID-19 has caused substantial economic damage and led to unprecedented deficit spending to

Figure 3. Baseline Projections of Major Federal Outlays as Percentage of Gross Domestic Product Compared to 25 and 50 Years Ago



Source: Congressional Budget Office, “An Update to the Budget Outlook: 2020 to 2030,” September 2020, <https://www.cbo.gov/system/files/2020-09/56517-Budget-Outlook.pdf>.

mitigate its impact. Without economic growth, government debt (and its associated interest payments) is expected to increase pressure to cut so-called discretionary government spending, including defense, for years to come (Figure 3).¹⁰

This type of “solution,” to balance the government books largely on the backs of those in uniform, was tried after the 2008 financial crisis through the Budget Control Act (BCA)¹¹ and led to devastating readiness consequences for the past five years—including preventable peacetime deaths.¹² Repeating knee-jerk defense cuts for debt reduction after the military has yet to fully repair its foundation weakened by the BCA era of 2011–20 would be downright criminal. As former-Secretary of Defense James Mattis summarized in 2018:

Our military remains capable, but our competitive edge has eroded in every domain of warfare—air,

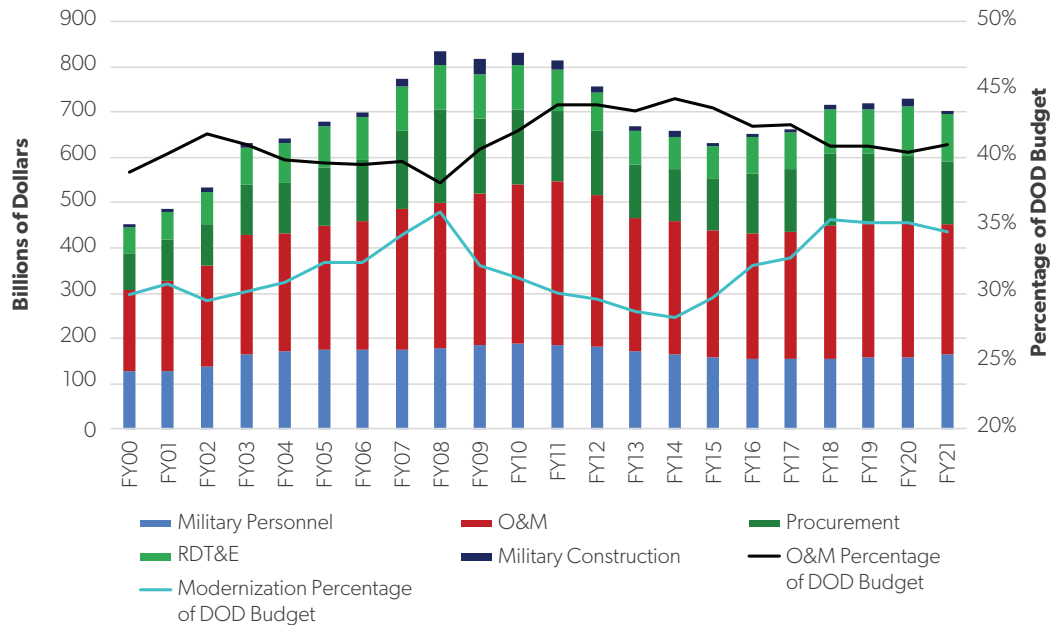
land, sea, space, and cyber. The combination of rapidly changing technology, the negative impact on military readiness resulting from the longest continuous period of combat in our Nation’s history, and a prolonged period of unpredictable and insufficient funding, created an overstretched and under-resourced military.¹³

Years of insufficient defense budgets have backed the military into a corner. If no action is taken, something will break and do so spectacularly.

What Factors Are Making the Modernization Spending Crunch Worse?

For various reasons alluded to previously, both understandable and shortsighted, the Terrible 20s are here. The key now is to acknowledge the problem exists

Figure 4. O&M vs. Modernization as a Percentage of the Discretionary Budget for the DOD, FY 2000–FY 2021



Note: Figures are in FY21 constant dollars (inflation-adjusted using DOD deflators), including war and supplemental funding.

Source: Under Secretary of Defense, “National Defense Budget Estimates for FY 2021 (Green Book),” April 2020, Table 6-1, https://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2021/FY21_Green_Book.pdf.

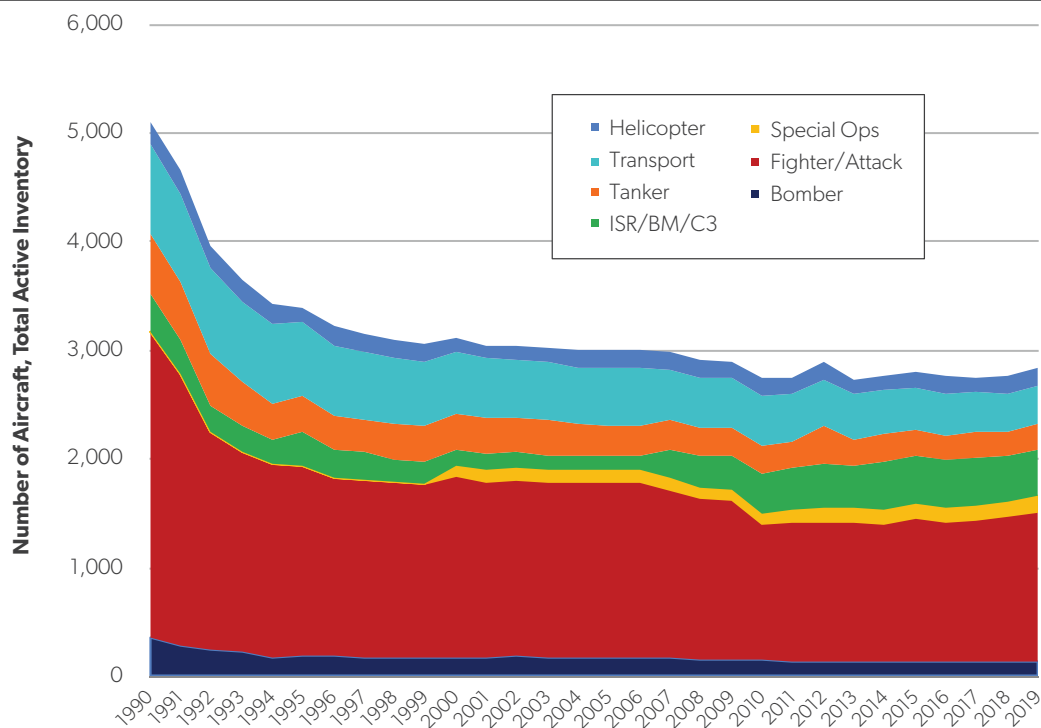
and address it in earnest, not make more excuses or poor assumptions along the lines of the past 30 years to delay needed investment yet again.

Military Recapitalization Has Been Repeatedly Delayed Since the End of the Cold War. A death spiral of delaying necessary procurement for newer military equipment began with the so-called procurement holiday and peace dividend of the 1990s. These downward trends worsened during the emphasis on demands of the Iraq and Afghanistan wars and reached a peak with the combined defense spending reductions of the Obama administration and the 2011 BCA and the ensuing 2013 sequestration. Consequently, each decade, everything gets older. The Pentagon is attempting to lead a long-overdue effort to recapitalize and modernize the equipment service members use on the front lines. Failure to act now will not only break our *two* sacred contracts to provide service members with the tools they need to

never be in a fair fight but also unfairly burden American taxpayers in the long term.¹⁴

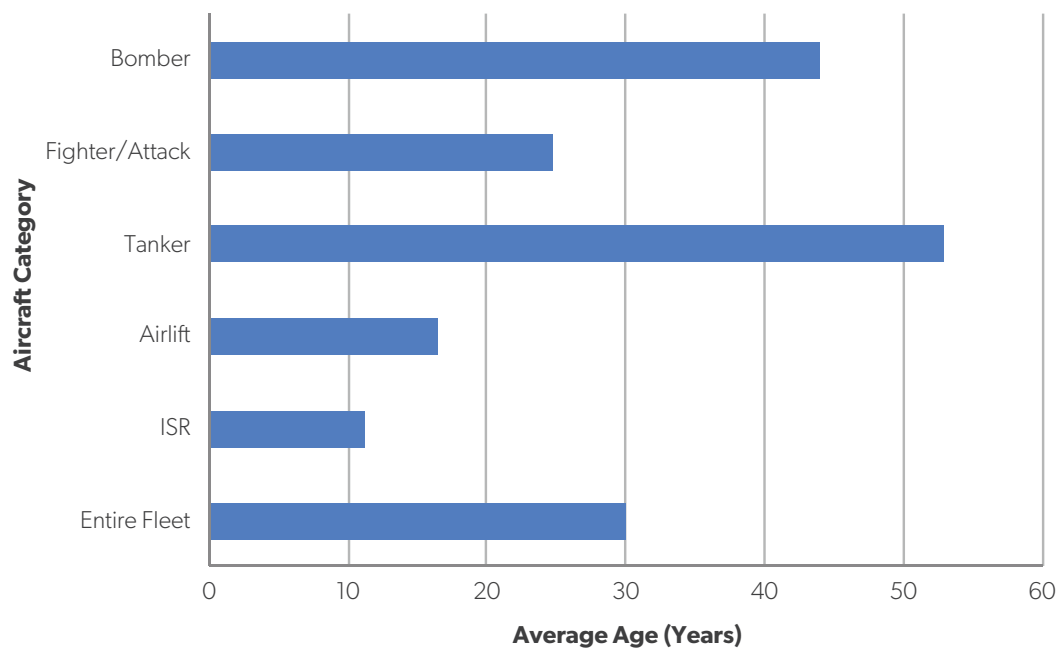
The Share of the DOD’s Budget for Purchasing Equipment, Rather Than Developing or Maintaining Them, Has Shrunk. As the services made do with aging weapons during the 2000s and 2010s, the cost to operate and sustain those systems increased. Think about the effort it takes to maintain an old car: The more miles you put on it, the more often it requires a visit to the mechanic. The analogy is particularly bracing when placed in context. In 2015, by automobile standards, 12 fleets of Air Force aircraft were “authorized antique license plates in the state of Virginia.”¹⁵ These trends play out over and over again across the branches and specialties. Over the past two decades, the DOD consistently dedicated roughly twice as much of its major public law account expenditures to operations and maintenance (O&M) costs as it did to new procurement (Figure 4), while

Figure 5. US Air Force, Aircraft Total Active Inventory, 1990–2019

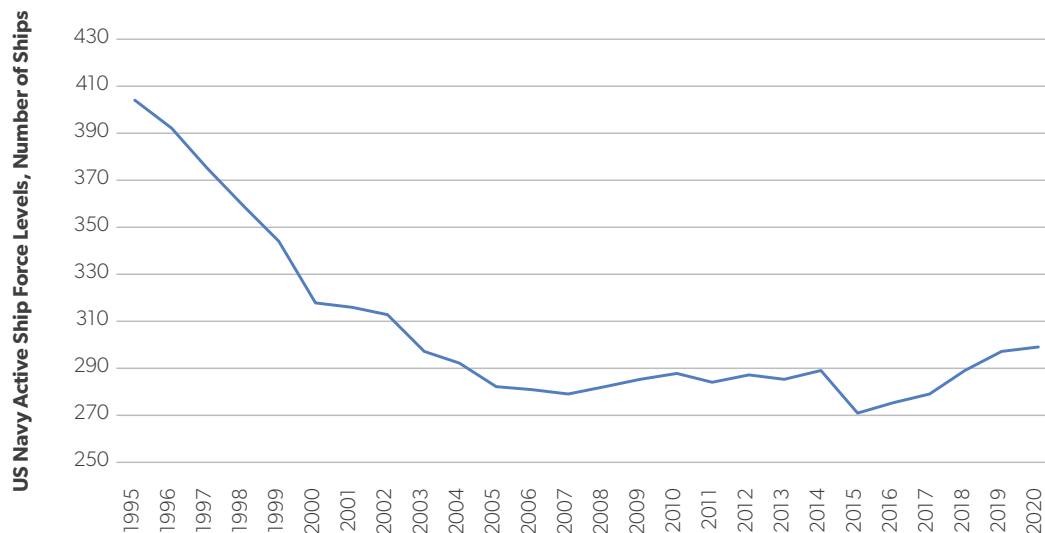


Source: *Air Force Magazine*, “Air Force Magazine USAF Almanac: The US Air Force in Facts and Figures,” May 1997, 2002, 2008, 2012; and *Air Force Magazine*, “Air Force Magazine US Air Force and Space Force Almanac,” May 2020, <https://www.airforcemag.com/app/uploads/2020/06/Equipment.pdf>.

Figure 6. Average Age of US Air Force Aircraft, 2020



Source: John Venable, “2021 Index of U.S. Military Strength: An Assessment of U.S. Military Power U.S. Air Force,” Heritage Foundation, November 17, 2020, <https://www.heritage.org/2021-index-us-military-strength/assessment-us-military-power/us-air-force>.

Figure 7. Total Navy Active Ships, 1995–2020

Source: Naval History and Heritage Command, “US Ship Force Levels 1886–Present,” November 17, 2017, <https://www.history.navy.mil/research/histories/ship-histories/us-ship-force-levels.html>; Mark Cancian, “U.S. Military Forces in FY 2020: Navy,” Center for Strategic and International Studies, October 3, 2019, <https://www.csis.org/analysis/us-military-forces-fy-2020-navy>; and Brent Sadler, “U.S. Navy,” in *2021 Index of U.S. Military Strength*, Heritage Foundation, November 17, 2020, <https://www.heritage.org/2021-index-us-military-strength/assessment-us-military-power/us-navy>.

inventories of aircraft, ships, and vehicles continued to both age (Figure 6) and shrink (Figures 5 and 7). In effect, the Pentagon is paying evermore in repairs for fewer miles. That leaves less money for buying newer replacements.

The Price per Weapon Has Risen Because of Increased Technological Complexity, but Sacrificing Capacity Is Not a Solution.¹⁶ Consider associated cost considerations for the B-21, the Air Force’s next-generation bomber. The B-21 Raider incorporates stealth technology and the additional costs of nuclear capabilities, and it is part of a family of systems that will benefit from additional enabling technologies, according to Air Force officials.¹⁷ It will supplement the Air Force’s existing aging fleet of bombers,¹⁸ limited from when Congress reduced the purchase of B-2 bombers from the planned 132 down to 21.¹⁹ Unfortunately, the B-21s alone will not rescue the Air Force bomber force. The bomber fleet is shrinking and worn thin by a legacy of B-1 retirements

that were made in the early 2000s to float the sustainment costs of the remaining force.

However, demand for bombers is increasing each year, particularly in the Indo-Pacific due to their range and payload capacity. And yet, as former Air Force Vice Chief of Staff Gen. John Michael Loh (ret.) notes, the Air Force’s FY21 budget request canceled a crucial upgrade to the B-2s (the only stealth bombers in the fleet today), lining it up for an early retirement.²⁰ Loh concluded, “The Air Force entered the new decade with the smallest bomber force in its history,” and “there comes a point where doing more with less does not work.”²¹ It is far more realistic to acknowledge that the DOD will need both high-end capabilities and expanded capacity. One cannot be sacrificed to finance the other; it’s a false trade-off.

Moreover, it is naive to suggest that networked technologies—such as unmanned platforms—will not create new expenses. Consider, for example, the challenges of integrating unmanned systems into existing US military operations.²² A premise of ensuring

the utility of unmanned systems depends on their ability to communicate and share data with manned systems, ideally across warfighting domains. Implementation efforts for increased data sharing across the services and their systems (think of it as a military Internet of Things) is already one of the Joint Chiefs of Staff's highest priorities, led by the Air Force's joint all-domain command and control investments.²³

Policymakers and uniformed leaders are sleepwalking into strategic insolvency.

However, the DOD struggles substantially with rapid and effective software development.²⁴ Further, even after the military develops new software, sustainment costs must be considered. For example, in February 2019, the Government Accountability Office (GAO) reported Pentagon estimates of sustainment costs for weapons software at \$15 billion over the next five years.²⁵ However, GAO cautioned that number might be low because some systems have incomplete cost data, increasing the chances of not having the necessary resources available in the future.²⁶ Relying on advanced technologies that depend heavily on continuous software advancements (not to mention advanced network security) is no guarantee of future cost savings.

The Military's Overall Budgetary Needs Are Consistently Underestimated. Comprehending the scale of the deferred modernization spending squeeze is challenging because defense budget documents do not reflect planned spending beyond a five-year time horizon known as the Future Years Defense Program (FYDP). In its analysis of the defense budget request for 2019, the Congressional Budget Office (CBO) noted that planned increases in military personnel, operations and sustainment,

acquisition, and infrastructure costs would be difficult to execute absent real growth in the defense budget beyond 2023 (the end of the 2019 FYDP).²⁷

Further, beyond 2023, the base budget for the DOD would need to increase by 11 percent in real terms by 2033 to fund existing plans. The problem, of course, is that such optimistic budget increases almost never arrive.²⁸ In its analysis of the defense budget request for 2021, the CBO once again predicted the Pentagon's plans will require inflation-adjusted budget growth of 10 percent between 2026 and 2035 (the 10 years after the FY21 FYDP), with nearly 70 percent of that increase dedicated to O&M costs and further funding of military personnel.²⁹

Years of such unmitigated willingness to "pass the buck" in Congress, at the Pentagon, and inside the White House have created an untenable, and unfortunately enduring, mismatch of strategy and resources.³⁰ Policymakers and uniformed leaders are sleepwalking into strategic insolvency.³¹ Even ambitious plans now, such as the framework set forth by the House Armed Services Committee's Future of Defense Task Force, led by Reps. Seth Moulton (D-MA) and Jim Banks (R-IN), may still fall short of the strategic imperatives imposed on the United States by our adversaries.³² Published in September 2020, the bipartisan task force report affirmed the need to meet the threat posed by China's and Russia's militarization, emphasizing the need to focus on "the development of emerging technologies over fielding and maintaining legacy systems."³³ The report includes smart proposals for modernizing the US military, accounting for dwindling margins for error and limited resources.

It remains that while the 2018 National Defense Strategy was right to prioritize the threats China and Russia pose, it still took a soda-straw view of America's strategic requirements—focusing on two peer competitors to the detriment of most else. Like a disintegrating paper straw in your cocktail, this myopic view tends to fall apart under the pressures of politics, time, and bureaucratic friction or inertia.³⁴ The strategy fails to account for the political difficulty of reducing the priority given to global threats and missions; as always (and as evidenced by AEI's 2015

report *To Rebuild America's Military*), great powers do not pivot and should not pretend they can.³⁵ The National Defense Strategy Commission responded to the 2018 strategy by noting that “concepts such as . . . ‘accepting risk’ in lower-priority theaters . . . are imprecise and unpersuasive.”³⁶ Improving the US military’s conventional posture vis-à-vis China and Russia should have been conceived of as an additive demand for resources. Instead, leaders decided to assume away certain threats and missions while hoping US adversaries will agree.

The consequences of such limited and short-sighted decision-making are becoming alarmingly clear. While the lower limits of an advisable or even workable end strength for each service are difficult to definitively label (and reasonable analysts can disagree), certain patterns are undeniable. Most obviously, while each service sets forth plans for end strength increases in the past four years—driven by threat assessments—it seems increasingly unlikely that any of these projections will survive contact with reality. The Navy’s original plan for a 355-ship fleet, established in 2016, went underfunded in the budget request for 2021. This outcome is unsurprising, since putting 355 hulls in the water has always been more of an aspiration than an executable plan, given years of insufficient funding patterns. For example, in its analysis of the service’s FY20 shipbuilding plan, the CBO concluded that planned shipbuilding costs over the next 30 years (as set forth by the Navy in its FY20 budget request) would be almost *double* what the Navy received in shipbuilding appropriations over the previous 30 years.³⁷ The Navy’s even loftier ambitions for a 500-plus-ship fleet known as Battle Force 2045, announced this past fall, are also likely dead on arrival without a serious cash infusion.³⁸

The Air Force is going in the other direction. It is reconsidering the goal of fielding 386 squadrons that it established in 2018, with the new Chief of Staff Gen. Charles Q. Brown Jr. announcing he is not attached to that number, saying, “I think about, more so, what is the capability that would give me the equivalent of 386? What things can I do?”³⁹ He continued, “What I’m really trying to do is maximize my capacity.”⁴⁰

In 2017, then-Army Chief of Staff Gen. Mark Milley said he would prefer between 540,000 and 550,000 soldiers in the active force.⁴¹ Two years later, the House Armed Services Committee’s report accompanying the FY20 National Defense Authorization Act (NDAA) explicitly noted that the service’s original FY20 request for an active force end strength of 480,000 active soldiers was below the 487,500 level set by the previous FY19 NDAA and did not reflect recent statements from Army leaders indicating that active end strength goals should be closer to 500,000 soldiers by the end of the 2020s.⁴² The final FY20 NDAA set the active force at 480,000,⁴³ but the Army actually overshot that goal by 5,000; managing fluctuating recruitment, reenlistment, and retainment numbers is an imperfect science. However, the Army’s subsequent budget request for FY21 slowed growth, adding only 900 active soldiers in FY21, and though personnel budget request documentation submitted for FY21 does not include data for the full FY21–FY25 period, Maj. Gen. Paul Chamberlain, director of the budget at the Office of the Assistant Secretary of the Army, said, “We’re going to have modest growth of about 1,000 soldiers per year for the next four or five years.”⁴⁴

On top of slow walking growth (despite the recent bump), the Army’s active-duty end strength has already been identified by many analysts as a probable bill payer for potential debt reduction drills in the near future. In March 2020, Army Lt. Gen. David Barno (ret.) and Nora Bensahel argued that “active Army and Marine Corps end strength may shrink substantially” to fund investments in next-generation technologies.⁴⁵ Writing for *Defense Priorities*, also in 2020, Gil Barndollar submitted a proposal titled “Cut the Army First.”⁴⁶ Michael O’Hanlon at the Brookings Institution endorsed a proposal from Gen. Joseph Lengyel, the head of the National Guard Bureau, to move active forces into the Army National Guard, which will achieve savings if they are not activated—so the idea works “if the overall military is somewhat less busy than before.”⁴⁷ In a *Foreign Affairs* article in October 2020, former-Secretary of State Hillary Clinton also suggested

cutting some of the Army's active armored brigade combat teams (ABCTs) and their associated personnel.⁴⁸ Despite the furor and general willingness to treat the Army as the sacrificial service, in responding to the prospect of cutting Army end strength below the high 400,000s after 2020, Army Gen. James McConville cautioned, "I think as we start to come below those numbers, we accept a risk that I would not recommend as Chief Staff of the Army."⁴⁹

The Threat Environment Is Changing Rapidly.

It's nearly cliché at this point to reiterate the various ways China and Russia will pose challenges to the United States over the coming decades, not to mention the unforeseen problems that will surely confront America. As then-Secretary of Defense Robert Gates wryly observed in 2011, "When it comes to predicting the nature and location of our next military engagements, since Vietnam, our record has been perfect. We have never once gotten it right."⁵⁰ As the 2018 National Defense Strategy stated, "The central challenge to US prosperity and security is the reemergence of long-term, strategic competition" with China and Russia.⁵¹

Both revisionist powers are bent on achieving their national objectives at the expense of other states' economic, diplomatic, and security decisions and interests. They are taking military competition with the US seriously, be that judged in China's extraordinary naval shipbuilding efforts, Russia's nuclear arsenal expansion and modernization, or a slew of other metrics and benchmarks of military might.

China's defense budget continues to climb, with the Pentagon noting in its annual *China Military Power Report* that the People's Republic of China (PRC) announced a 6.2 percent defense budget increase in early 2019, continuing more than 20 years of sustained defense spending increases.⁵² Further, the PRC's defense budget has nearly doubled since 2010. China's defense expenditures fund advancements in Chinese precision missiles;⁵³ the expansion of the People's Liberation Army Navy's (PLAN) size—overtaking the US Navy fleet back in 2019—and capabilities;⁵⁴ and targeted investments in training, operations, and modernization, paired with

expansive defense industrial-sector reforms intended to improve weapons system research, development, acquisition, testing, evaluation, and production.⁵⁵ While some analysts are quick to point out compositional differences between the US and Chinese navies, perhaps most notably including the superior US aircraft carrier fleet, Jerry Hendrix provides a ready counter: United States' competitors understand that "even the most lethal ship cannot be in more than one place at a time."⁵⁶

Like China's navy, the People's Liberation Army Air Force (PLAAF) is also undergoing rapid transformation. As summarized by Scott Harold in his 2018 RAND report on China's military aerospace goals in relation to the United States,

It is critical that the USAF [US Air Force] understand the advances that China is making in specific domains related to ISR [intelligence, surveillance, and reconnaissance], strategic and tactical lift, and strike platforms and assets, as well as power projection in and through space and against space-based satellite architectures.⁵⁷

As Harold concluded, the People's Liberation Army is focused on not just competing with the United States, but rather "detering US intervention and defeating the US military if the United States and China do come into open conflict."⁵⁸

Russia's defense spending roughly doubled between 2000 and 2017, with much of the increased expenditure going toward acquiring new matériel, according to a 2019 RAND report on the future of the Russian military.⁵⁹ The same analysis also reported that future Russian military expenditures are expected to focus on ground capabilities and conventional long-range strike systems, such as air-launched cruise missiles.⁶⁰ Other Russian investments include advanced air defenses, submarines, sophisticated offensive cyber capabilities, and anti-satellite weapons.⁶¹ The implications are expansive. Russia perceives threats from NATO enlargement. Moscow has undeniable aspirations for regional dominance, focused on former Soviet satellite states such as Ukraine and Georgia,

combined with an advantage in ground forces in Europe. In a widely circulated 2016 study based on a series of wargames, David Shlapak and Michael Johnson found that it would take Russian forces just 60 hours (max) to reach the Estonian or Latvian capitals of Tallinn and Riga at the outset of a conflict.⁶² Although critiques have been levied against the structure and assumptions that underpinned the study by analysts such as Michael Kofman—including Shlapak and Johnson’s treatment of Russian strategy and objectives—Russia’s military has only grown stronger since the study was originally published about four years ago.⁶³

The authors of the 2019 RAND report also observed that while Russia is unlikely to undertake expansive global expeditionary operations, it can still offer support to proxies that may work against US interests—including supplying advanced weapons systems.⁶⁴ China might be the undeniable long-term threat, but the US underestimates Russia to its peril. There are inherent risks in allowing US ground forces to atrophy or shrink, underinvesting in options such as improved electronic warfare (EW) capabilities and air and missile defenses to counter Russia’s long-range strike capabilities, and taking other appropriate actions. Should Russia attempt to gain a foothold in the most exposed members of NATO via subversion or a (less likely) high-intensity conflict, the US must be able to deny Russia’s war plans.

As Elbridge Colby observed at the Center for a New American Security in May 2019⁶⁵ and as an AEI report warned in 2012,⁶⁶ the era of US military superiority has ended. Now, the US “risks losing a war to China or Russia—or backing down in a crisis because it fears it would—with devastating consequences for America’s interests.”⁶⁷ Due to rapidly evolving military (and dual-use) technology and Chinese and Russian military investments, the primary concern is not that the US military is thoroughly obsolete (yet), but rather that its ability to credibly deter China and Russia is eroding precipitously—increasing the chances of a direct conflict that the US might conceivably lose or allowing the perception of the fait accompli to prevail in challengers’ minds.⁶⁸ This shifted strategic balance has vast

implications for the future of the geopolitical landscape. As Colby discussed in 2019, if US allies and partners lose ground to Russia or China—or capitulate because they fear for their territorial integrity, let alone their economic and electoral security—US alliance commitments could easily be in jeopardy.

If Concrete Actions Are Not Taken, the Choices Get Worse. Today’s strategic imperative is to bridge the gap between fielding new weapons systems that can meet the challenges of today and incorporate the technology required to contend with the threats of tomorrow, all while ensuring that defense planning is bound by fiscal, political, and technological realities. There are feasible ways to address that gap. To begin with, weapons systems should not be evaluated via a binary framework of “new” versus “legacy” platforms.⁶⁹ The US military can still wring a great deal of utility from older platforms that can be upgraded in increments to include new technologies, and the Pentagon does not have the time, track record, or funding to field entirely new fleets of aircraft, ships, or vehicles over the next five to 10 years.

Evolutionary upgrades work when revolutionary next-generation capabilities are still far away and expensive. However, the time for revisiting full-service life-extension programs for legacy weapons systems should be mostly over; they are not a good use of limited dollars. For example, as the Navy focuses more on undersea systems, no one should be suggesting a service life extension for the *Los Angeles*-class attack submarines (SSNs) to pointlessly inflate the Navy’s ship count. (This is true regardless of delays to the *Columbia*-class ballistic missile submarines or a slow build of the *Virginia*-class SSNs.) In 2019, Vice Adm. Thomas Moore, the head of Naval Sea Systems Command, observed of older ships that “the issue is really not can you keep them 50 years the issue is can they keep combat relevance?”⁷⁰ The answer to that question is complex, but the conclusion is often a resounding no.

This is true for a myriad of reasons, but two are most notable. First, older weapons systems often cannot be upgraded to the degree required to ensure their survivability and lethality in a high-end fight

even 10 years from now. They can be enormously useful proving grounds for new technologies that are continuing to advance in nonlinear ways, but they may not have the bandwidth to accommodate *enough* of these new technologies to remain relevant for the next 10 or 20 years. Even if the service lives of aircraft, ships, and vehicles can be extended, many platform frames will be outdated before they are retired. Consider the difference between *Gerald R. Ford*- and *Nimitz*-class aircraft carriers. The *Ford*-class carrier is powered by nuclear reactors that produce more than three times the electrical power of its predecessor, the *Nimitz* class. As a result, the *Ford* can support new weapons that will require significantly more power, such as directed energy, rail guns, and lasers. The *Nimitz* cannot, so concerns about its survivability in a high-end fight abound.⁷¹ As a broad rule, the military will need a lot more energy in general to power next-generation platforms, sensors, robots, artificial intelligence (AI), and more.⁷²

Such disorganization underscores the inefficiencies inherent in a system that validates pushing hard decisions off until the last possible minute as an acceptable method of conducting business.

Accordingly, the Navy is designing its new ships such as the FFG(X) for the long haul, packing them with more growth margin in terms of space, weight, power, and cooling (SWaP-C) to ensure their

relevance for extended service lives—though debates continue regarding the adequacy of growth margin provided.⁷³ Further, ensuring that new weapons systems have the capacity for necessary future growth is not a concern unique to the Navy. In describing the need for the Army's Next Generation Combat Vehicles (NGCVs) in 2018, Brig. Gen. Ross Coffman, director of the NGCV Cross-Functional Team, explained that the Bradley Fighting Vehicle had reached the limits of its growth capacity because it also could not obtain any future growth margins in SWaP-C.⁷⁴ Although aware of the challenge, the services are maxing out the growth margins of their existing platforms to their detriment. Attempts to replace the US Army's thousands of Bradleys have been underway since 2003, for example. Such disorganization underscores the inefficiencies inherent in a system that validates pushing hard decisions off until the last possible minute as an acceptable method of conducting business.⁷⁵

Second, a worrisome number of platforms are reaching or will soon reach the edge of their ability to incorporate new technologies, becoming unsustainably ancient. About 80 percent of the Air Force's roughly 2,050 fighters are A-10s, F-15C/Ds, F-15Es, and F-16C/Ds—all originally designed in the 1970s and purchased through the 1990s.⁷⁶ B-52s date back to the Dwight Eisenhower administration. This pattern cannot be interminably sustained. As Air Force leaders testified before the House Armed Services Committee's Subcommittee on Tactical Air and Land Forces in March 2020, the service's 234 F-15C/Ds reach the end of their service life in the next six to eight years, and additional life-extension programs are simply not cost-effective.⁷⁷

The Navy is astoundingly considering extending the life of a few select *Ohio*-class submarines beyond their currently intended 42 years, to provide cushion for delays to the replacement *Columbia*-class program.⁷⁸ This extension will reportedly sustain just a few *Ohio* submarines for a few months or years, since the majority of the fleet will simply be too old for another upgrade—a decision that is both strategically and financially unwise.⁷⁹

The Air Force's Minuteman III intercontinental ballistic missiles (ICBMs), the land-based leg of the

US nuclear triad, are also at the end of their service life, having first deployed in the 1970s. As Mark Gunzinger wrote in 2019, Pentagon leaders are appropriately concerned about the effectiveness of the Minuteman III against substantially advanced missile defenses and other threats to its survivability, such as the new challenges posed by EW and directed energy weapons.⁸⁰ The 2018 Nuclear Posture Review reiterated starkly, “The Minuteman III service life cannot be extended further.”⁸¹ All the services have run out of rope; there is no more time or budgetary bandwidth left to account for procurement schedule slips, cost overruns, inertia, or otherwise. As demonstrated by the potential *Ohio*-class upgrade, new procurement spending must happen now, or the force will be harmed, and the fault will be entirely our own and, worse, preventable.

What Does Addressing the Modernization Crunch Mean for the US Military in the 2020s?

The future is unlikely to be kind to a shrinking, aging US military. The DOD not only will be forced to deter high-end adversaries such as China and Russia but also will have to manage a burgeoning portfolio of “low-intensity operations,” such as counterinsurgency wars (large and small), perpetual counterterrorism, and more frequent disaster relief missions due to climate change. Without technological overmatch, adequate fleets, and inventories of equipment, service members will be shortchanged.

In 2016, former Under Secretary for Acquisition, Technology, and Logistics Frank Kendall warned that “our account for [early-stage] work is now bigger than the amount that is actually building products for production.”⁸² This statement followed a period of defense budget cuts that partly contributed to the mass reduction of weapons systems procurement programs, undertaken in the early 2010s by Gates. The GAO reported that the number of Major Defense Acquisition Programs (MDAPs) shrank from 97 in 2010 to 78 by 2016.⁸³ The resulting research and development (R&D) versus procurement investment

breakdown Kendall described makes sense only if a majority of the money spent on R&D efforts results in new platforms and capabilities entering the force. It didn’t happen. Instead, Kendall and his leadership team viewed themselves as simply providing time and options for the next administration. But without high levels of funding for new procurement, all those options generated by new R&D are largely wasted.⁸⁴ Although well-intentioned, Kendall facilitated the creation of a spending spike that led nowhere.

Today, the R&D bulge is getting so large as to preordain that even winning ideas may not bear fruit as programs of record. All too often, new technologies and capabilities supported by innovation incubators like the Defense Innovation Unit (DIU) never receive the investment they need to enter the force and support mission requirements, resulting in a so-called “valley of death” that many potentially valuable programs fall into.⁸⁵ This problem of R&D investments that lead nowhere is exacerbated by delays to existing programs of record. Further postponing major modernization programs will simply increase the total cost to address the modernization bow wave, even as that bill is passed off to the next generation.

As a result of failing to undertake necessary modernization, the military instead pays for aging platforms to stay in the force. In fact, the problem mirrors our broader national challenge with net interest.⁸⁶ Just as a quarter or more of debt growth over the next decade will be net interest on the debt itself, the military has begun to pay more to keep old equipment running, which makes it increasingly difficult to invest in new platforms. It’s a vicious cycle, often called an “acquisition death spiral.”

Besides the research and purchasing valley of death and acquisition death spiral, another main determinant of progress is stable, adequate funding regardless of acquisition reform.⁸⁷ Strong bipartisan work on acquisition in the past bodes well for our ability to modernize cost-effectively—but with the arrival of the Joe Biden administration’s competing domestic priorities and the fiscal carnage of COVID-19, the future of the US military’s much-needed modernization is dangerously uncertain. The time to begin addressing the procurement

crunch was four years ago; the US military no longer has the luxury of time.

If we fail to manage this modernization crunch, the utility of the US military as the foundation of American national power—a tool that supports our diplomatic, economic, and information efforts—will erode further.

For years, defense leaders have understood all too well the dire choices their successors will face absent a concerted push to get out ahead of the spending crunch. Consider the following statement from former Principal Deputy Under Secretary for Policy Brian McKeon in 2016.

“We’re looking at that big bow wave [crunch] and wondering how the heck we’re going to pay for it, and probably thanking our stars we won’t be here to have to answer the question,” he added with a chuckle.⁸⁸

McKeon was probably not laughing out of malice, but out of absurdity. His question—how are we going to pay for it—still demands an answer.

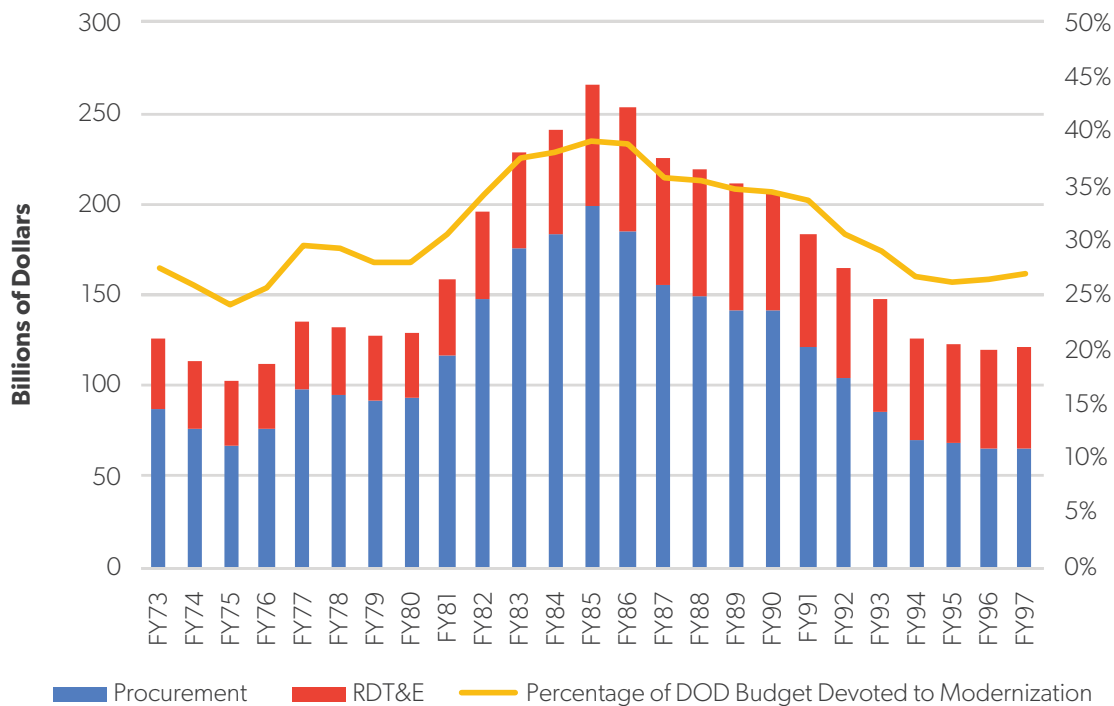
What Went Wrong: Identifying the Causes of the 2020s Modernization Crunch

Military modernization efforts can manifest in both capacity and capability. Broadly speaking, the US military usually modernizes by either investing in a smaller number of next-generation technologies or upgrading and expanding current-generation technologies. As Daniel Gouré observed at the Heritage Foundation in 2018, modernization efforts can close capability gaps, qualitatively improve capabilities, or reduce costs.⁸⁹ Gouré also noted that modernization extends well beyond hardware and software updates to include appropriate new organizations, concepts of operations, tactics, command and control systems, and supporting infrastructure.⁹⁰ When an immense number of weapons systems must be updated or recapitalized in a short period, it’s a modernization crunch.

The genesis of this decade’s impending modernization crunch begins with the late Cold War era. In the second half of his administration, President Jimmy Carter belatedly realized the fracturing of détente and initiated a buildup of America’s armed forces that his successor Reagan would embrace and expand (Figure 8). Led by then-Assistant Secretary of Defense for Research and Engineering William J. Perry, the Pentagon laid the seeds of a technological leap ahead in the early to mid-1970s that would restore American overmatch in capability. Yet high-end capability—the F-117 and B-2 stealth aircraft, Aegis surface warships, and precision munitions—were not enough for Reagan, who also desired an expansion in capacity or end strength—the size of the armed forces.⁹¹ The cumulative Reagan boost from FY83 to FY87 clocked in at \$436 billion above the average modernization spending for a decade before and after the buildup, in FY17 dollars.⁹² There has been no comparative buildup of military combat power since Reagan.

When an immense number of weapons systems must be updated or recapitalized in a short period, it’s a modernization crunch.

The US Military Is Still Largely the One Reagan Built. The United States initially reaped the benefits of this two-pronged military modernization strategy. The US successfully deterred the Soviet Union and simultaneously imposed significant costs on Moscow; both contributed somewhat to the eventual dissolution of the USSR. More starkly, this military modernization proved its cost-effectiveness in the first Gulf War. The United States possessed tangible military

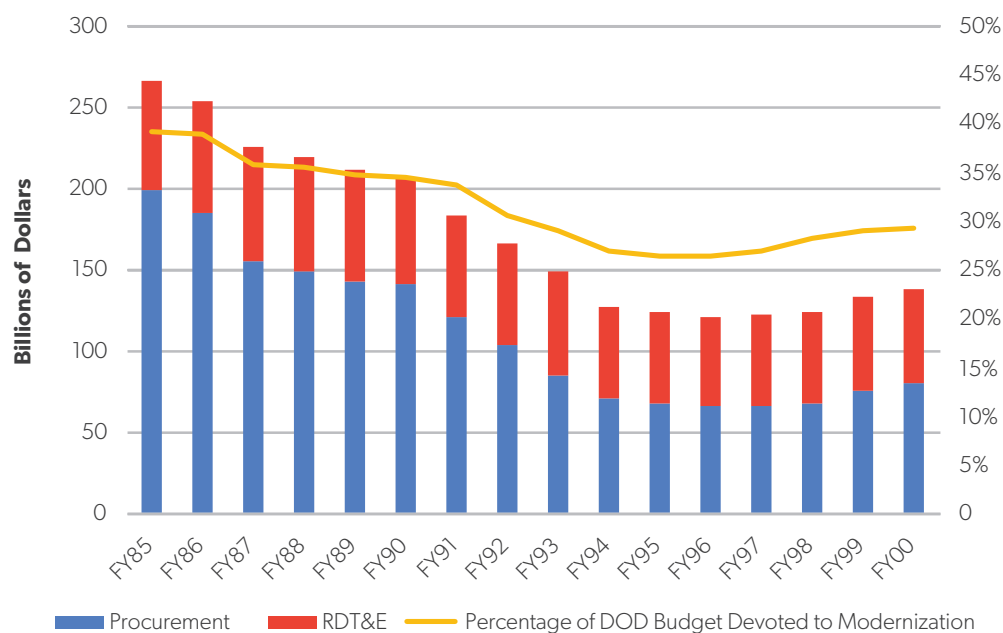
Figure 8. US Military Modernization Spending, FY 1973–FY 1997: Living Off the Reagan Buildup

Note: The figure is in FY21 constant dollars (inflation-adjusted using DOD deflators), including discretionary, mandatory, war, and supplemental funding. The “Reagan buildup” is defined as FY83–FY87, the five years with the largest total of modernization spending. Source: Under Secretary of Defense, “National Defense Budget Estimates for FY 2021 (Green Book),” April 2020, Table 6-1, https://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2021/FY21_Green_Book.pdf.

superiority not only against Iraqi forces but also *at scale*,⁹³ utterly picking apart the Iraqi military with few casualties despite predictions of thousands of American deaths.⁹⁴

Yet even as the American military achieved victories in the western Iraqi desert, policymakers were making choices that would initiate the creation of an eventual procurement crunch back in Washington, DC. The US military expected a drawdown following the Cold War—indeed, the drawdown began in the George H. W. Bush administration—but the drawdown cut deeper and lasted longer than most anticipated. By the end of the Bill Clinton administration, the Pentagon had laid out a strategy to update and replace the Reagan-era fleets. This plan hinged on justifying end strength reductions across the services with the increases in combat power delivered by new and improved military technologies.

When explaining this reasoning for the American Enterprise Institute in 2007, Robert Work used the example of advancements made to the shipboard vertical launch systems (VLS).⁹⁵ In 1989, 108 large surface combatants carried 1,525 VLS cells, with an aggregate magazine capacity of 7,133 battle-force missiles. By 2004, the Large Surface Combatant (LSC) fleet shrunk to 71, but it carried 6,923 VLS, with a fleet magazine capacity of 7,539 battle-force missiles. More revolutions in satellite-guided weapons, unmanned aerial vehicles, missile defense systems, and improved targeting and radar technology are also cited as demonstrable examples of key new battlefield technologies from the Clinton years, even as modernization spending on procurement and R&D plummeted from its peak in FY85 to a new low a decade later (Figure 9).

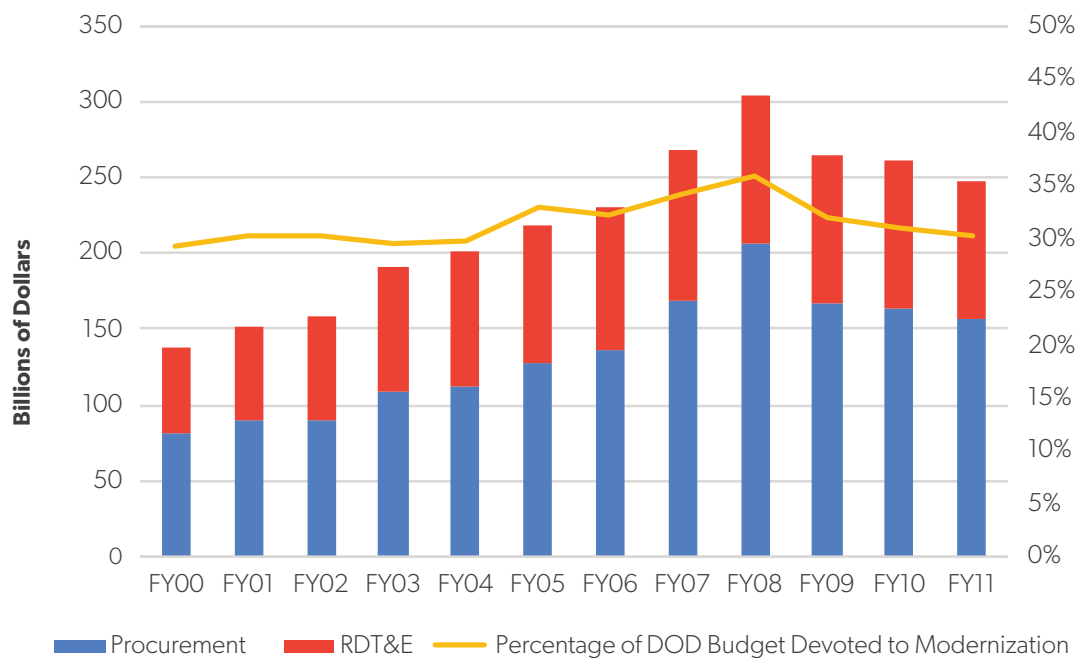
Figure 9. Modernization Spending, FY 1985–FY 2000: The 1990s Downturn

Note: The figure is in FY21 constant dollars (inflation-adjusted using DOD deflators), including discretionary, mandatory, war, and supplemental funding.

Source: Under Secretary of Defense, “National Defense Budget Estimates for FY 2021 (Green Book),” April 2020, Table 6-1, https://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2021/FY21_Green_Book.pdf.

In the 1990s, Smaller DOD Budget Spent Even Less on Weapons: Consequences of the Procurement Holiday. Enter the George W. Bush administration and Secretary Donald Rumsfeld’s Pentagon, which somewhat surprisingly shared many of the assumptions of the Clinton Pentagon as it sought to modernize. The revolution in military affairs would allow the US military to do more with less, and plans were laid to modernize the Reagan-era equipment fleets with high-tech, groundbreaking weapons systems. The terrorist attacks of September 11, 2001, and the war in Afghanistan called those plans into question; the invasion and occupation of Iraq dashed them. Entering a planned modernization period, the Pentagon found itself enmeshed in two wars that not only called for new and different equipment but also sucked the oxygen out of the modernization effort, leading to schedule delays and cost overruns on legacy or traditional weapons programs, which later become the justification for their truncation or cancellation.

Modernization During Iraq and Afghan Wars Appears Adequate. Although modernization spending increased as America went to war in the early 2000s, by 2009 the joint Clinton-Bush military modernization effort hung by a thread (Figure 10). Politically vulnerable because of outside pressures, new programs stood no chance and were killed en masse by the new administration. President Obama felt liberal pressure to curtail the military-industrial complex and defense spending, while Gates took personal offense at a military bureaucracy still focused on preparing for conventional conflict instead of pouring its full energy into the ongoing counterinsurgencies and counterterror operations in Iraq and Afghanistan.⁹⁶ The bureaucracy scaled down its plans below its own requirements and sought to shield programs from permanent death by keeping their pilot flames lit. These choices created a second round of cancellations near the turn of the decade that dwarfed the Rumsfeld cluster.

Figure 10. Modernization Spending, FY 2000–FY 2011: The Forever Wars

Note: The figure is in FY21 constant dollars (inflation-adjusted using DOD deflators), including discretionary, mandatory, war, and supplemental funding.

Source: Under Secretary of Defense, “National Defense Budget Estimates for FY 2021 (Green Book),” April 2020, Table 6-1, https://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2021/FY21_Green_Book.pdf.

The Wars’ Hollow Buildup. There’s long existed a debate over whether the wartime era represented a reprise of the Reagan buildup or an extension of the 1990s procurement holiday. Conducting analysis of the Pentagon’s Selected Acquisition Reports and blending it with the work of other analysts, I conclude that the wartime era represented a mixed bag of modernization with more characteristics of a procurement holiday. This is not to say important modernization efforts did not occur during the wars. For example, Russell Rumbaugh analyzed defense procurement from FY01 to FY10, finding that “in the past decade the Army modernized its fleets of combat and support vehicles, as well as its inventory of small arms.”⁹⁷ Rumbaugh concluded that in 2011, “The Army [had] an expanded force outfitted with the most up-to-date technology on platforms that [were] the best in the world.”⁹⁸ Even though such clear progress was effected, modernization efforts during the wars are still inflated at face value due

to a plethora of canceled programs and short-term investments that occurred over the same period.

There are, of course, well-known examples of shifting acquisition priorities during Iraq and Afghanistan—prominently including the F-22 truncation and the massive investment in Mine Resistant Ambush Protected (MRAP) vehicles—that the US military no longer uses. But how much core defense spending was actually eschewed during these wars? To answer that question, it is illustrative to revisit and expand on AET’s 2017 in-depth analysis of the department’s Selected Acquisition Reports, which detail spending for large modernization programs, to assess the scope of sunk costs during this period.⁹⁹

The DOD Spent over \$80 Billion on Canceled Programs, FY02–FY12. Compared to earlier analyses, *Repair and Rebuild* found the scope of program cancellations was slightly larger than previously considered and that deferral of spending was likely

as inefficient, if not more so. Todd Harrison at the Center for Strategic and International Studies has tabulated a list of canceled weapons programs for a while now.¹⁰⁰ Kendall's office also included a count of canceled weapons programs in its 2016 annual report detailing the performance of the acquisition system.¹⁰¹ Combining attributes of both analytic approaches while combing through Selected Acquisition Report line items, it is possible to find over \$81 billion in FY21 inflation-adjusted dollars of modernization spending on canceled weapons programs that produced little to nothing (Table 1). With a few notable exceptions, such as technology from the axed Crusader artillery system used for later Paladin artillery upgrades, these efforts rarely significantly informed their successor programs.

Additionally, this overview identified not only \$81 billion in sunk costs in just a decade but also more than \$400 billion in *deferred* modernization as a result of these cancellations (again, in FY21 inflation-adjusted dollars). Nor does this account for other large sums of canceled procurement, such as the truncation of the F-22 air superiority fighter from 750 aircraft to 187 or the *Zumwalt*-class destroyer from 32 to three, both of which generated poor returns on investment.¹⁰² This analysis also does not account for indefinitely postponed purchasing, a category of spending often neglected in these conversations. The Selected Acquisition Reports actually contain dozens of examples totaling tens of billions of dollars of deferred modernization spending that resulted in decreased efficiencies for the Pentagon. For instance, the Navy threw away half a billion dollars when it slowed procurement of its MQ-8 Fire Scout drone helicopter in 2010 to the minimum sustaining rate.¹⁰³ There are several instances of such inefficiency in every year of the Selected Acquisition Reports, with particularly egregious cases coming during periods of unexpected budgetary constraints. (See Figure 10.)

Future Priorities Compete with Urgent Needs During Defense Budget Downturns. The numbers are more troubling after combining the conclusions of this programmatic analysis with those of a significant study on rapid acquisition authority

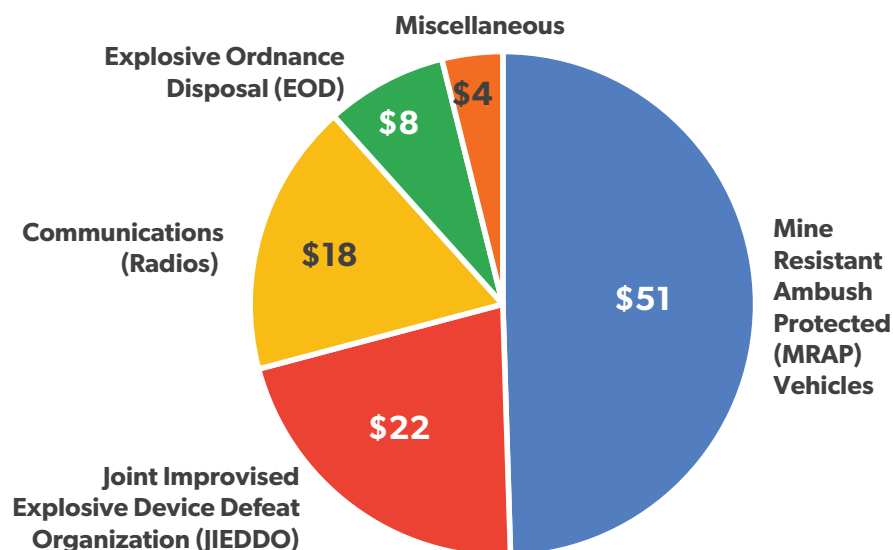
conducted by Jonathan Wong at RAND in 2016.¹⁰⁴ One of the most significant problems in assessing to what degree long-term modernization priorities suffered at the hands of immediate needs is in defining which weapons programs fall into each category. For instance, you might see this debate in arguments over incremental upgrades to Army vehicles. Proponents such as Rumbaugh note that the Army used extra wartime spending to complete its incremental upgrades faster than it would have otherwise. Detractors insist these upgrades only really treaded water in terms of maintaining capability relative to new adversary advances, such as the Russian T-14 Armata. Wong's insight is that he substitutes weapons purchased through rapid acquisition authorities for subjective assessments about whether certain weapons systems are geared toward short- or long-term needs. He concludes that the Pentagon spent at least \$103 billion (in nominal FY02–FY12 dollars, not adjusted for inflation¹⁰⁵) on procurement directly related to unforeseen wartime needs,¹⁰⁶ such as MRAPs, counter-improvised explosive device technology, and tactical radios (Figure 11).¹⁰⁷

Much Wartime Procurement Devoted to Immediate Needs. This combined approach suffers from serious limitations, but we believe it starts to shrink the margin of error and illustrate the issue more clearly. Between FY02 and FY12, over \$80 billion was spent on programs that fielded little to nothing (Table 1). Over \$400 billion of planned funding was deferred. Over \$100 billion (again, not adjusted for inflation) was spent on short-term equipment to address immediate tactical or operational challenges (Figure 11). The combination of canceled programs, deferred spending, and procurement spending for immediate needs meant a second decade after the 1990s of inadequate funding for core long-term weapons programs. This research underscores the argument an AEI report advanced in 2012. Defense budget growth after 2001 was dedicated to fighting immediate wars and making up for the trough left by budget cuts of the 1990s; little money was dedicated to improving cutting-edge capabilities for the US military.¹⁰⁸ The defense “buildup” of the 2000s

Table 1. Canceled Modernization Programs, FY 2002–FY 2012, Millions of FY 2021 Dollars

Service	Program	Sunk Cost	Future Funding Deferred	Follow-On
Army	FCS	\$22,058	\$172,283	Numerous
Army	RAH-66 Comanche	\$10,845	\$54,893	ARH
MDA	ABL	\$5,444	\$3,167	—
Air Force	TSAT	\$4,246	\$25,841	AEHF/WGS
Navy	EFV	\$4,001	\$14,911	ACV 2.0
Army	MEADS Fire Unit	\$3,736	\$21,722	PAC-3 Mod
Air Force	NPOESS DWSS	\$3,696	\$9,769	N/A (JPSS)
Navy	VH-71 Presidential Helo	\$3,292	\$5,054	VH-72A
Army	Crusader SPH	\$3,104	\$13,057	—
Army	JLENS	\$2,650	\$6,549	—
Air Force	C-130 AMP	\$2,597	\$4,840	AMP Inc 1
Army	ATACMS-BAT	\$2,044	\$5,838	—
Army	JTRS GMR	\$1,951	\$20,613	JTRS (Harris)
Army	Inc 1 E-IBCT	\$1,499	\$1,822	—
Air Force	ECSS	\$1,139	—	TBD
Joint	DIMHRS	\$1,013	—	Multiple
Navy	ASDS	\$979	\$1,723	JMMS, DCS
Air Force	B-1 CMUP	\$926	\$1,333	—
Army	Land Warrior	\$847	\$10,680	Nett Warrior
Navy	RMS	\$835	\$886	TBD
MDA	KEI/MKV	\$827	\$6,375	RKV/MOKV
Air Force	E-10	\$790	—	JSTARS Recap
Navy	ADS	\$683	\$1,141	—
Army	ARH	\$665	\$5,876	FVL CS 1
Navy	ERM	\$505	\$1,377	TBD
MDA	PTSS	\$462	\$1,363	—
Army	Joint Common Missile	\$400	\$10,718	JAGM
Navy	CG(X)	\$180	—	FSC
TOTAL		\$81,415	\$401,832	

Source: US Department of Defense, Selected Acquisition Reports, FY00–FY12; and Under Secretary of Defense, “National Defense Budget Estimates for FY 2021 (Green Book),” April 2020, Table 5-6, https://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2021/FY21_Green_Book.pdf.

Figure 11. Short-Term Acquisition Priorities, FY 2002–FY 2012, in Billions

Note: The figure is in current-year FY02–FY12 dollars, not adjusted for inflation.

Source: US Department of Defense, Selected Acquisition Reports, FY01–FY15; and Jonathan P. Wong, “Balancing Immediate and Long-Term Defense Investments,” RAND Corporation, 2016, https://www.rand.org/pubs/rgs_dissertations/RGSD378.html.

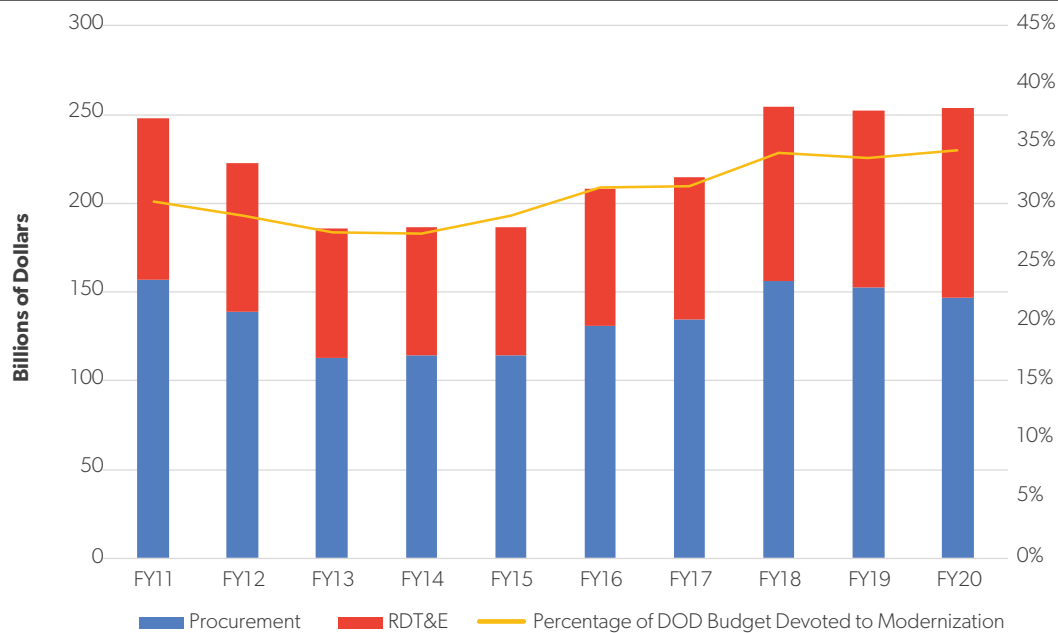
was hollow, lacking revolutionary investments. Today, the US military is in the middle of a future that was mortgaged to pay for the wars of yesterday (and today) in the Middle East.

The Sequestration Years. In 2011, following the hollow buildup of the 2000s, Congress and the president’s failure to agree on entitlement and other reforms resulted in the BCA. Two years later, the BCA led to the sequestration of 2013, which swung a budgetary axe mostly on discretionary funding, half of which sustains the US military.¹⁰⁹ The Pentagon responded largely by canceling dozens of programs permanently and delaying almost everything else except for present-day needs (Figure 12). Leaders calculated they could accept risk in the mid to long term, as long as large swaths of troops were still engaged in ongoing conflicts and another large part stood ready to fight on a moment’s notice.

Unfortunately, the outside world stepped in and ruined those risk calculations. Even as the military watched its end strength shrink and its modernization

portfolio slowly evaporate amid continued sequestration, policymakers demanded increased operational tempos to deal with burgeoning threats, the new détente with Russia collapsed, and China began to seriously throw its weight around.

The BCA Killed the Pentagon’s Pivot to Great-Power Threats. In testimony before the Senate Budget Committee in February 2019, Theresa Gullo from the CBO pointed out that defense outlays fell by 21 percent between 2011 and 2018, even though discretionary appropriations have consistently exceeded BCA budget caps due to legislative adjustments.¹¹⁰ During this era, the Pentagon did not abandon its modernization ambitions, but it constantly shunted programs to another year or beyond the FYDP entirely—all-too-nebulous futures that rarely arrive. Three decades after the Reagan buildup, leaders in the executive and legislative branches keep reaching for the same “solution” of cutting modernization to buy immediate priorities. The consequences continue to unfold in real time, and most manifest through

Figure 12. Modernization Spending, FY 2011–FY 2020

Note: The figure is in FY21 constant dollars (inflation-adjusted using DOD deflators), including discretionary, mandatory, war, and supplemental funding.

Source: Under Secretary of Defense, “National Defense Budget Estimates for FY 2021 (Green Book),” April 2020, Table 6-1, https://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2021/FY21_Green_Book.pdf.

horrific mishap rates across the services—increasingly leading to preventable deaths of service members in a period of unsteady but relative peace.

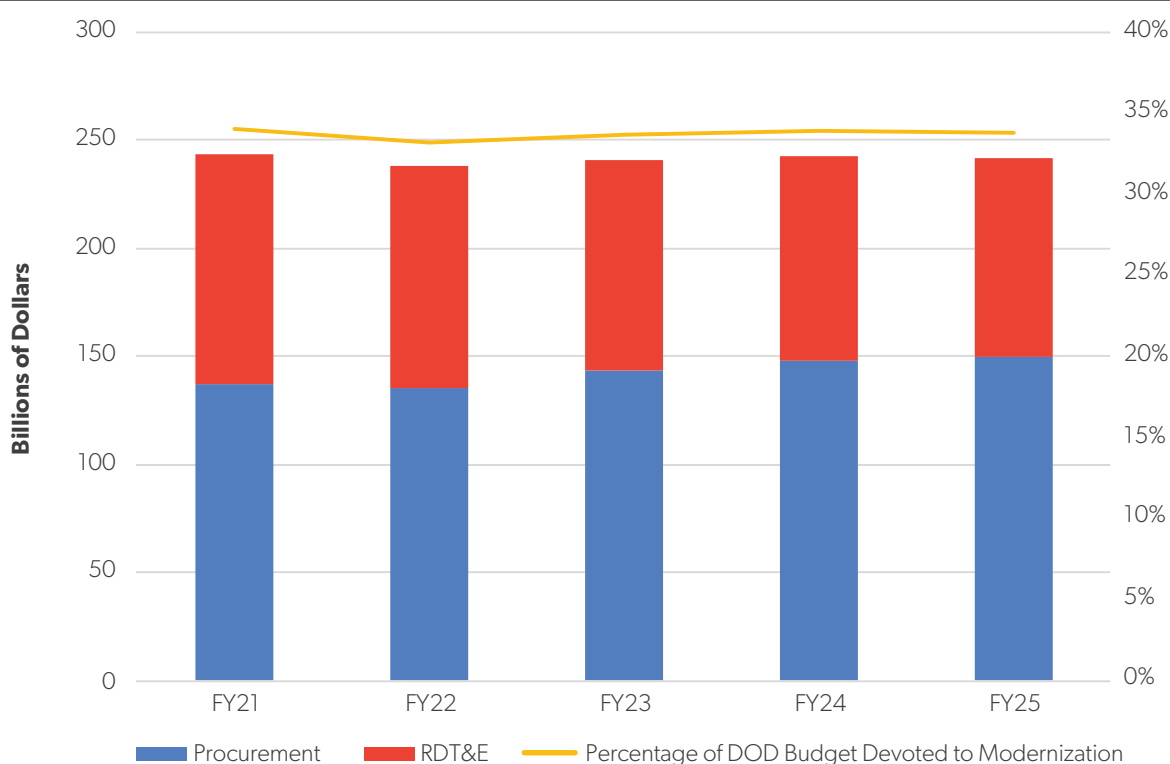
To fund new long-term investments and fence off readiness and end strength, the services initially delayed significant chunks of their procurement portfolios, dating back even to the FY17 presidential budget request when the Trump administration still set ambitious budgets. Often, the services didn’t *permanently* cut much; they merely pushed the costs into the future. Funding for dozens of line items was pushed beyond five years so that it did not “count” for the Pentagon’s budgetary purposes. In the FY17 request, for example, five fewer F-35s were planned for purchase, and another 40 jets were pushed beyond 2021, the end of the FY17 FYDP.¹¹¹

Disconcertingly, defense budget realities mean this practice has largely not changed (Figure 13). In the FY21 budget request, the Air Force requested 19 fewer F-35s than it received funds to buy in FY20 (though Congress added to this request),¹¹² despite

former Air Force Chief of Staff Gen. David Goldfein’s underscoring of the service’s need to buy 72 new aircraft a year.¹¹³ Further, the Air Force proposed steep retirements for a range of other aging aircraft in FY21 to free up cash, at least partly for new networking investments such as Advanced Battle Management System (ABMS), even though demand for Air Force missions is still so high that squadrons must continue to operate at a breakneck pace, with thoroughly insufficient levels of readiness.¹¹⁴

The Pentagon, White House, and Congress know the base budget for the DOD has been inadequate and arbitrary during the BCA years, demonstrated in part by all parties’ substantial reliance on the Pentagon’s war spending account for OCO, which became a workaround for funding many base requirements for the department (Figure 14).

Most recently, in its FY21 budget request, the DOD identified roughly \$16 billion (23 percent of the total request) in OCO dedicated to the military’s basic, everyday activities that do not relate to

Figure 13. Modernization Spending, FY 2021–FY 2025

Note: The figure is in FY21 constant dollars (inflation-adjusted using DOD deflators), including discretionary, mandatory, war, and supplemental funding. The FY21 total reflects the president's budget requested, not enacted funding.

Source: Under Secretary of Defense, "National Defense Budget Estimates for FY 2021 (Green Book)," April 2020, Table 6-1, https://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2021/FY21_Green_Book.pdf

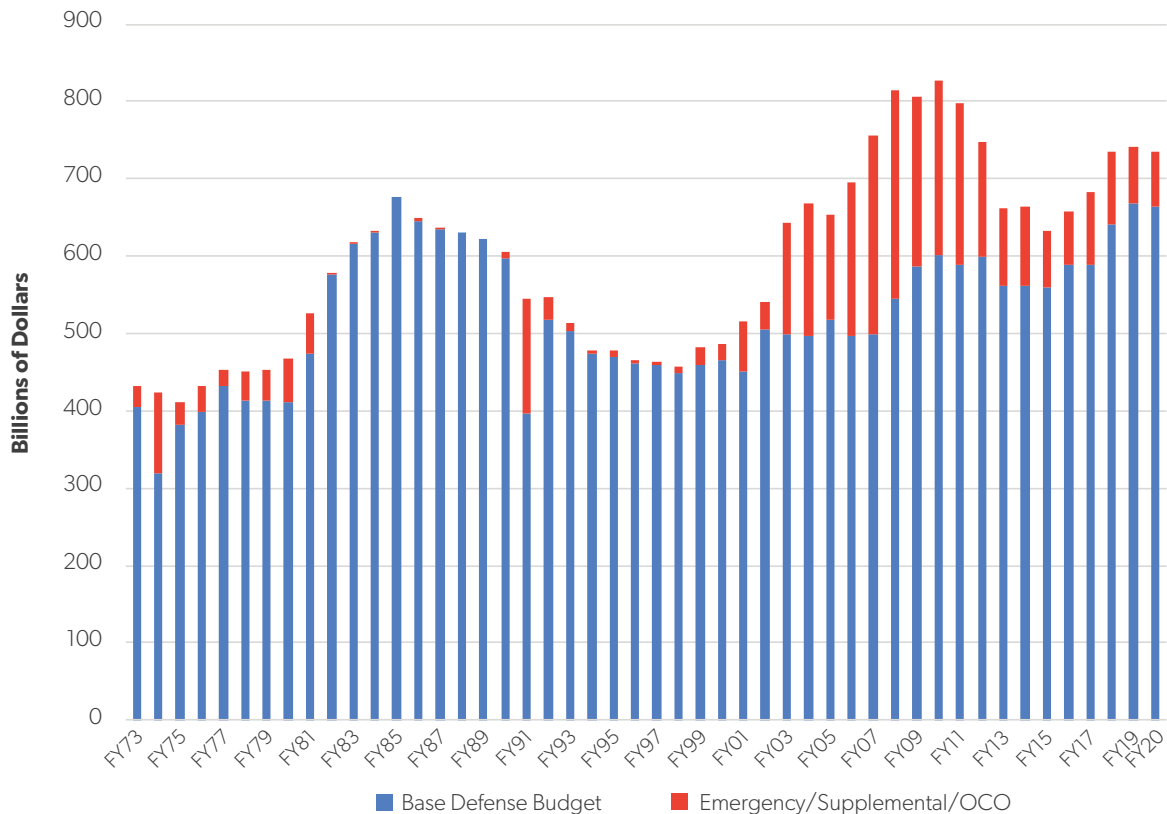
ongoing conflicts, underscoring the extent to which OCO has been used to fund activities that truly belong in the DOD base budget. Separately, roughly \$53 billion of the OCO budget request for FY21 qualified as "real OCO" for enduring and direct costs related to troops in combat and combat operations (Figure 15).

The Department of Defense's Modernization Bill Is Not Alone. In addition to an outstanding tri-service modernization bill, a slew of complicating factors will contribute to rising defense costs over the next 10 years.

In its analysis of the FY21 FYDP, the CBO found that costs for the Military Health System (MHS) will increase roughly 2 percent annually, on top of economy-wide inflation. The CBO concludes, "At that

rate, costs for the MHS would grow by 22 percent from 2025 to 2035, from \$50 billion to about \$61 billion."¹¹⁵ More broadly, while the total amount spent to fund military personnel has remained relatively flat over time,¹¹⁶ the cost per person of active-duty personnel has risen dramatically.¹¹⁷ The result is a much smaller force for the same personnel costs as decades ago. That's not necessarily a problem; military personnel are professionals and should be compensated as such. Still, it is a notable development to keep in mind when considering broad trends in defense budget accounts.

Separately, practically annual budgetary uncertainty resulting from continuing resolutions over the past decade have resulted in misaligned dollars, delayed starts to new weapons programs or restricted production, and general waste because of duplicated work, higher prices, and contracting delays.¹¹⁸ As the

Figure 14. Emergency, Supplemental, and OCO Funding, FY 1973–FY 2020

Note: The figure is in FY21 dollars, inflation-adjusted using the Office of Management and Budget Table 10.1 deflators for defense. Source: Under Secretary of Defense, “National Defense Budget Estimates for FY 2021 (Green Book),” April 2020, Tables 2-1 and 6-1, https://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2021/FY21_Green_Book.pdf; Congressional Budget Office, *Funding for Overseas Contingency Operations and Its Impact on Defense Spending*, October 23, 2018, <https://www.cbo.gov/publication/54219>; and Office of Management and Budget, “Table 10.1: Gross Domestic Product and Deflators Used in the Historical Tables: 1940–2025,” https://www.whitehouse.gov/wp-content/uploads/2020/02/hist10z1_fy21.xlsx.

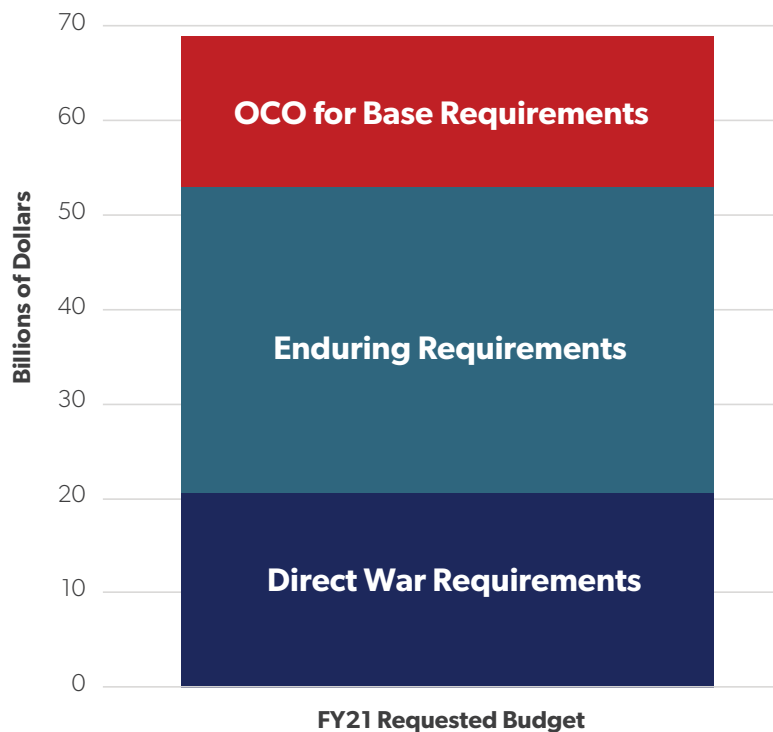
era of the BCA comes to an end, designing a new federal budget regime may lead to still more delays and wasteful stop-gap funding measures.

William Greenwalt has noted that outdated defense budget processes, among “the last bastions of Soviet-style central planning in the world,” hurt development time, innovation, and the adoption of new ideas and concepts.¹¹⁹ Constant combatant commander demand for forces around the world are straining the readiness gains of the past several years, increasing wear and tear on existing ships, aircraft, and vehicles.¹²⁰

For nuclear forces—in addition to modernizing the nuclear triad of submarines, bombers, and ICBMs—the Department of Energy’s National

Nuclear Security Administration (NNSA) is also undertaking four modernization programs: life extension programs for the B61-12¹²¹ and the W80-4 and modifications for the W87-1 and the W88 Alteration 370.¹²² It also plans to begin new programs, such as the W93 (\$53 million in the FY21 budget request), a submarine-launched ballistic missile warhead. While the W88 and B61 programs are projected to be completed by 2025, the W80 and W87 programs will easily continue through 2031.¹²³

In 2017, the GAO warned that the NNSA made optimistic assumptions about the future-year costs of its nuclear arsenal modernization programs and noted that costs during 2022–26 would require a

Figure 15. OCO Used for Base Requirements in the FY 2021 Defense Budget Request

Source: Department of Defense, "Overview—FY2021 Defense Budget," February 2020, https://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2021/fy2021_Budget_Request_Overview_Book.pdf#page=66.

sharp increase in funding to be feasible.¹²⁴ This spike is beginning to hit now, as the NNSA's FY21 budget request of \$15.6 billion was a 25 percent increase above the NNSA's 2020 appropriation, and the administration intends to ask for \$81 billion through 2026 for weapons activities, a roughly 24 percent increase over the NNSA's budget plans for the same period in 2020.¹²⁵

Even if the scale of these warhead programs were reduced, the NNSA still has high fixed costs, as it is currently managing multibillion dollar construction projects necessary to modernize the infrastructure used to produce the components and materials required in the weapon programs. These infrastructure costs in particular will be difficult to sidestep or push off because, as then-NNSA Administrator Lisa Gordon-Hagerty warned in September 2020, "Sixty percent of NNSA's

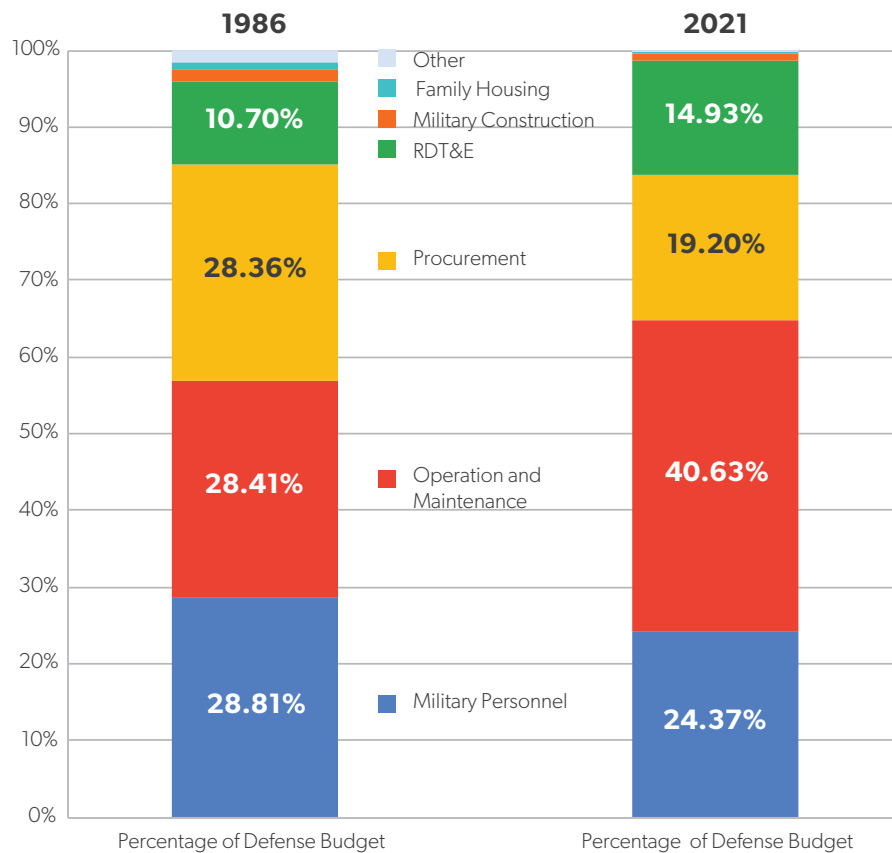
facilities are more than 40 years old and nearly forty percent are in poor condition."¹²⁶ This list can easily continue, but unfortunately, every complicating factor contributing to rising national defense costs is beyond the scope of this analysis. To stretch the personal budget comparison, it is perhaps enough for now to emphasize that just because you're addressing one set of bills—for your house, car, or child's education—that does not prevent the water, electricity, and internet bills from continuing to arrive.

Without Tackling Modernization Bow Wave, the DOD Will Remain Stuck in Acquisition Death Spiral. It is particularly illustrative to compare the impending modernization dash of today to the peak of the Reagan buildup in the 1980s. The presidential budget request for FY21 squeezed modernization spending to fund O&M costs. Compared to 1986, the FY21 military personnel budget remains roughly the same, albeit for a much smaller force.

The real story is in the aging of Reagan-era weapons systems and the exponentially increasing maintenance costs (highlighted by O&M spending in Figure 16) on these older systems—crowding out investments in their replacements today.

Defense Budgeting After COVID-19: Expanding Spending Priorities Stress the Federal Budget.

The current modernization crunch is a perfect storm of our own making, but the damage and human tragedy wrecked by COVID-19 is the opposite. The terrible immensity of the virus that swept around the world in 2020 is extraordinary, and the consequences were not anticipated by the public or private sectors. With the defense budget, there are several key points to keep in mind because the national and DOD-specific consequences of the pandemic will affect where

Figure 16. Reagan Modernization vs. FY 2021 Modernization by Appropriations Title

Note: The figure is in FY21 constant dollars (inflation-adjusted using DOD deflators), including discretionary, mandatory, war, and supplemental funding. The FY21 total reflects the president's budget request, not enacted funding.

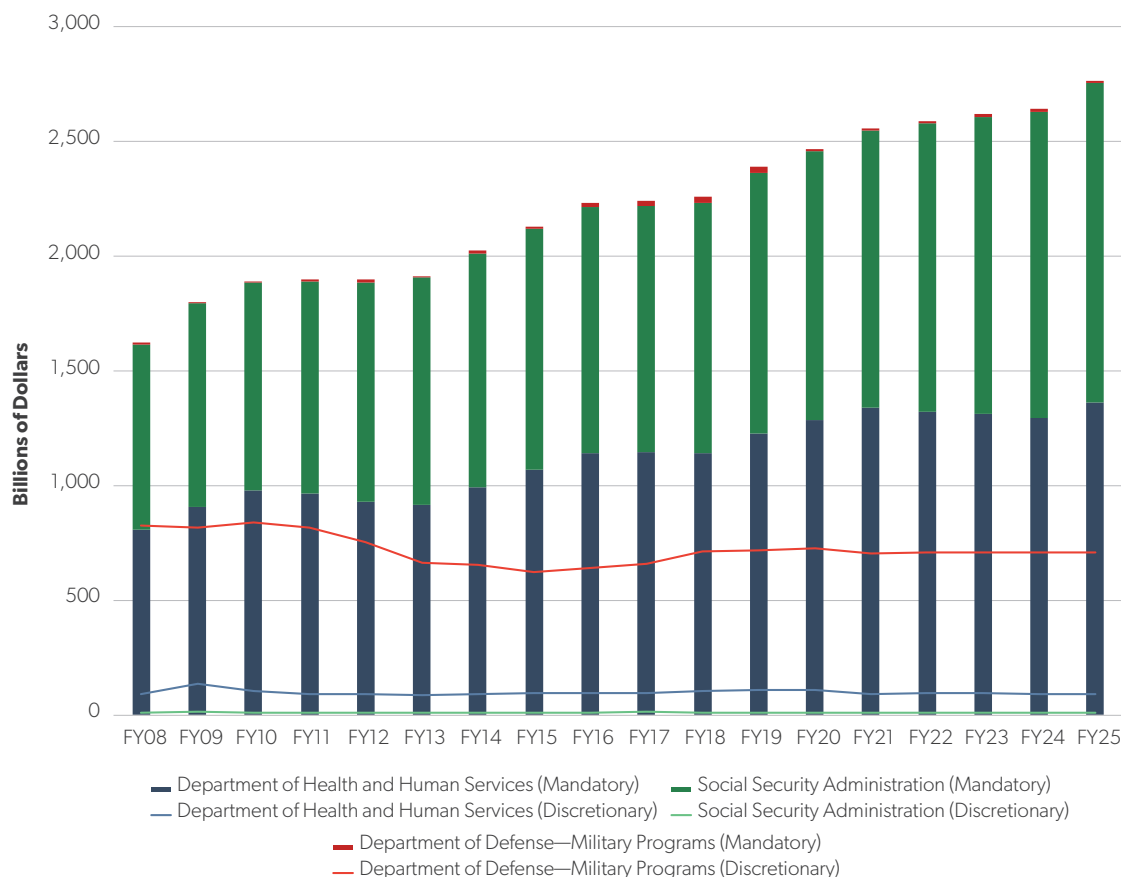
Source: Under Secretary of Defense, "National Defense Budget Estimates for FY 2021 (Green Book)," April 2020, Table 6-1, https://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2021/FY21_Green_Book.pdf.

and how the Pentagon will spend increasingly constrained resources.

First, the future of readiness and training for the force is uncertain. Mark Cancian at the Center for Strategic and International Studies noted this in October 2020. In spring 2020, the services shut down training and paused the induction of new recruits for basic training, and though deployments and training have since restarted, precautions are still in place.¹²⁷ Sustaining the health of the force is imperative for the DOD, but ensuring that supplies, training schedules, and other necessary health and safety precautions are in place will have ripple effects that are currently unclear.

Second, the rising national debt and deficits, plus a slowly recovering economy, spell trouble for the defense budget topline. In the short term, most analysts expect only 0–2 percent budget topline cuts in FY22 and probably FY23. That 0–2 percent is a murky metric, because it is not entirely clear which defense budget topline will be cut by 0–2 percent (i.e., the base budget, the base budget plus OCO, etc.).

In the longer term, over the next 10 and 20 years, the defense budget outlook is more dire. Based on analysis conducted by the Committee for a Responsible Federal Budget (CFRB) on the CBO's adjusted 2020 long-term budget outlook, rising health, interest, and retirement costs are driving federal spending

Figure 17. Mandatory and Discretionary Spending for Selected Departments and Agencies, FY 2008–FY 2025

Note: To standardize across different departments and agencies, this figure is in FY21 dollars, adjusted for inflation using the gross domestic product Chained Price Index published in the Office of Management and Budget Table 10.1 with a base year of FY21.

Source: Office of Management and Budget, “Table 5.2—Budget Authority by Agency: 1976–2025,” https://www.whitehouse.gov/wp-content/uploads/2020/02/hist05z2_fy21.xlsx; Office of Management and Budget, “Table 5.4—Discretionary Budget Authority by Agency: 1976–2025,” https://www.whitehouse.gov/wp-content/uploads/2020/02/hist05z4_fy21.xlsx; and Office of Management and Budget, “Table 10.1—Gross Domestic Product and Deflators Used in the Historical Tables: 1940–2025,” https://www.whitehouse.gov/wp-content/uploads/2020/02/hist10z1_fy21.xlsx.

growth.¹²⁸ Even before the pandemic, CFRB predicted that interest payments on the national debt would surpass defense spending by 2024.¹²⁹ Combined, spending on Social Security, major health care programs, and interest on the national debt will rise to 23.6 percent of gross domestic product by 2050 from their current 12-odd percent. Essentially all these nondefense, largely mandatory spending categories are likely to increase in the future—and they were expected to do so well before the pandemic began, as

demonstrated by the Trump administration’s budget request for FY21 (Figure 17).

Further, interest rates are low right now because the economy is struggling, but high and rising debt will eventually put pressure on them to climb. High levels of debt mean even small increases to interest rates result in substantially higher interest payments. The CBO’s projections were also based on spending projections under current law, not what the federal government *might* spend in the future if

the Biden administration extends health care coverage and Social Security. Hikes to federal spending right now will also not be offset with tax revenues from a strong economy. High mandatory spending could further squeeze the defense budget.

Third, the pandemic is damaging the defense industrial base—a workforce designated “essential” largely by the Department of Homeland Security. Current programs were delayed due to social distancing and other requirements for factories, and contract costs shot up as firms paid to retain talent that could not work due to lockdowns.¹³⁰ While the preliminary congressional response was robust—with dollars for the DOD included in the stimulus bills—a series of overly sensationalized and inaccurate depictions of how the DOD spent its stimulus dollars are worrisome. The defense industrial base is designed for efficiency; it is highly dependent on second- and third-tier suppliers and subcontractors, so if the defense industrial base faces extended damage from the pandemic, particularly without congressional support, it may well take years to recover.¹³¹ The ramifications of a limited national security base do not bode well for procurement efforts.

Fourth, there are hidden externalities that may well compound the consequences of a damaged national security industry. Small, innovative companies—precisely whom the DOD intends to work with more closely—are uniquely a risk because it is easy for them to go bankrupt due to their tight operating margins. Further, the potential cost increases imposed by new legislation that would force US defense contractors to re-shore a higher percentage of their supply chains could easily strain middle-tier suppliers when they also have slim margins for error.

Fifth and finally, the COVID-19 pandemic contributed to two concerning lines of policy debate: either health care infrastructure should be expanded at the expense of defense or the definition of national security should be made so broad that the Pentagon could conceivably be made responsible for more comprehensive domestic interests in the future. Neither discussion is productive. Public safety and national security are equally important. That is because the military only supports the former mission while it

helps lead the latter, just as it should be.¹³² Forcing Americans to make a binary choice between one and the other demonstrates a lack of judiciousness and foresight.

Additionally, some would charge the DOD with more responsibility for confronting so-called “soft” national security threats such as infectious diseases. This is also ill-advised, but for different reasons. Asking the Pentagon to be responsible for an ever-expanding menu of responsibilities—domestic or otherwise—serves no one. The US military already supports election security, drug interdiction operations, counter-piracy missions, and more missions outside its core competencies. Rather than advancing a ruthless implementation of the 2018 National Defense Strategy, these tangential demands work against the interests of nonmilitary departments and the services as they struggle to balance their under-resourced responsibilities. Kori Schake summarized the challenge in October 2020.

We often resort to military force because the military can be thrust into difficult circumstances and can figure out how to achieve what elected officials want done. But we should build that capacity throughout our national security agencies, not continue to assign to the military functions that are inherently civilian in nature.¹³³

Modernization in the Era of Sequestration and Its Aftermath. The sum of defense funding trends since the Reagan buildup shows a stubbornly enduring strategy-resource mismatch for the US military. Further, it’s not clear what the total, all-in bill would be for the DOD if it budgeted for its full needs, including modernization efforts, personnel costs, and basic operations. However, without striking and sustaining the right balance for these spending accounts, modernization programs across the department will be shortchanged. At the lowest possible estimate, the CBO found that the requested current program of record for FY21 will require an additional \$77 billion over its current funding levels to be executed.¹³⁴ Pushed further out, when combined with end strength and readiness needs,

the total investment needed over the next 10 to 15 years likely tops \$1 trillion, a figure that numerous independent assessments agree on. In a fall 2016 testimony, then–House Armed Services Committee Staff Director Bob Simmons noted that over a trillion dollars would be needed “to put the military back on its feet.”¹³⁵ When analyzing the potential impact of COVID-19 on the DOD, analysis from Daniel Egel et al. held the defense budget at a steady 3.2 percent of gross domestic product; given the damage done to the US economy, they found that “the potential losses to DoD from COVID-19 would be roughly comparable to a second sequestration.”¹³⁶ With a flat or declining budget for the foreseeable future, far from climbing a mountain of deferred modernization spending, the DOD will be—once again—launched off a cliff in the wrong direction, likely scrambling for more short-term fixes on the way down.

The Shape and Size of the Tri-Service Modernization Crunch

The 2020s modernization crunch consists of several parts, with different timelines. In general, this report has evaluated program costs using two distinct time frames. The first time frame is the FY21 five-year FYDP, from FY21 to FY25, inclusive.¹³⁷ Program-specific procurement and research, development, test, and evaluation (RDT&E) data were largely reported by the DOD for these years as part of the department’s budget request for FY21. The second time frame is from FY26 to FY31, inclusive, to cover a 10-year projection period beyond FY21, sometimes referenced as the “FY26 FYDP” for this report. Separately, while the FY21 NDAA has been passed, the following cost analysis is based on the DOD’s FY21 budget request. Still, updates and commentary have been added when possible to reflect the FY21 enacted budget.

For this analysis, a “platform” denotes any individual weapons system, such as a ship, vehicle, or aircraft. “Modernization” describes the entire military acquisition effort: procurement and R&D and

replacing and recapitalizing the fleets and inventories of the services. For our purposes, “upgrading or modifying” means making changes to existing weapons platforms. “Recapitalizing” is keeping up with the Jones’; it means procuring new platforms that essentially do the same thing as the old platforms do but more efficiently. “Replacing” is procuring new platforms that do things the old platforms simply cannot.

To begin, it is important to clarify a few misconceptions surrounding procurement, particularly around “unwanted” or “unrequested” procurements and the nature of modernization efforts.

First, the military services have “programmed” spending. This spending is hardwired into the yearly budget request and its five-year spending outlook, and much of it is already contracted out to various companies of the defense industrial base. Existing programs fall under this category. Sensationalist articles occasionally refer to Congress spending money on programs “the military didn’t request” or “that the Pentagon doesn’t want.”¹³⁸ The purchasing of additional M1 Abrams tank upgrades in 2013 serves as a famous case.¹³⁹ Yet beyond fetishizing the executive branch and minimizing Congress’ role, these stories are fundamentally disingenuous.

The continued atrophy of defense budgets with concomitant instability has deeply perverted the procurement process. The military services maintain their own lists of equipment priorities. It is only in jamming those requirements into the funding strait-jacket imposed by the Office of Management and Budget (and, by extension, civilian political leadership at the Pentagon) that uniformed military leaders are forced to make trade-offs between requirements. Take the tanks, for instance. Then–Army Chief of Staff Raymond T. Odierno would undoubtedly have loved to invest in Abrams upgrades so that his reserve formations did not enter battle with outdated equipment. Yet getting his formations more training time amid historically low readiness levels obviously took precedence. This same dynamic plays out year after year when the services submit their respective “Unfunded Priorities List”—requirements that did not fit into the budget space that the secretary of

defense offered the services. Congress granting more funding for these “unfunded priorities” is not spending the military doesn’t want; it’s spending the military often needs.

Second, the military services have “planned” spending. This is spending that fits into the Pentagon’s longer-term planning but falls outside the five-year budget window or has yet to transition to “programmed” spending. For example, the vast majority of nuclear modernization funding is planned spending for our purposes. A portion of this total bill is currently programmed—the *Columbia* program, B-21 bomber, and Ground Based Strategic Deterrent—but much of it falls beyond the five-year window. Still, Pentagon officials repeatedly articulate the priority given nuclear modernization funding, so it can be considered planned spending likely to become programmed spending. Additionally, programs such as the *Virginia*-class nuclear attack subs are core programs unlikely to disappear from the programmed budget beyond the five-year window, but they often do not come with overall cost estimates, or those cost estimates shift frequently in associated budget documentation such as the Selected Acquisition Reports. These data anomalies make it difficult to compare long-term modernization plans.

Third, estimations of “probable” spending in this report are based on likely purchases that are not programmed or planned yet but remain probable based on outside cost estimates and the status of current weapons platforms. For example, this analysis tracks with the CBO’s 2018 assumption that the

Air Force will continue buying C-130Js throughout the 2020s.¹⁴⁰

In the next section, the modernization crunch of each military service is previewed according to its programmed, planned, and probable funding. Adjustments are not made for historical cost growth or inflation in the cost of labor and parts, as the Navy’s shipbuilding costs are by the CBO, for example. Additionally, this analysis and sketch relies more heavily on qualitative rather than quantitative analysis. Several other analysts have completed quantitative analyses that seek to project the likely cost and timing of each service’s modernization crunch. Given massive chunks of funding with no cost estimates (as with the Air Force’s long-term aircraft replacement plans) and the uncertainty of existing and conflicting plans—the fate of the Navy’s latest Battle Force 2045 shipbuilding plan remains to be seen once it reaches Congress in the FY22 budget request—this report attempts to explain where assumptions were made and aims to remain conservative and discuss existing ambiguities.

In keeping with this analytical objective, unless RDT&E data were available beyond the FY21 FYDP in the primary source material, they were not included or projected. These limitations must be emphasized because it is important to underscore that while the budget numbers are crucial for framing the scale of the challenge facing each service, a 10-year projection will inherently be rough and subject to change. However, the underpinning trends informing the projections are likely to remain true over the next decade.

The Navy: The Conspicuous Modernization Crunch

Of all the services, Navy leadership usually best articulates the severity of its approaching crunch. The sea services possess significant advantages in both an analytical and legislative context. Armed with long-range shipbuilding forecasting, a dedicated congressional naval caucus, and a 355-ship goal enshrined in executive and legislative policy, Navy leadership began sending up flares about the modernization crunch years ago.¹⁴¹ Annually, the CBO also sounds the alarm.

If the Navy received the same average annual amount of funding (in constant dollars) for ship construction in each of the next 30 years that it has received over the past three decades, the service would not be able to afford its 2020 shipbuilding plan. . . . CBO's estimate of \$31.0 billion per year for the full cost of the plan is almost double the \$16.0 billion the Navy has received in annual appropriations, on average, over the past 30 years for all activities funded by its shipbuilding account.¹⁴²

This unified effort delivered results, or at least generated awareness, in the past. In 2014, former House Armed Services Subcommittee on Seapower and Projection Forces Chairman Rep. Randy Forbes (R-VA) led an attempt to preempt the crunch. Forbes and the naval caucus established the National Sea-Based Deterrence Fund in the 2015 NDAA by arguing the Navy's replacement program for the *Ohio*-class submarines (the later-named *Columbia* class) counted as a "national asset" and therefore should not be included in the Navy's own shipbuilding account. The fund is still used today, and it has been expanded in recent years to include all nuclear-powered ships,¹⁴³ with the Navy reprogramming dollars into the account since it

provides special contracting authorities.¹⁴⁴ Still, without topline growth, the fund's budget remains little more than an accounting gimmick that largely serves to shunt money around.¹⁴⁵

More concretely, the Navy has benefited from accelerated acquisition authorities, many of which originated in the 2016 NDAA, specifically employing them in support of new unmanned platforms, though Congress has since asked for more background on acquisition strategy management for such programs.¹⁴⁶ Almost all the Navy's accounts for procuring ships and aircraft also have multiyear procurement authority or similar contracting authorities that lock in better efficiency at the expense of flexibility.

Because the Navy submits a 30-year shipbuilding plan with its budget request each year, outside analysts—such as the venerable Eric Labs and Ronald O'Rourke—can look beyond the present to estimate spending far into the future, speculative as it may be. The Navy also published an R&D companion to its annual shipbuilding strategy in 2018.¹⁴⁷ By contrast, the Air Force's aviation plan is muddled by ever-shifting metrics, and the Army's long-range procurement documents avoid openly stating desired procurement numbers. This same contrast is evidenced in the Navy's 2016 Naval Aviation Vision, which contains only rough timelines.¹⁴⁸

Similarly, the Pentagon's decision to stop producing its annual aviation inventory and funding plan in 2019—which had been sent to Congress for nearly a decade—does not help the services formulate a compelling aviation requirements signal, in comparison to the shipbuilding crisis demonstrated annually by the Navy's shipbuilding plans.¹⁴⁹ In one sense, this is understandable; the service life for ships can reach several decades, and managing the limited capacity

of shipyards requires years of advanced planning, so there is far greater clarity on exactly what the Navy will be buying in the future and how much those ships will cost. By comparison, while other services may advance a detailed sketch of their long-range needs, such as the Air Force's 386-squadron goal, such plans are often more flexible. Still, a positive shift is reflected in Section 151 of the conference report for the FY21 NDAA, which reinstates the delivery of yearly aviation procurement plans. This is a smart move, and using it to launch a better long-term planning document for the Air Force would be yet another step in the right direction.¹⁵⁰ Separately, the story of the Navy's shipbuilding deficit also benefits from the independent cost estimates completed by the CBO, an analysis not completed or publicly available for large parts of the Air Force or Army, with only tangentially related reports available such as the past two years of CBO reports on the cost of replacing the DOD's aviation fleets.¹⁵¹

In the Navy's case, its short-term 2020s procurement crunch centers on shipbuilding, partly because the Navy's aviation modernization is largely wrapping up, relatively speaking. After dropping to only 271 battle-force ships in 2015,¹⁵² the smallest Navy since World War II, the service is challenged by the twofold task of replacing its aging submarine and destroyer fleet while procuring enough ships to work toward the 355-ship goal set in its 2016 Force Structure Assessment (FSA) and confirmed by the Trump administration's National Defense Strategy and the FY18 NDAA. Delayed updates to the 2016 FSA, unmet requirements, errors, inefficiencies, anemic funding, and more frustrated this buildup—culminating in the Navy's budget request for FY21, which both cut the fleet and planned procurement and was unaccompanied by a robust and congressionally mandated shipbuilding plan.¹⁵³

Today, the service is purchasing the fleet's backbone *Virginia*-class attack subs and *Arleigh Burke*-class destroyers while partially replacing its amphibious fleet and its entire ballistic missile submarine fleet (Figure 18). However, though current programmed and planned Navy shipbuilding comes in well above historical spending averages, the number of ships

envisioned in these plans derives from the outdated benchmark set in the 2016 FSA.¹⁵⁴ During 2020, the Navy, the Office of the Secretary of Defense, the DOD's Cost Assessment and Program Evaluation (CAPE) office, and outside experts conducted reviews of the Navy's shipbuilding plan.¹⁵⁵ These reviews resulted in Battle Force 2045, which former-Secretary of Defense Mark Esper detailed at the Center for Strategic and Budgetary Assessments on October 6, 2020.¹⁵⁶

Broadly, the new plan emphasizes reaching 355 ships before 2035 (the original goal) and expanding the fleet to roughly 500 manned and unmanned ships by 2045.¹⁵⁷ This Battle Force 2045 build-out still prioritizes attack submarines—both the *Virginia*-class and its eventual SSN(X) replacement—comparatively de-emphasizes the role of carriers, reiterates the importance of small surface combatants and unmanned platforms, and affirms the need for logistic enablers. The bill for this effort will be high; Esper announced that the Navy would dedicate 13 percent of its budget to shipbuilding in 2022, up from the current 11 percent to fund the new plan.¹⁵⁸ However, the Navy's ability to sell Congress on such an ambitious plan remains to be seen. As such, this analysis centers on the Navy's previous shipbuilding plans—a conservative estimate of the Navy's potential future investments.

Separate from procurement, but equally concerning, is the ever-increasing cost of manning, operating, and maintaining a larger, older fleet—something the Navy and the shipbuilding industry have not had to do for over two decades. Even if automation and unmanned vessels lessen the need for large crews in the future, these ships will still need to be maintained, and the cost per sailor is always increasing.¹⁵⁹ As the Navy observed in its FY20 30-year shipbuilding plan,

Because the Navy [until recently] has been shrinking not growing, and because of the disconnected timespan from purchase to delivery, often five years or more and often beyond the FYDP, there is risk of underestimating the aggregate sustainment costs looming over the horizon that must now be carefully considered in fiscal forecasting.¹⁶⁰

Further, GAO and others have expressed concern about the poor state of the Navy's four remaining shipyards.¹⁶¹ After years of underinvestment, it is unclear if the shipbuilding industrial base, already struggling to maintain the Navy's current force, could keep up with the demands of a larger fleet.¹⁶² These issues make the 355-ship goal appear largely unrealistic and put the Navy at risk of creating a hollow force of poorly maintained and undermanned ships. Meanwhile, the Chinese navy has been expanding both its size and its shipbuilding capacity, growing its navy by over 27 percent and its commercial shipbuilding by 60 percent from 2007 to 2017, now far surpassing American industrial capability with no signs of slowing.¹⁶³

The Navy and Congress knew this crunch was coming, but the rapid growth of competitor navies in both capability and capacity underscores the impending consequences of failing to finally address the shipbuilding bow wave. The Navy's fleet is overused, and it is struggling to meet the present demands of combatant commanders around the world while maintaining even baseline levels of readiness.¹⁶⁴ Even with budget growth, service life extensions for aging ships, and scaled-back presence missions, the constraints within shipyards may still frustrate the fleet's necessary restoration and growth.

Navy Modernization Spending, FY21–FY25

As previously noted, the Navy's short-term 2020s modernization spending crunch centers on shipbuilding.

Aircraft Carriers and Amphibious Assault Ships, FY21–FY25. For the foreseeable future, the Navy plans to return to and maintain its 12-carrier fleet by building aircraft carriers at a pace of one every five years, the next in FY28. The Navy intends to procure seven total *Ford*-class carriers between now and 2049, but with the first *Nimitz* class retiring in 2025, the Navy's FY20 30-year shipbuilding plan still leaves the service with only 11 carriers available until FY24, when that number wavers between 10 and nine from FY25 to FY49.¹⁶⁵ Given the length of procurement needed

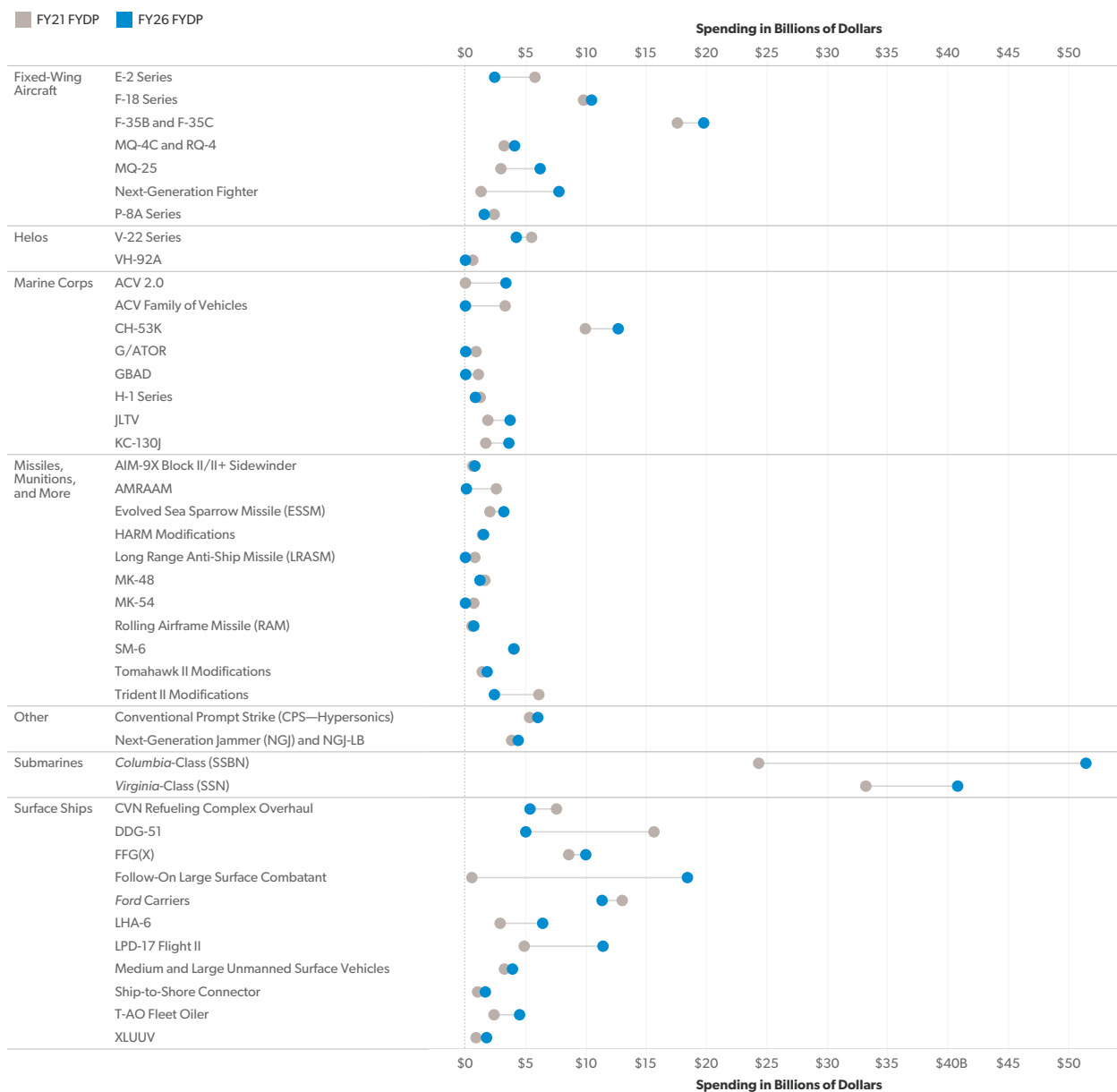
for a ship of this size, the only likely adjustments are a move toward quickening the rate of procurement to one every four years, as recommended in AEI's 2017 report *Repair and Rebuild*,¹⁶⁶ or slowing it to one every six years.¹⁶⁷

Notably, a procurement slowdown will only add costs and should not be considered a viable option at this stage.¹⁶⁸ The Navy has bought or started to buy four *Ford*-class carriers, the last being the *Dorris Miller* (CVN-81), authorized in FY19 and set to be commissioned in 2030. Separately, the Navy delayed its planned decommissioning of the USS *Harry S. Truman* (CVN-75) in its FY21 budget request, a reversal from its FY20 proposal due to bipartisan pressure, which will cost upward of \$5 billion over the FY21 FYDP, currently reflected in the Navy's carrier overhauls and refueling budget.¹⁶⁹

In 2017, AEI's *Repair and Rebuild* reiterated the importance of amphibious assault ships with aviation capabilities due to their ability to support distributed short takeoff and vertical landing operations, dispersing Marine Corps airpower in austere land locations in theater. Navy Secretary Kenneth Braithwaite's recent October 2020 suggestion to create up to six light aircraft carriers as part of Battle Force 2045 underscores this need but undercuts the value resident in the Navy's proven amphibious ships.¹⁷⁰ The Navy's Flight 0 *America*-class amphibious assault ships (LHAs) can carry 16 to 20 F-35B Joint Strike Fighters, but these aviation capabilities were exchanged for larger well decks in the Flight 1 LHAs. As such, the Navy's *America*-class Flight 1 LHA-9 includes a well deck, and Congress has already provided advanced procurement money to speed up the ship's purchase from FY24 to FY23. If the Navy pursues more light aircraft carriers in the future, it will mean starting yet another development program, doubtlessly introducing larger questions of acquisition risk while funding remains an open question.

Separately, the Navy also wants to procure two more LPD-17 Flight II *San Antonio*-class small-deck amphibious ships between now and FY25.¹⁷¹ The service budget documents originally suggested that three ships would be purchased over the FY21 FYDP, but that included LPD-31, which was previously authorized by Congress in FY20.¹⁷² The Marine Corps'

Figure 18. Planned, Possible, and Probable Navy and Marine Corps Modernization Spending, FY 2021–FY 2031



Source: Author's calculations using Congressional Research Service; Congressional Budget Office; FY 2021 Navy justification books; and Selected Acquisition Reports.

August 2019 Commandant's Planning Guidance, however, could affect the Navy's amphibious plans. As the Marines shift to a more expeditionary and distributed doctrine, it will be important to square the Marine Corps' operational plans with the Navy's

expectations for the future of large amphibious vessels. Already, the Marine Corps is talking about buying a fleet of smaller light amphibious warships that could be acquired within the FYDP for "the price of just one or two traditional amphibious ships."¹⁷³

Large Surface Combatants, FY21–FY25. To protect its carriers, the Navy will purchase another eight *Arleigh Burke*-class Flight III destroyers with a new radar over the next five years for over \$15.6 billion. The Navy has already decided to keep existing *Arleigh Burke*-class ships in service for 45 years instead of 35 to get closer to its 355-ship objective, although the flat FY21 budget request has caused the service's leadership to consider keeping the ships' original timelines. James Geurts, the Navy's assistant secretary for research, development, and acquisition, testified in 2020 before the Senate Armed Services Committee on the *Arleigh Burke*-class procurement crunch, saying,

Service life extensions do add to the size of the fleet, but they kind of just push the cliff to the right. . . . So you've got to be cautious you don't keep extending forever without building because eventually, you'll run out of the ability to extend.¹⁷⁴

Unfortunately, the Navy's effort to field a fleet of replacement large surface combatants for the *Arleigh Burke* destroyers and *Ticonderoga*-class (CG-47) Aegis cruisers has been frustrated often. The *Zumwalt*-class (DDG-1000) program was truncated from 32 hulls to three in the late 2000s, with the so-called CG(X) cruiser subsequently canceled at the start of the Obama administration in 2010. With the Navy's FY20 30-year shipbuilding plan projecting the retirement of the remaining *Ticonderoga*-class cruisers between FY21 and FY38,¹⁷⁵ the need to finally get serious about the next LSC is difficult to understate. New ship development can take as much as a decade, and while the Navy requested urgently needed RDT&E in FY21 for the new ship, congressional authorizers and appropriators in the House and Senate cut that funding.¹⁷⁶

This is particularly regrettable because continuing to buy more *Arleigh Burkes* and extending their life cycles works only as a stopgap measure. *Arleigh Burke* destroyers lack the growth margins necessary in both physical size and power generation to fulfill future air defense missions and host more energy-reliant weapons, such as lasers and rail guns, or account for new sensor systems and computing resources. The FY21 request planned to launch preliminary RDT&E

spending for the new ship, starting with \$46.5 million in 2021 and tripling to \$129.5 million in 2022. As discussed, those plans did not survive contact with Congress. Still, the service's rough design plans likely remain unchanged: The goal is to incorporate air and missile defense systems designed for Flight III *Arleigh Burkes* and install them on a new hull, along with larger vertical launch system tubes to accommodate new missiles. Bryan McGrath observed this method is a smart approach that “sort of harkens back to the glory days of Aegis: Build a little, test a little, learn a lot.”¹⁷⁷

Particularly with a slew of planned retirements for the *Ticonderoga* class on the horizon, continuing to push back the new LSC will end badly, and steel should be cut sooner rather than later. The Navy's surface combatants support both sea control and missile defense (and air defense in the case of the Flight III *Arleigh Burkes*). Even with the Navy focusing on submarines and small surface combatants, the value of the LSC fleet should not be compromised by extension—and yet, that is precisely the path before the Navy.

Small Surface Combatants and Mine Warfare, FY21–FY25. The drive toward more numerous smaller vessels has pushed the development of the FFG(X)—a new frigate—alongside the already truncated Littoral Combat Ship (LCS) program. Battle Force 2045 calls for an increase of small surface combatants up to 66 by FY45.¹⁷⁸ However, the Navy has only a little over 30 small surface combatants today, and it currently plans to add only two per year through the 2020s under the existing funding plan.¹⁷⁹ The Navy is already citing modernization and mounting shipbuilding costs as reasons to retire the first four LCS, one of which is just over six years old.¹⁸⁰ It follows that increases to the small surface combatant fleet will likely come from increasing the FFG(X) program's size.

Although seasoned analysts such as O'Rourke have raised concern about the accuracy of the Navy's current FFG(X) cost estimate,¹⁸¹ Geurts claims that the Navy learned its lesson with the LCS and is pursuing a more proven ship design with matured technology

for the FFG(X).¹⁸² The Navy wants to buy eight frigates within the FYDP. Even so, retiring LCSs is not pushing the Navy closer to its 355-ship goal and raises doubts about the service's ability to pay to keep existing LCSs in the water while building a new line of guided missile frigates, especially if FFG(X) program costs start to similarly balloon.

With the mine countermeasure fleet, the wind-down of the LCS program is markedly damaging. Only a few LCS hulls will be certified for mine countermeasures mission packages (MCM MPs) by the end of 2020.¹⁸³ The FY20 budget removed life extensions and accelerated the retirement of all 11 *Avenger*-class mine countermeasure ships by 2023.¹⁸⁴ Both instances speak to a lack of focus on the enduring threat of mine warfare. As Rep. Rob Wittman (R-VA), ranking member of the Subcommittee on Seapower and Projection Forces, noted in May 2020, Russia and China are estimated to have inventories of 250,000 and 100,000 sea mines respectively, with China also fielding hundreds of mine-capable ships and aircraft.¹⁸⁵

While Navy leaders have telegraphed a renewed focus on small surface combatants, the fleet will remain deleteriously small and constrained through the 2020s.

Unmanned Underwater Vehicles and Unmanned Surface Vessels, FY21–FY25. Although a key element of Battle Force 2045, and a long-held ambition for the fleet, the Navy's pursuit of unmanned surface vessels (USVs) has caused considerable concern and controversy in recent budget cycles. Most recently, the FY21 NDAA included stipulations about the reliability of engines and power generators for USVs.¹⁸⁶ Although Chief of Naval Operations Adm. Michael Gilday stated in January that unmanned vessels will not count toward the 355-ship goal,¹⁸⁷ they are crucial enablers of the distributed maritime operations concept.¹⁸⁸ Indeed, in August 2020, Rear Adm. Casey Moton, program executive officer for unmanned and small combatants, reportedly said, "USVs are the centerpiece for distributed maritime operations."¹⁸⁹ The Navy expects to spend around \$1 billion in RDT&E on the medium and large USVs over the next two years, with procurement and RDT&E increasing only after

FY23. Congress and others are right to worry that the USV program is following in the footsteps of the LCS, DDG-1000, and other ships built using premature concepts and technology. It also remains to be seen how the Navy will transition these programs from RDT&E to procurement and how unmanned programs will be weighed against other shipbuilding initiatives.

While it's legitimate for Congress to ask the Navy to prove its technologies, the constraining variable is time. The Navy intends to employ accelerated acquisition strategies to procure unmanned vehicles so they enter the fleet more rapidly. Weighting the relative importance of unmanned and optionally manned platforms against other intensely important shipbuilding programs will be key for the Navy, since the actual fielding of the three current programs—the extra-large unmanned undersea vehicles (XLUUV), medium USV, and large USV—will not begin until the prototyping stage is finished, beyond the FY21 FYDP.

Submarines: SSBNs and SSNs, FY21–FY25. At over a quarter of all procurement spending in the FY21 FYDP, submarines dominate Navy acquisitions over the next five years and beyond. The Navy continues to purchase the *Virginia*-class fast attack subs to replace the *Los Angeles* class, with FY21 funds buying the 33rd boat in its class. A second *Virginia*-class sub was at the top of the Navy's unfunded priorities list, and Congress accordingly provided full funding.¹⁹⁰ The Navy wants to continue buying two *Virginius* each year through FY30.

Beginning this fiscal year (FY21), the Navy has also started to buy its replacement for the *Ohio*-class ballistic missile submarine, the *Columbia*. The service will purchase the second SSBN in FY24 for an estimated \$9.3 billion. Although the National Sea-Based Deterrence Fund was established to prevent the *Columbia* from marginalizing other shipbuilding efforts, the CBO still writes, "The cost of the 12 *Columbia*-class submarines included in the 2020 shipbuilding plan is one of the most significant uncertainties in the Navy's and CBO's analyses of future shipbuilding costs."¹⁹¹

The construction of the first *Columbia*-class SSBNs begins in 2021, and another submarine will be

procured in 2024, as discussed. In the next FYDP, one *Columbia* class will be procured per year through 2035. Over the same period, *Virginia*-class SSN production remains steady at two per year, but in his remarks on the future Battle Force 2045, Esper said that to reach a fleet of 70 to 80 attack submarines, “If we do nothing else, the Navy must begin building three Virginia class submarines a year as soon as possible.”¹⁹²

Combat Logistics Fleet, FY21–FY25. To support a larger fleet, the Navy also plans to begin in earnest on replacements for its fleet of combat logistics ships, oilers, and salvage and rescue tugs through the early 2030s. Most notably, the Navy will replace its 1980s vintage *Henry J. Kaiser* oilers with 20 of the new *John Lewis* class. The service chose to cut the number of oilers procured in the FYDP from six to four between the FY20 and FY21 budgets. Although these Military Sealift Command vessels lack the glamor of massive carriers and sleek frigates, they play an increasingly important role in allowing carrier strike groups and amphibious ready groups to operate in a forward-deployed fashion in the Pacific theater.¹⁹³

Naval Aviation, FY21–FY25. While the Navy will continue to purchase F-35C Joint Strike Fighters, V-22 Osprey carrier onboard delivery variants, MQ-25 Stingray carrier-based drone tankers, and MQ-4C Triton surveillance drones throughout the 2020s, it will have largely completed the majority of its immediate aircraft modernization by the end of this decade. This effort includes the F/A-18E/F Super Hornet fighter, the EA-18G Growler electronic attack aircraft, the P-8A Poseidon anti-submarine and multi-mission patrol aircraft, the E-2D Advanced Hawkeye radar plane, the MQ-8C Fire Scout unmanned helicopter, and the new MH-60 helicopters.¹⁹⁴

However, the Navy cut planned procurement of more F/A-18s last year to instead focus on “accelerated development of the Next Generation Air Dominance (NGAD) and other key aviation wholeness investments.”¹⁹⁵ It remains unclear what the future of the carrier air wing holds, but the Navy is accepting risk by retiring F/A-18s in the coming years before a replacement is developed.

Missiles, Munitions, and More, FY21–FY25. The Navy intends to continue upgrading and procuring successful munitions programs such as the Tomahawk land-attack missiles, AIM-9 Sidewinder, Evolved Sea Sparrow Missile (ESSM), and Advanced Medium Range Air-to-Air Missiles (AMRAAM), with a notable emphasis on long-range offensive strike options. The Navy will spend between \$500 and \$900 million each year throughout the FYDP to procure Standard Missile-6 (SM-6) extended-range surface-to-air missiles, a key capability considering the increasing effectiveness and ubiquity of anti-ship cruise missiles and other A2AD technologies. Similarly, the Navy’s investments in Long Range Anti-Ship Missiles, though less expensive over the FYDP, also emphasize expanding the Navy’s ability to contend with China’s rapid advances in both naval capabilities and standoff weapons. Still, munitions and torpedoes (excluding Trident submarine-launched ballistic missile modifications) make up only 6–7 percent of major Navy procurement programs.¹⁹⁶

Navy Modernization Spending, FY26–FY31

Although certain priorities are clear, the Navy’s modernization costs after FY26 are in flux, dependent on new operating concepts and associated changes to existing shipbuilding plans.

Aircraft Carriers and Amphibious Assault Ships, FY26–FY31. Beyond the CVN-81, the future of the aircraft carrier is somewhat uncertain. Former Acting Secretary of the Navy Thomas Modly commissioned the Future Carrier 2030 Task Force to study what the aircraft carrier should be after the *Ford* class, but this task force has reportedly been canceled since Modly’s resignation.¹⁹⁷ Ultimately, the future of the supercarrier could be radically different given the expected shift to a more distributed fleet. Still, appropriations for CVN-81 will continue through FY28. Further, the costs of CVN refueling and complex overhaul life extension programs will continue for *Nimitz*-class destroyers, with CVN-76

USS *Ronald Reagan* scheduled for its four-year refueling around 2028.

Uncertainty in the future costs of aircraft carriers and amphibious assault ships partly stems from unclear plans for a light aircraft carrier. As Tyler Rogoway noted in 2018, while the *Ford* costs roughly \$12 billion, *America*-class amphibious assault ships have a unit cost of approximately \$3.5 billion, and they carry F-35B STOVL fighters.¹⁹⁸ As such, the Marine Corps has already conceived of a “Lightning Carrier” configuration that might be a cheap solution to the Navy’s interest in a smaller carrier.¹⁹⁹ However, if the Navy chooses to pursue a fully new design, prices are anyone’s guess. When the Navy designed the *Ford* class, growing costs and delivery delays resulted, largely to the new technologies incorporated on the platform; then–Senate Armed Service Committee Chair Sen. John McCain (R-AZ) called the *Ford* program “one of the most spectacular acquisition debacles in recent memory.”²⁰⁰ Whether the Navy pursues an all-new design or modifies amphibs, carrier costs will likely increase from FY26 to FY31. Further, at least two new amphibs (LHA-6s) are planned between FY26 and FY31 at a unit cost of little over \$3 billion each.²⁰¹

Large Surface Combatants, FY26–FY31. At some point, the Navy must move beyond its *Arleigh Burke*-class destroyers and *Ticonderoga*-class cruisers, as their designs can no longer be expanded on. Plans to do so in the past 15 years continually fizzled out, first in the early aughts with DD(X) and then with the CG(X) program, which sought to use the massive, stealthy, and power-generating *Zumwalt*-class destroyer as a basis for a new cruiser, with construction starting in 2028.²⁰² With the *Zumwalt* class out, the Navy’s FY20 30-year shipbuilding plan shows a new LSC class being procured for the first time in FY25 alongside the *Arleigh Burke* and then taking the place of the *Arleigh Burke* class completely in FY26. Geurts, however, told Congress in 2020 that the Navy was taking a “strategic pause” with the LSC program.²⁰³ Until a new class of ship is fully developed and matured, he expects to continue producing the Flight III *Arleigh Burkes*.

A shifting focus from large ships to more numerous small vessels further obscures the future of the LSC program.²⁰⁴ O’Rourke of the Congressional Research Service cites the CBO to note that these ships will likely cost more than the Navy currently believes²⁰⁵ and certainly more than the current *Arleigh Burke*-class destroyers. When forced to compete with the hugely expensive submarine programs and the potential growth of future unmanned initiatives, the LSC could become a target for cuts. While previous Navy shipbuilding plans suggested that this new LSC might be purchased as early as 2023, it is unlikely to make it into the budget books in any substantial way until the late 2020s, if then.²⁰⁶

Small Surface Combatants and Mine Warfare, FY26–FY31. Based on the Navy’s revised Battle Force 2045, it is highly likely that small surface combatants such as the FFG(X) will be expanded and large capital ships such as supercarriers, cruisers, and some destroyers cut back. As discussed, early estimates place the new number of small surface combatants between 60 and 70, which might increase the planned number of FFG(X) from 20 to a higher figure, subsequently increasing costs for the full program. Based on the current plan, each FFG(X) costs roughly \$1 billion, with the full shipbuilding schedule indicating another \$10 billion will be spent after the FY21 FYDP to complete the program.²⁰⁷

Unmanned Underwater Vehicles and Unmanned Surface Vessels, FY26–FY31. Much of the Navy’s distributed maritime operations concept relies on introducing unmanned vessels to act as sensors for a widely distributed fleet of small surface combatants, but it remains to be seen how the Navy transitions current unmanned prototypes to active members of the fleet. Despite the recent trouble with Congress, Geurts noted in July 2020 that rather than being worried about unmanned technology maturing, he is more concerned with getting prototypes into service so that the Navy can learn how unmanned vessels are best used in the fleet.²⁰⁸ The lessons learned from these prototypes will no doubt influence spending on future unmanned projects in the next two decades.

Although the XLUV, or the Orca, remains a small program in the FYDP, it could grow beyond FY25. As unmanned technologies improve and employment techniques are tested with unmanned surface prototypes, the subsurface fleet will likely get its own complement of unmanned teammates. Yet, as in many other areas, future purchasing requirements are opaque. In a 2016 report to Congress on autonomous undersea vehicle requirements for 2025, Ray Mabius wrote, “While nominal force structure requirements for 2025 cannot be determined yet, the Navy is committed to growing both the size and composition of the AUV [autonomous undersea vehicles] force.”²⁰⁹ Throughout 2020, reports indicated that the total planned growth in unmanned and optionally manned ships could range from 80 at the lowest estimate to 240 at the high-end.²¹⁰

Submarines: SSBNs and SSNs, FY26–FY31. The *Columbia*-program SSBN only grows in its share of total costs beyond FY25, with the Navy set to buy one *Columbia*-class submarine per year from 2026 to 2035.²¹¹ Between FY26 and FY31, *Columbia* procurement will consume over 18 percent of major Navy procurement spending identified in this analysis. When combined with the *Virginia* (buying two subs per year until 2033), submarines will make up at least 30 percent of Navy procurement in the same period. Even with this ambitious schedule, the Congressional Research Service and others have identified a low point in the mid-2020s and early 2030s, in which attack boats are retired faster than they are bought, leaving the Navy with only 42 SSNs around 2028.²¹²

As discussed, in October 2020, Esper advised beginning to build three *Virginia*-class submarines a year as soon as possible.²¹³ *Virginia* subs have a unit cost of around \$3.4 billion, so an increase to three subs per year would drive up our estimates from a \$40.8 billion cost during FY26–FY31 to \$61.8 billion. In early December 2020, Gen. Milley predicted “a lot of bloodletting” in the Pentagon’s budget to fund the Navy’s buildup, and indeed, it will be extraordinarily difficult to execute these plans without robust growth in the Navy’s shipbuilding account; that money will need to come from somewhere.²¹⁴

Further, the full freight cost of such an ambitious build schedule is dependent on not just the unit cost of submarines. To meet the schedule for the top-priority *Columbia* and add another *Virginia* per year, the Navy is looking at shipyard expansion options, likely requiring investment at General Dynamics’ Electric Boat and Huntington Ingalls Industries’ Newport News Shipbuilding.²¹⁵ The shipyards will reportedly need new facilities, machines, and more. This expansion is crucial, because the recent Block IV boat (SSN-792)—the first time the yards switched to building two boats per year—overran its contractual construction duration at 71.5 months instead of 62.²¹⁶ The Navy is also reportedly evaluating the maintenance capacity at Electric Boat and Newport News.²¹⁷

Combat Logistics Fleet, FY26–FY31. The Navy will continue procuring its new oiler through the FY26 FYDP at a rate of one per fiscal year with a unit cost of roughly \$750 million.²¹⁸ However, in addition to rebuilding its own logistics fleet, the Navy must begin to replace the core of the Military Sealift Command fleet, which ensures the Army’s ability to provide surge follow-on forces for major conflicts. As Transportation Command Deputy Commander Army Lt. Gen. Stephen Lyons notes,

The Military Sealift Command fleet will age out beginning really in about the mid-2020s. . . . We’re getting with the Navy and Congress to come up with a strategy to recapitalize that fleet. We know we’re going to have to do that.²¹⁹

The Navy may also find itself initiating a crash program to generate more merchant marines and reinvigorate repair facilities stateside.²²⁰

Naval Aviation, FY26–FY31. Moving past the previously noted risk in retiring F/A-18s before a replacement is found, the future of carrier aviation remains something of a mystery. Gilday has stated as much, saying, “I do think we need an aviation combatant, but what the aviation combatant of the future looks like? I don’t know yet.”²²¹ The Navy originally hoped to field the F/A-XX (or NGAD) as soon as the late

2020s,²²² but already budget analysts are wondering if the Navy will have the funds in the coming years to develop an entirely new aircraft.²²³ The vast majority of the costs for the F/A-XX will likely stay in RDT&E over the FY26 FYDP, with the goal of fielding the first of the sixth-generation fighters at the start of the 2030s.²²⁴ Bryan Clark, a naval analyst at the Hudson Institute, has suggested that the new fighter will incorporate more autonomous operations, and an extended range, over its predecessor, the F-35C.²²⁵ However, Clark also cautions that the Navy is driving for an accelerated timeline for a program that will involve high technology risk due to new designs, despite tight budgets, leading to “challenges in all three dimensions of a new program: cost, schedule, and performance.”²²⁶

Missiles, Munitions, and More, FY26–FY31.

Along with the other services, the Navy continues to explore directed energy and hypersonic weapons. Within the FYDP, it is pouring between \$800 million and \$1.3 billion per year into research related to the Conventional Prompt Strike weapon, the Navy’s hypersonic weapon intended for the *Virginia*-class

sub. The service expects to field an initial version of the weapon as early as FY28.²²⁷

Other substantial investments that will continue through the FY2026 FYDP include planned purchases of the SM-6, modifications to the Tomahawk II, AGM-88 high-speed anti-radiation missile modifications, and procurement of the ESSM.

Finally, though not reflected in the Navy’s FY21 budget documents, in June 2019, reports surfaced on the Air Force’s and Navy’s ongoing effort to replace their AIM-120 AMRAAM with the AIM-260 Joint Air Tactical Missile (JATM).²²⁸ Air Force officials have suggested that JATM will have more range than the AMRAAM does, competing with China’s PL-15 air-to-air missile and its range of more than 100 miles. Navy F/A-18E/F Super Hornets and all variants of the F-35 are expected to be the first to carry the missiles. Initial operating capacity for the AIM-260 is expected in 2022.²²⁹ Given the history of the AMRAAM, the costs and procurement schedule of the AIM-260 can safely be expected to rise over the FY26 FYDP.²³⁰ As the Air Force is the lead service for the program’s development, preliminary cost estimates were included in the Air Force FY26 budget.

The Marine Corps: A Deferred Modernization Crunch Driven by Transformation

The United States Marine Corps (USMC) is entering a new era of transformation since Gen. David Berger, the commandant of the Marine Corps, released his 2019 planning guidance.²³¹ While he envisions the USMC remaining the nation's most flexible and responsive military force, he has doubled down on the Marines' forcible-entry and amphibious role. Citing the need to adapt to fight with the Navy and other services in a contested maritime environment, he aims to move the USMC away from being another land army in the Middle East and Europe and toward becoming America's premier expeditionary naval warfare element in the Pacific, albeit with updated and forward-looking doctrine and platforms.

To aid in this mission, Gen. Berger has completely reenvisioned the Marine Corps' organization and equipment to deal with the realities of modern A2AD technology. First and foremost, he is moving the Marines and Navy away from the long-standing requirement to maintain the capability to deliver two Marine Expeditionary Brigade (MEB) forcible-entry forces (which required 17 amphibious ships per brigade). This is a huge change, not only because of the aforementioned impact on Navy shipbuilding but also because the majority of Marine equipment procured for decades has centered around the MEB concept and the requirement to operate with these large amphibious ships.²³²

The Marines' new concept, much like its plan for amphibious shipbuilding, focuses on dispersed operations using more numerous but smaller platforms.

Because of the advances in anti-ship missile technology and precision-guided munitions, Gen. Berger envisions smaller units of Marines operating across a large geographic area. This will drive the need for longer-range transportation, communications, sensors, and fires to support a more distributed, agile force.

Most shocking is Gen. Berger's clear declaration that if confronted with budgetary shortcomings while implementing his guidance, he is ready to cut the Marine Corps' size in favor of modernization efforts.

We will divest of legacy defense programs and force structure that supports legacy capabilities. If provided the opportunity to secure additional modernization dollars in exchange for force structure, I am prepared to do so.²³³

The Marine Corps should be commended for making its trade-offs clear (Figure 18). It moved beyond simply saying it intends to divest of legacy systems by not only articulating its priorities but also identifying where it is willing to make cuts. The Army and the Air Force have similarly identified lower-priority programs as targets for cuts or divestment. Still, Gen. Berger's guidance remains primarily policy on paper. As the FY21 budget cycle ends and the FY22 cycle picks up, it remains to be seen if his changes will be implemented where they matter—and if hard budget decisions will be made. FY22 will be a make-or-break year for Marine Corps modernization.

Marine Corps Modernization Spending, FY21–FY25

Much of the Marine Corps' short-term modernization spending will be informed by efforts to implement Gen. Berger's vision of the future of the service.

Ground Forces, FY21–FY25. On the ground, the Marines' most expensive program in the FY21 FYDP remains its Amphibious Combat Vehicle (ACV). The ACV is the replacement for the Amphibious Assault Vehicle (AAV) and the successor to the Expeditionary Fighting Vehicle program, canceled in 2011 after over \$3 billion was spent in development funding.²³⁴ Formerly divided into two separate programs with differing mobility requirements, the USMC combined the programs and is now buying a wheeled amphibious vehicle capable of swimming from ship to shore, albeit at nearly the same low speed as the AAV.²³⁵ The service intends to use lessons learned from this ACV before deciding to develop a larger, faster, and tracked ACV 2.0. In the meantime, the Marines are left relying on existing Landing Craft Air Cushions (LCACs) to get to the shore faster than 7 knots.²³⁶

Also being completed in the near term is the fielding of the Joint Light Tactical Vehicle (JLTV) to replace the high-mobility multipurpose wheeled vehicle (HMMWV) and other light vehicles. The USMC will also finish fielding its G/ATOR radar system in the next few years, which reduces the need for separate systems by combining into one platform air defense and C2 radar with artillery-counterfire radar.²³⁷ As the USMC deactivates its Abrams-equipped tank battalions and reinvests in unmanned technology and long-range fires, spending will likely increase on unmanned sensors, high-mobility artillery rocket systems, and rocket munitions such as the Guided Multiple Launch Rocket System (GMLRS).²³⁸

The loss of heavy armor is also likely to influence the replacement of the Light Armored Vehicle (LAV), which is approaching 40 years in service. A replacement program is under consideration, the Advanced Reconnaissance Vehicle (ARV), but it was delayed due to COVID-19.²³⁹ For now, the ARV's future is fairly uncertain, and spokespeople for the program went

quiet in fall 2020.²⁴⁰ As the USMC focuses on improving the lethality and versatility of its infantry battalions, it's not thoroughly clear what the future might hold for an LAV replacement.

Unfortunately, during an era of constricting budgets, it probably will not be a high priority. Cancian observed that the Marine Corps has a "vision for small, highly agile teams that will use long-range precision fires." Cancian concluded, "Combat vehicles don't fit very well into this concept . . . the Marine Corps looks to be fighting at long range."²⁴¹ Gen. Berger also wrote, "I remain unconvinced that additional wheeled, manned armored ground reconnaissance units are the best and only answer—especially in the Indo-Pacific region," in his "Force Design 2030" report.²⁴² The ARV program is unlikely to receive any substantial modernization spending during the FY21–FY31 period. In the meantime, the Marines continue to update the LAV and other key ground platforms such as the M777 howitzer.

Like the Army, the Marines are pouring money into rebuilding short-range air defense capabilities. The Ground Based Air Defense program is slated to cost just over \$1 billion in the FY21 FYDP and will provide the USMC with the ability to kill low-flying helicopters, planes, and unmanned aircraft systems (UAS) from a JLTV-based platform.²⁴³

Aviation, FY21–FY25. The Marine Corps' largest aircraft programs in the FYDP are the F-35B/C and CH-53K. The Marines skipped upgrading its F/A-18Cs and Ds to the E/F variants in favor of waiting for the F-35B, with its unique STOVL capabilities, and the F-35C—both now replacing the F/A-18s and the aging Harrier. Recent changes to force structure may lower the Marines' procurement quantity of F-35Bs from 353 to 299.²⁴⁴

Procurement for the CH-53K King Stallion takes off in the coming years, with the USMC spending over \$2.6 billion a year by FY25. With the CH-53E airframes becoming increasingly unreliable and costly, the King Stallion is expected to complete testing in 2021 and hit the fleet in 2023–24.²⁴⁵ The program was restructured by Geurts after running into several development issues but as of 2020 is progressing forward. Still, the

final scale of the program should be viewed with skepticism. As Cancian pointed out, Force Design 2030 (the agenda-setting strategy document for the Marine Corps' future) proposed cutting the number of heavy-lift squadrons from eight to five, based on the logic that with reduced heavy equipment and less infantry, there's less need for heavy-lift helicopters. Cancian concluded, "The cut of three squadrons implies a one-third cut to the replacement CH-53K program."²⁴⁶ The Marine Corps has also nearly completed procuring its MV-22 Osprey tiltrotor medium helicopter, KC-130J cargo/refueler aircraft, and AH-1Z helicopters.

Marine Corps Modernization Spending, FY26–FY31

After FY25, the Marine Corps will still be challenged to determine the composition of its future amphibious vehicle fleet and potential unmanned capabilities.

Ground Forces, FY26–FY31. Although the USMC is comparatively well-equipped in the air (despite indications of platform overuse and degraded training),²⁴⁷ it needs new ground vehicles. The JLTV and ACV acquired in the FY21 FYDP will go a long way toward this end, but more spending looms. The aforementioned LAV replacement will likely start procurement in the late 2020s.

The major potential spending question for the Marine Corps remains its high-speed amphibious vehicles. The problem is not complex, but top Marine Corps innovator Lt. Gen. Robert Walsh (ret.) explains it best.

My father was in World War II. He went ashore in an AmTrac going four to six knots. . . . Marines today are going to shore in [assault amphibious vehicles] at about the same speed. Let's look at the technology out there and find different ways to do this.²⁴⁸

The ACV being procured in the near term still does not solve this problem; it moves about as fast as the

AAV does. The question is: Do you send some Marines ship to shore in the vehicles they fight in, or do you drop everyone off at the beach?

The faster Ship to Shore Connector that is currently being procured to replace the LCAC solves a piece of the puzzle but still leaves a number of Marines riding to the beach in slow AAVs or ACVs. The ACV 2.0, which is being put off until 2025, is intended to move Marines ashore from over the horizon at greater speeds. But the ACV 2.0 remains on paper and, if the ACV 1.1 and 1.2 are any indication, will undergo considerable changes before being procured. As the Marine Corps evolves to operate in contested maritime environments, finding a distributed solution to moving large numbers of Marines from ship to shore from vessels hiding outside the reach of anti-ship cruise missiles is one of its largest problems. Lt. Gen. Brian Beaudreault, the deputy commandant, described the urgency best: "We must find a high-water-speed vehicle on the surface. We must."²⁴⁹ Urgency aside, this effort will likely consume a large chunk of the USMC's budget in the late 2020s.

Aviation, FY26–FY31. The USMC aviation will be mostly upgraded by the end of the 2020s thanks to expensive procurement in recent years. That said, the Marines still lack the unmanned capability that the other services get from the MQ-9, MQ-4C, and MQ-1C. The USMC has yet to unveil a definitive path forward with unmanned vehicles, and this represents a large question mark in future spending.

In 2020, the Marines canceled plans to add the Marine Air-Ground Task Force Unmanned Aerial System Expeditionary (MUX) ship-based vertical-takeoff multi-mission drone to its fleet.²⁵⁰ This large drone would have complemented V-22s over long distances as an interim escort solution and a persistent strike or intelligence, surveillance, and reconnaissance (ISR) asset. However, too many competing requirements for the MUX have led the USMC to instead pursue a family of land- and ship-based unmanned systems that together will fill the roles of the previously imagined drone. Gen. Berger has described the MUX as a capability rather than a single platform, saying,

In the future, we have to get to a point where an aerial vehicle can take off of this ship, any ship, go do its mission, land on that ship over there. Change payloads, launch, do another mission, land on a third ship. We're nowhere near that right now. We've got to get there.²⁵¹

In manned aviation, the USMC has not yet budgeted for its plans to equip its entire KC-130J (79 aircraft) and MV-22 fleet (reaching 360 aircraft in the coming years) with the Harvest Hawk multi-mission package, which will add new sensors, an electronic warfare pod, and new precision-guided missiles. The USMC also planned to make a significant number of its Ospreys capable of aerial refueling but has paused funding on this upgrade since

FY20.²⁵² These capability upgrades will be extensive and expensive, but the Marines believes they are necessary to increase the extent to which the USMC can operate independently.

Although Marine aviation will be mostly replaced or recapitalized by the end of the 2020s, questions remain about procurement costs taking away from maintenance and training. After a series of deadly accidents in the past several years, questions have been raised about the USMC's ability to maintain expensive procurement programs simultaneously with operating costs such as maintenance parts and personnel and pilot training hours.²⁵³ When the costs of unmanned programs and other weapons system procurement grow in coming years, the Marines may struggle to maintain its fleet of new F-35s, MV-22s, CH-53Ks, and KC-130Js.

The Air Force: A Modernization Crunch for the Underappreciated Billpayer

In August 2020, Gen. Brown published his vision document shortly after becoming chief of staff of the Air Force. In the aptly named “Accelerate Change or Lose,” Brown bracingly wrote,

Tomorrow’s Airmen are more likely to fight in highly contested environments, and must be prepared to fight through combat attrition rates and risks to the Nation that are more akin to the World War II era than the uncontested environment to which we have since become accustomed.²⁵⁴

Further, Brown emphasized that the Air Force faces “increasing budget pressure based on growing costs of sustainment for current and aging force structure, continuous combat operations, and long-deferred modernization.”²⁵⁵ He concluded that past decisions were made with the best intentions—but have not delivered the Air Force needed for competition with China and Russia. Indisputably, Brown is correct. The Air Force has been allowed to untenably diminish—and the 2020s will be a decade of reckoning.

Writing for the Heritage Foundation in 2020, John Venable, veteran aviator turned analyst, observed that the Air Force shrunk so precipitously during the early aughts and 2010s that by the start of 2021, the service will have only “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 near peer competitor” at the height of its Cold War buildup in 1987.²⁵⁶ Indeed, as Douglas Birkey wrote in November 2020, the service absorbed the largest budget cuts of all the services following the

Cold War—with procurement funding dropping by 52 percent between 1989 and 2001.²⁵⁷ While the service’s budget topline has grown since 2016, its procurement budget has failed to keep pace with inflation.

Unlike the Army, the Air Force actually shrank during the global war on terror years as new acquisitions failed to keep pace with aircraft retirements. As the service procured unmanned drones to meet the demands of counterinsurgency, other aviation programs were canceled, cut, or left to fester. Todd Harrison of the Center for Strategic and International Studies dubbed this period a “hollow buildup” for the Air Force.²⁵⁸ And unlike the Navy, the Air Force’s current long-range forecasting documents disappoint; there’s no 30-year shipbuilding plan for aircraft.

Still, in association with the 2018 National Defense Strategy, former-Secretary of the Air Force Heather Wilson detailed a goal of growing from the service 312 squadrons to 386 (a 24 percent increase), an effort branded “The Air Force We Need.”²⁵⁹ That number has since proved slippery at best. Brown hedged in October 2020 when asked if he was still shooting for such precipitous squadron growth, saying, “I think about, more so, what is the capability that would give me the equivalent of 386? What things can I do?”²⁶⁰ It’s a fair question to ask—but there is a worrisome pattern in Air Force defense planning of attempting to shrink the force to fund modernization programs, and it rarely pays out. Now, with the Air Force intending to invest heavily in networks such as the ABMS, Birkey advanced a fair caution: “Better networks are of little use without the ability to complete the kill chain, and that takes aircraft.”²⁶¹

Further, even as the Air Force attempts to commit to rapid modernization to meet the challenges of the 2020s and beyond, new programs are competing with their nonnegotiable predecessors. Nearly half a decade ago in 2016, Lt. Gen. James “Mike” Holmes, a former deputy chief of staff of the Air Force for strategic plans and requirements, ominously predicted that the Air Force’s bow wave would begin to crest in the early 2020s: “Our problems become unmanageable in FY22 when the Ground Based Strategic Deterrent (GBSD) advances.”²⁶²

Simultaneously, the Air Force is attempting to update its acquisition strategies. The Air Force’s 30-year strategic document from 2014 identifies the service’s “ability to adapt and respond faster than adversaries” as its greatest long-term challenge.²⁶³ The Air Force acknowledges that one vital part of this challenge is moving beyond “industrial-era development cycles measured in decades” and using rapid prototyping to drive an expedited, flexible acquisitions process capable of delivering advancements in technology before they are obsolete.²⁶⁴

In 2016, Holmes further observed that the Air Force will begin to experience its procurement crunch between FY22 and FY26 and continue dealing with it in the following five-year period from FY27 to FY31.²⁶⁵ The wave is just beginning to swell. Simultaneously, the Air Force must achieve its modernization plans even as it pays more per unit for a smaller legacy fleet, as maintenance costs continue to rise outside the tanker fleet.²⁶⁶ And all this will likely take place with reduced funding in the near term.

While rolling out the service’s new plan to reach 386 squadrons, Wilson repeated the need to confront the growing modernization bow wave over the next decade.²⁶⁷ Still, several analysts have noted that Air Force procurement spending continues to lag behind RDT&E spending and remains insufficient for modernization efforts.²⁶⁸ It seems that service leadership is continuing to bet on investments in RDT&E resulting in next-generation technologies and programs reducing the need for near-term modernization and recapitalization.

Even if these technologies do revolutionize warfare in the air domain—a notion Venable has called

“unlikely”²⁶⁹—recent history suggests that Congress will prevent the Air Force from divesting of legacy systems and truly doubling down on next-generation tech. While service leadership hyped the FY21 budget as the pivot point in which near-term sacrifices would be made in favor of the future, the actual budget remained conservative in cuts and retirements.²⁷⁰ Even so, Congress has sought to reduce these limited cuts and keep more legacy systems flying, citing the continuing demands of combatant commanders.²⁷¹ Both Air Force strategy documents and Wilson discuss the need to build trust and confidence with Congress, but conflicting interests remain.

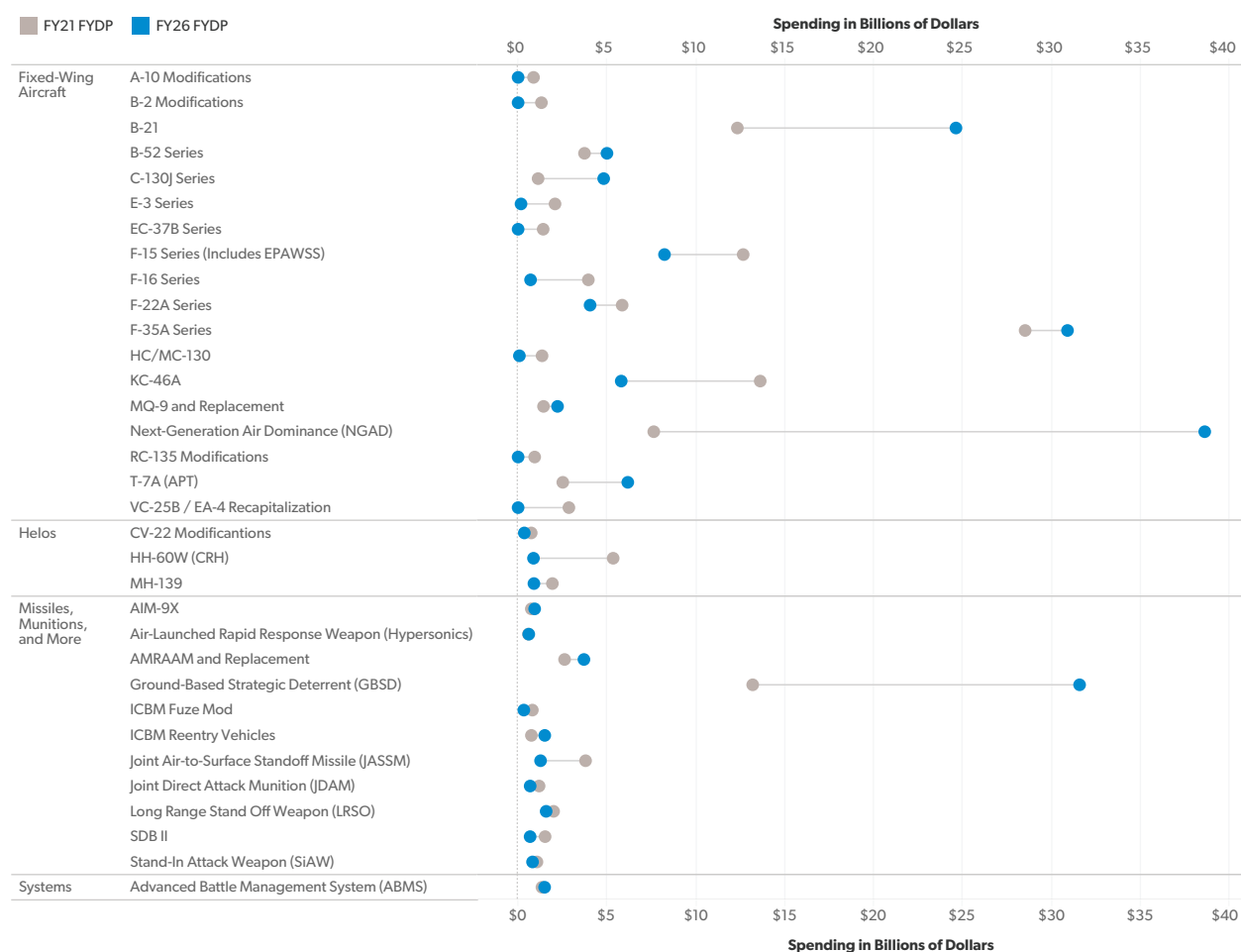
This leaves the Air Force trapped in a near-term catch-22 and correct in assessing its greatest challenge as adapting faster than adversaries. On one hand, it is trying to divest itself of decades-old legacy airframes, which drive up O&M costs every year, so that it can reinvest in next-generation platforms. On the other hand, its replacement aircraft programs will not be operational fast enough to meet the ongoing demands of global operations, even if the net savings from legacy divestments are sufficient to fund new platforms. The result is a stagnation that adds to the bow wave and leaves the Air Force with an outdated fleet and delayed next-generation aircraft programs (Figure 19).

Air Force Modernization Spending, FY21–FY25

For the time being, the Air Force is attempting to convince Congress that it can garner savings from substantial aircraft retirements and invest those recouped dollars in new platforms.

Medium and Heavy Airlift, FY21–FY25. In September 2020, shortly after Air Force Gen. Jacqueline Van Ovost took over leadership of Air Mobility Command, she detailed that, in response to Brown’s vision of “Accelerate Change or Lose” and the prospect of declining budgets, she was “looking at all roles and missions and how do we do them better, more effectively?”²⁷² To be sure, increasing efficacy will be

Figure 19. Planned, Possible, and Probable Air Force Modernization Spending, FY 2021–FY 2031



Source: Author's calculations using Congressional Research Service; Congressional Budget Office; FY 2021 Air Force justification books; and Selected Acquisition Reports.

key, but FY21–FY25 does not fully capture the scale of the challenges facing the service's medium and heavy airlift fleet. Over the FY21 FYDP, the largest airlift modernization costs are for continuing procurement of C-130Js. However, as the CBO discussed in its 2018 report "The Cost of Replacing Today's Air Force Fleet,"²⁷³ the service's current 222 C-17 cargo aircraft will require replacements beginning in 2037, if they are retired at age 45, necessitating a C-17 replacement appropriation to begin in 2035 and RDT&E for such an aircraft to begin even earlier.²⁷⁴

Further, though the 2019 Selected Acquisition Report for the Air Force's C-130Js suggests the

conclusion of the program by 2025,²⁷⁵ the CBO's report predicts the Air Force's continued acquisition of the aircraft through the 2050s at roughly \$750 million per year. This is not implausible, as the Air Force currently maintains a fleet of 171 less capable C-130H Hercules in the total force (127 of which are in the National Guard) that will likely require an upgrade or replacement to retain relevance through the 2020s and beyond.²⁷⁶

Tankers, FY21–FY25. Of prime importance, the KC-46A Pegasus tanker has begun initial fielding as the final product of the KC-X program. Although over

30 aircraft have been delivered, the Air Force has chosen to keep the Pegasus from participating in operations until problems with its boom and Remote Vision System are fixed around 2023.²⁷⁷ In the meantime, the KC-135 (averaging 58 years old) and KC-10 (averaging 34 years old) will continue to support worldwide refueling. This has created additional friction between the Air Force and Congress. When the Air Force attempted to retire a number of KC-135s and KC-10s in its FY21 budget, lawmakers fought back, preventing their retirement until the KC-46's issues are resolved. Over the FY21 FYDP, the RDT&E and procurement costs for the KC-46 are second only to those of the F-35A in the aircraft category.

Ground Attack and Multi-Role Aircraft, FY21–FY25. As demonstrated in Figure 20, the F-35A represents the lion's share of programmed Air Force modernization spending, even at the anemic rate of 48 aircraft per year out to FY25. The rate already fell from 80 to 60 aircraft per year in 2016, and the service was able to procure over 60 jets in FY20 only due to additional funding from Congress.²⁷⁸ As the procurement rate flattens, the Air Force is unable to reap the expected savings from economies of scale. The Air Force intends to eventually buy 1,777 F-35As—enough to replace all previously retired F-117s and active A-10s and F-16s.²⁷⁹

The arrival of new F-35s is much needed, because the Air Force's fighter fleet is already, on average, 29 years old.²⁸⁰ To boost the number of new fighters after the curtailment of the F-22 program and delays (not to mention higher-than-expected operating costs) in the F-35 program, the service is also buying 144 F-15EXs, an upgraded Strike Eagle meant to plug the gap as F-15Cs are retired in the late 2020s.

Proponents of the F-15EX argue it will save costs by allowing the Air Force to ramp up purchases of the F-35 once the Block 4 version enters production (now expected in 2026), thereby reducing the number of F-35s that will have to be upgraded to the latest configuration at that time.²⁸¹ Critics point out that the F-15EX is expected to already be outclassed by near-peer air defense systems before it is finished being fielded (around 2028).²⁸² Still others

contend that, because the comparative advantage of the stealthy F-35 is lost if it carries weapons externally, the F-15EX will remain a sensible complement for the Air Force's F-35s regardless, particularly as new weapons loads such as hypersonics enter the force.²⁸³ Between the F-35 and F-15EX, the Air Force is still buying only 60 to 67 fighters per year through FY25, when it has previously stated it must buy 72 fighters per year to replace its aging fleet and prevent furthering the procurement crunch.²⁸⁴

Bombers: Long-Range Strike, FY21–FY25. Competing with funding for fighters is the B-21 Raider Long Range Strike Bomber, which the Air Force expected to take its first flight by the end of 2020.²⁸⁵ The B-21 is currently consuming well over \$2 billion per year of RDT&E through FY25, with procurement beginning in FY22. The Air Force expects to buy 100 Raiders, which it will use to replace its B-1 and B-2 bombers by 2040. Already, the service is pushing to retire 17 B-1s in its FY21 budget to avoid increasingly expensive maintenance on aging airframes.²⁸⁶ However, once again, the Air Force will be working against Congress; in its draft of the FY21 NDAA, the Senate aimed to set minimum bomber inventory levels (Subtitle D, Section 144), which would be established by a recommendation from the secretary of defense on the number of aircraft required to carry out the service's long-range penetrating strike mission.²⁸⁷

Separately, the B-2s and B-52s are also facing opaque upgrade futures. First, as previously mentioned, the service's FY21 budget request zeroed out the Defensive Management System Modernization (DMS-M) for the fleet of 20 B-2s, though the Air Force planned to spend over \$236 million in RDT&E alone to finish out the program (as reported in the program's FY20 budget request).²⁸⁸ Although the DMS-M program was consistently behind schedule, Valerie Insinna reported the cut undermines the B-2's future survivability, since key features that help the aircraft detect new threats will not receive important upgrades.²⁸⁹ In February 2020, Air Force spokesman Capt. Clay Lancaster countered that "the Air Force continues to execute over \$1.3 billion in B-2 modernization efforts . . . to address obsolescence," but

undermining the viability of the B-2s only puts more pressure on the delivery of the B-21s.²⁹⁰

Second, the program costs to re-engine the fleet of B-52s are easily among the largest category of expenses for the aircraft, but the upgrade is crucial if the service is to execute on its plans to continue flying the bombers until 2050. (The B-52s are already 60-plus years old.) In 2018, Air Force Acquisition Chief Will Roper estimated the total re-engine program (now referred to as the B-52 Commercial Engine Replacement Program in Air Force budget documents) would be worth between \$7 billion and \$8 billion.²⁹¹ In the FY21 budget request, the service planned to spend roughly half of B-52 squadron modification RDT&E dollars on the program each year through 2025, when procurement begins at an estimated \$684 million.²⁹² Further, the FY21 budget request only reflected total RDT&E dollars at a little over \$1.5 billion, if the full plan for FY21–FY25 is executed.²⁹³ So, a conservative estimate means that (if all goes according to plan, which it might not for a program that the Air Force itself describes as involving “significant risk”), the Air Force can still expect to drop between \$5 billion and \$6 billion after FY25.²⁹⁴

Close Air Support, FY21–FY25. The FY21 budget request also attempted to kill the Air Force’s OA-X Light Attack Aircraft (LAA) program. Originally intended to support special operations in permissive environments and fill a similar role to the A-10 (which the Air Force can’t seem to get rid of), the OA-X was a hard sell to Air Force leadership scrounging for dollars to prepare for high-intensity conflict.²⁹⁵ The cancellation of the OA-X leaves the current array of manned and unmanned platforms performing the close air support role for the foreseeable future. However, as Elaine McCusker wrote in late 2020, the search for a light attack aircraft is not necessarily over; US Special Operations Command (SOCOM) incorporated a light attack aircraft in its FY21 budget submission as “Armed Overwatch,” but both the House and Senate subsequently criticized the program, and it ultimately failed to receive the support of Congress (FY21 NDAA, Sec. 163).²⁹⁶ While the 2019 Air Force budget submission described the LAA as “a viable cost

effective capability to counter the violent extremist threat freeing 4th and 5th generation aircraft to face emerging threats,” it’s worth critically examining the benefits of buying a new light attack aircraft now. The frequency of the missions these aircraft would carry out—broadly defined counterinsurgency and reconnaissance type efforts in complex terrain—are (or should be) dropping. Weighing the life cycle costs of a new aircraft against older platforms that could continue to fulfill similar missions is a piece of justifiable analysis that should be completed.

C4ISR and Support Aircraft, FY21–FY25. A plurality of the Air Force’s unique support aircraft will reach the end of their service lives soon. These aircraft include the E-8C Joint STARS (JSTARS) ground battle management plane, the EC-130H Compass Call, the E-3C AWACS airborne battle management plane, and the suite of RC-135 specialty sensor planes. The Air Force has decided not to replace the E-8C JSTARS, which will be retired in the mid-2020s. The ground surveillance plane has been deemed too vulnerable in high-threat environments and will instead be replaced by the ABMS, a network of advanced sensors and command and control systems that has been a target of congressional oversight in recent budget cycles.²⁹⁷ MQ-9 Reapers could get a new ground surveillance radar to maintain the JSTARS’s capability.²⁹⁸

The Air Force is spending just short of \$2 billion through FY25 to upgrade its E-3C AWACS fleet with advanced communications and networking equipment. Additionally, the service plans to pay \$1.4 billion in the FY21 FYDP to move its Compass Call electronic warfare suite from outdated EC-130 airframes to EC-37Bs—modified Gulfstream jets.²⁹⁹ The RC-135 Rivet Joint continues to receive upgrades with no replacement in sight. And last but not certainly not least, despite former President Trump’s haggling with Boeing, R&D for the VC-25B Air Force One program and recapitalization of the E-4B NAOC fleet will cost over \$2.8 billion in the FYDP.

Missiles, Munitions, and More, FY21–FY25. Also of concern is the number of precision munitions in Air Force stockpiles after years of flying missions in

Syria and Afghanistan. After maxing out production lines for a few years, stockpiles of JDAMs, SDBs, and Hellfires are returning to normal levels.³⁰⁰ Now, the Air Force is shifting to procuring longer-range weapons with the necessary standoff for use in great-power competition.

At the top of the list is the Joint Air-to-Surface Standoff Missile, with the Air Force set to buy around 2,500 cruise missiles for \$3.5 billion in the FY21 FYDP. Also of note is RDT&E funding for the Stand-In Attack Weapon, an anti-radiation missile for the F-35 intended to take on future A2AD systems.³⁰¹ In the near term, the Air Force will continue to purchase the AMRAAM and Sidewinder air-to-air missiles before replacements are developed in the future.

However, the most important and most costly missile program for the Air Force is the modernization of the ICBM force from the Minuteman III to the GBSD—the program Holmes in 2016 said would tip the service’s modernization challenge over the “unmanageable” precipice. He was right. Although the Minuteman IIIs will not begin retiring until 2029, modernization spending on the GBSD will cost \$13.2 billion over the FY21 FYDP.³⁰² Further, counting an ICBM Fuze Modernization program that the GBSD shares with Minuteman IIIs, the service’s spending on one-third of the nuclear triad is predicted to reach \$14 billion by FY25. The GBSD will unavoidably squeeze aircraft procurement, underscoring the Air Force’s challenge to modernize two legs of the nuclear triad in tandem. Modernization spending for the B-21 reaches over \$12 billion across the FY21 FYDP. Combined, the Air Force will shell out over \$26 billion by FY25 to sustain the US nuclear deterrent.

Air Force Modernization Spending, FY26–FY31

When considering cost estimations for Air Force modernization programs in the out-years, it is helpful to reiterate that, like the Navy, the Air Force maintains a number of large, well-defined programs that allow for strong visibility into the long term, albeit with less-detailed reporting (Figure 19). Compared

to naval aviation, the Air Force is about a decade and a half behind in its current cycle. During FY26–FY31, the Air Force’s largest major acquisition projects will likely be the following: F-35A Joint Strike Fighter, NGAD, GBSD/ICBM replacement program, the B-21 bomber, and potentially the KC-46A Pegasus tanker.

However, the Air Force suffers from significant uncertainty regarding the size and scope of several of these programs. Most significantly, the B-21 program seems likely to grow beyond the current program of the record 100 airframes. Second, the KC-46A program—significant as it is—replaces only one-third of the tanker fleet. The Air Force has 59 KC-10 Extenders in its total inventory (including reserves and the National Guard) and 379 KC-135 Stratotankers,³⁰³ but the full KC-46 program budgets for only 175 new aircraft.³⁰⁴ Third, the NGAD initiative—originally conceived as the F-22’s replacement, will likely encompass more weapons systems than a single faster and more maneuverable fighter jet would.³⁰⁵

Medium and Heavy Airlift, FY26–FY31. Since the C-17s replacement is the most tentative program we identified during FY26–FY31 and would likely only involve preliminary RDT&E costs, it is not prominently reflected in the Air Force’s modernization budget from FY26 to FY31. However, should the program’s time frame be accelerated, these projections might change. Current plans envision merely upgrading the C-17 Globemaster and C-5 Galaxy cargo aircraft to serve through the 2040s, though as discussed, more efficient cargo aircraft are likely to emerge in the next 10 to 15 years.

Tankers, FY26–FY31. As discussed, the Air Force intends to buy 175 KC-46 tankers by FY28, but this will replace less than half the aging KC-135 and KC-10 refuelers that enable America to project power globally.³⁰⁶ If the KC-46 program is not expanded, more than 330 KC-135s will remain in need of recapitalization. The Air Force originally intended to replace the remaining KC-135s with the KC-Y competition, possibly an upgraded Pegasus, by 2028. It remains to be seen if the Air Force pursues a KC-Y contest or simply buys more KC-46s.³⁰⁷

Still further in the future, the KC-Z program is intended to replace or recapitalize KC-10s beginning in the late 2030s. The requirements for the KC-Z remain murky, but Air Mobility Command has stated that it must be a tanker capable of supporting the NGAD fighter. Like other future aviation programs, the ability to operate in contested airspace using stealth or advanced defense systems and possibly unmanned or unmanned teaming will be crucial to future aerial refuelers.³⁰⁸ Lockheed is already working on a stealthy flying wing tanker, and Northrop could develop its B-21 into a refueling variant.³⁰⁹

Ground Attack and Multi-Role Aircraft, FY26–FY31. Despite the trouble thus far, the Air Force does plan to get to economical rates of F-35A Block 4 production; 80 per year is the threshold, but 100 would be better. While the F-35 stands as a rare program with full and detailed cost estimates, moving to higher production rates will only add to the size of the Air Force’s pre-2030 procurement crunch. At the same time, in the mid-2020s, the F-35 will begin to receive new engines currently under development, which are entering full-scale testing this year.³¹⁰

Beyond the F-35, the Air Force is pursuing a “Digital Century Series” to develop its next air-superiority fighter as part of the NGAD program. Referencing the Century Series aircraft of the 1950s, the Air Force intends to quickly develop and purchase several small batches of aircraft from multiple competing contractors.³¹¹ The advantage, according to Roper, comes from continuously churning out capable and operational fighters that keep China and Russia guessing, rather than pursuing a two-decade acquisitions process that results in a jet ill-suited for future threats.³¹² This is a significantly new direction from the Penetrating Counter Air (PCA) initiative the Air Force had previously described and reflects the assertion that the greatest future challenge is adapting more quickly than competitors.

The NGAD program goes further than the Digital Century Series and may eventually include other aircraft, sensors, and unmanned technologies. Already, the Air Force is eyeing the XQ-58A Valkyrie as a potential unmanned “wingman” to aid in reconnaissance

and strike missions.³¹³ The NGAD program remains in the RDT&E phase (\$7.6 billion over the current FYDP), and in 2018 the CBO estimated that purchasing the future fighter alone (PCA) would reach a yearly cost of roughly \$8 billion by the end of the FY26–FY31 period.³¹⁴

Out of an abundance of caution, we have kept our estimates high, but the final NGAD program costs might be indeterminate. As Steve Trimble detailed for Aviation Week Network, the CBO’s cost estimates were based on a single aircraft, such as the F-22 or F-35.³¹⁵ During a September 2018 press conference, Roper said, “I would say [NGAD now] looks more like a portfolio than a single initiative.”³¹⁶ The service then cut its budget projections for the NGAD program in half, and larger subsequent updates on the program have indicated that the final price tag might be lower than current estimates. With the unveiling of a flight demonstrator for the NGAD in 2020, Roper is attempting to make good on his vision for delivering new combat aircraft faster at a lower cost.³¹⁷

Bombers: Long-Range Strike, FY26–FY31. With bombers, Venable has previously noted that if the B-1 and B-2 development and procurement timelines are any indication, then the B-21’s timeline runs the risk of slipping further toward 2030.³¹⁸ By the time adequate numbers of B-21s are fielded in the 2030s, B-1s and B-2s will be hitting retirement. If “The Air Force We Need” strategy is maintained, despite Gen. Brown’s reservations, the service may need to buy around 75 additional B-21s to grow by seven bomber squadrons.³¹⁹

As discussed, despite concerns over the B-52s survivability and age, it is also expected to continue flying (with its new nuclear-tipped cruise missile, the Long Range Standoff Weapon) alongside the B-21 through the 2050s. Accordingly, the B-52’s operations and support costs should also be expected to increase as it ages, and the service will need to provide the billions of dollars required for the B-52s re-engine program, if they are to remain airborne.

C4ISR and Support Aircraft, FY26–FY31. As in many other places, repeated failure to modernize large support aircraft may force the Air Force to upgrade

current aircraft to keep them relevant even as it pursues true replacements. The E-3 AWACS will stay in service through the 2040s, with the E-8 JSTARS leaving service by the end of the decade.

Russian and Chinese advances in air defense may also necessitate investment in next-generation surveillance capabilities. Currently, only the defense industry discusses these new aircraft. But former Air Force ISR Chief Lt. Gen. Bob Otto (ret.) is reportedly “intrigued” by these plans, though the Air Force is staying relatively quiet in the current budgetary environment.³²⁰ The decision to move away from upgrading the E-8 JSTARS and pursuing a system of distributed, survivable sensors in ABMS is more suited to operating in the contested airspaces of future conflicts and mirrors the Navy’s procurement of the MQ-4C and MQ-8C instead of upgrading its EP-3E ARIES surveillance plane.³²¹

But much of the ABMS program, including its total cost estimate and timeline, remains unclear. The project is massive in scope and intends to “connect everything,” from Air Force sensors and platforms to Navy ships and Army shooters.³²² In 2020, the GAO warned that the ABMS initiative lacks specific requirements, a plan to adequately mature technologies, and an overall cost estimate—ultimately unfavorably comparing the program to other doomed efforts such as the network element of the Army’s canceled Future Combat System program from the 2000s.³²³ In 2009, the CBO estimated that to equip Army BCTs with the hardware required for the Future Combat System network, costs would average \$1.4 billion in 2009 dollars each year. The comparison is nowhere near perfect, but that’s why the Air Force needs to deliver true cost estimates as soon as possible.

The need for survivable networks and joint connectivity in future warfare is clear, but ABMS’s non-traditional acquisitions approach and software-heavy development runs the risk of becoming unaffordable for the Air Force. As time goes on, when defense spending flattens, and the procurement crunch is met, the ABMS will be forced to compete with the Air Force’s other high-dollar programs such as the F-35,

NGAD, B-21, and KC-46. Ideally, the future of ABMS may become more transparent in 2021 as many potential technologies and platforms are tested.

Missiles, Munitions, and More, FY26–FY31. As far back as 2016, as noted in the *Wall Street Journal*, the PLAAF air-to-air missiles has outranged those of the US Air Force.³²⁴ In June 2016, Air Combat Command Vice Cmdr. Maj. Gen. Jerry Harris averred that the AIM-120 AMRAAM lacks the range and counter-countermeasures to compete with adversary air-to-air missiles.³²⁵ The Air Force has since been working on a replacement, the AIM-260 JATM.³²⁶ The JATM and another similar project, the Long Range Engagement Weapon, remain highly secretive but will contribute to munitions costs as AMRAAM production trails off.³²⁷

Given the stated timelines about the near-term potential of directed energy weapons, the following quote from Defense Advanced Research Projects Agency (DARPA) Deputy Director Steven Walker indicates that funding for hypersonic technologies might explode *before* directed energy weapons spending would—meaning well within the 2020s.

I would say we’re closer on hypersonics than we are with directed energy in terms of making that a real capability. . . . I look forward to that being a key part of any U.S. air posture in the future.³²⁸

All the services are pushing forward quickly on hypersonics, and the Air Force was forced last year to halt its Hypersonic Conventional Strike Weapon to devote more funding to its other hypersonic program, the Air-Launched Rapid Response Weapon.³²⁹ Prototypes of this weapon are expected to fly in the next several years. Another munition, the Hypersonic Air-Breathing Weapon Concept, is an Air Force and DARPA joint project with a longer time frame.³³⁰ These programs will likely transition from R&D to procurement in the next decade, although total costs are difficult to estimate.

The Army: A Modernization Abyss and Hidden Crunch

It was the best of procurement; it was the worst of procurement. In some ways, the Army's track record on modernization ranks as quite impressive. Its core Reagan-era vehicle and helicopter fleets have proved remarkably durable, modular, and relevant (with updates and upgrades) since the early 1980s, and its triage program in response to sequestration kept vital equipment classes from obsolescence.³³¹ Yet all attempts since to replace these venerable "Big Five" platforms failed, beginning with the nixing of the Comanche attack helicopter, continuing in spectacular fashion with the aborted Future Combat System, and ending with the cancellation of the Ground Combat Vehicle. The Army's 2010 acquisition report accurately stated:

Every year since 1996, the Army has spent more than \$1 billion annually on programs that were ultimately cancelled. Since 2004, including FCS [Future Combat System], \$3.3 billion to \$3.8 billion, or 35 percent to 42 percent, per year of Army DT&E [development test and evaluation] funding has been lost to cancelled programs. The Army cannot afford to continue losing funds in this manner.³³²

Despite (and probably because of) its admittedly abysmal recent procurement record, the Army now maintains a well-articulated modernization strategy.³³³ In 2010 and 2014, it published modernization strategies for tactical wheeled vehicles and general combat vehicles, and its 2018 modernization strategy established six modernization priorities.³³⁴ At the outset, the Army announced it had redirected \$1.1 billion—or 80 percent of its available science and technology funding—to the new priorities:

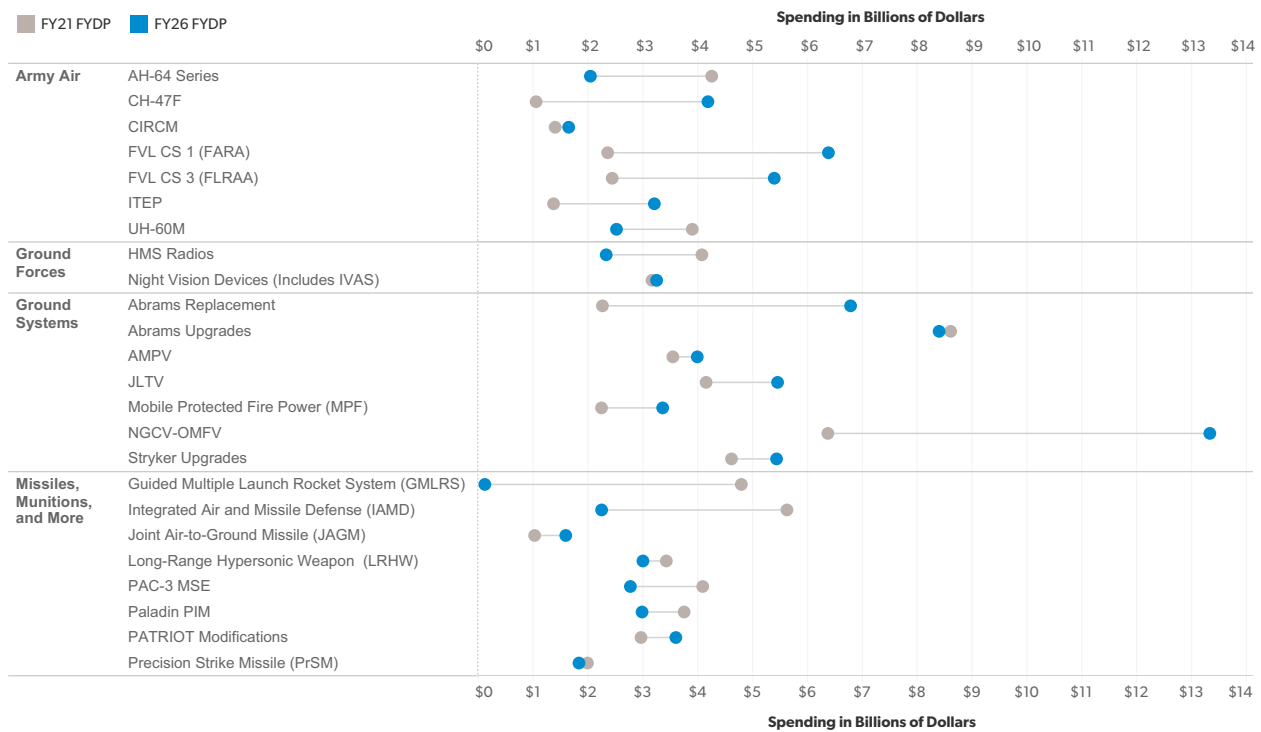
(1) long-range precision fires, (2) next-generation combat vehicles, (3) Future Vertical Lift program, (4) Army network, (5) air and missile defense capabilities, and (6) soldier lethality.³³⁵ The old Army Equipment Program document better captures relative timelines but does not include cost or quantities—and it is now outdated.

To avoid the acquisition follies of the past, the Army established its new Futures Command in 2018. Since becoming operational, Futures Command has sought to implement the service's modernization strategy by creating eight "cross-functional teams" that mirror the six modernization priorities, plus two enabling areas. Yet in other areas, no comprehensive plans harmonize short- and long-term objectives: replacements for flagship vehicles such as Abrams tanks or Bradley Fighting Vehicles and next-generation electronic warfare platforms or active protection systems.

While the Army chases these new priorities in its recent budget requests, H. R. McMaster has previously highlighted how much more difficult it can be to successfully write clear requirements to drive acquisition programs for the Army.

The Army's harder. It's much harder than any other service. . . . An aircraft carrier's super complex [and] a nuclear sub is super complex, but you can see that: It's a certain big tangible thing . . . and you can say that's my requirement: the next aircraft carrier, the next sub.³³⁶

This problem only gets worse the further into the future the Army peers. Still, overall, this aggressive new Army modernization strategy results directly from the strictures of sequestration and the repeated

Figure 20. Planned, Possible, and Probable Army Modernization Spending, FY 2021–FY 2031

Source: Author's calculations using Congressional Research Service; Congressional Budget Office; FY 2021 Army justification books; and Selected Acquisition Reports.

cancellation of reasonably performing programs as a result of fickle political winds.

The Army's Ground Combat Vehicle modernization program finds itself in particularly dire straits. As noted by the Army in 2015, "Observations of recent combat experiences (Israel in Lebanon and Gaza; France in Mali, U.S. in Sadr City, Russia and Ukraine) have highlighted the criticality of combat vehicles, and expose gaps in U.S. Army capabilities."³³⁷ The Army shied away from euphemism here: "In the near-, mid-, or far- terms, obsolete combat vehicles will prevent Army units from succeeding at their designated missions. Such a technical phrase obscures the reality of failed modernization: dead Soldiers and embarrassing defeat."³³⁸

What does this mean for the Army's modernization plans? As illustrated by Figure 20, the Army's current plan looks anemic, with a little over \$80 billion in the FY21 FYDP and another \$96 billion from FY26 to FY31. Both numbers underscore that a vast

amount of likely Army procurement spending simply does not appear on the books. While the Army could accelerate several programs into the FYDP, its current five-year spending is unlikely to break \$100 billion significantly, particularly given the decreasing likelihood of near-term force structure expansion.

Yet the second number—only \$96 billion of projected spending beyond the FY21 FYDP—truly mocks the Army's equipment needs. The Army's core modernization programs emphasize replacing and upgrading its ground vehicle and utility and attack helicopter fleets, both of which accelerated in the mid-to-late 2020s. As such, the Army faces a significant modernization crunch that is hitting slightly later than that of the Navy and Air Force. After years of keeping its figurative head down following the acquisition follies of the aughts, the Army has rearticulated its modernization needs. To support its modernization goals, the Army realigned \$33 billion in its FY19 budget

request, and it continues in FY21 with \$2.4 billion reallocated to modernization through reforms and savings.³³⁹ Congress has previously shown support for the Army's acquisitions reckoning in its funding of Army modernization priorities.³⁴⁰ However, with the Navy's evermore ambitious shipbuilding plans, and potential cuts to Army end strength as the US military focuses on its posture in the Pacific, long-term congressional support for the Army's modernization plans may prove capricious.

A lack of buy-in from Congress is reason to worry, because while the Army's modernization bow wave will probably not match the crunches of the capital-intensive Air Force and Navy, its final price tag will undoubtedly grow far larger than currently assumed or assessed. At a minimum, as Loren Thompson observed of the Army's 2021 budget request, the service acknowledges that it needs 60 more upgraded Stryker vehicles than it has currently budgeted, continues to push back upgrades to its heavy-lift Chinook helicopter, and stretches out the JLTV program—slow walking the replacement for less secure Humvees.³⁴¹

Army Modernization Spending, FY21–FY25

Once again, as demonstrated in Figure 20, largely programmed Army modernization spending is comparatively restricted, 59 percent that of the Air Force and 38 percent that of the Navy. Over half that Army spending is allocated to upgrades of existing ground vehicles and helicopters, with the other half dominated by air and missile defense spending and a conglomerate of spending on backbone information technology and network systems for mission command.

Army Aviation, FY21–FY25. The vast majority of near-term programmed Army aviation spending focuses on simultaneous refurbishments and incremental upgrades for its three main helicopters, the Blackhawk, Apache, and Chinook—alongside fleet-wide improvements in countermeasures to heat-seeking anti-air missiles that pose a burgeoning threat. The Chinook heavy-lift helicopter remains

the major uncertainty in the Army's fleet. The Army has delayed funding the upgrade of its entire fleet of Chinooks to the CH-47F Block II, but Congress has prevented the service from canceling the program outright.³⁴² The Army must now choose whether to pay to upgrade the Chinook fleet in the near term or field a replacement sometime in the 2030s, when the Blackhawk and Apache replacements are also being procured and adding to their existing aviation crunch. RDT&E costs relating to the Army's next generation of helicopters through the Future Vertical Lift program and the Blackhawk and Apache replacements will continue to increase through the FYDP.

Ground Combat Vehicles, FY21–FY25. Until FY25, ground vehicle investment focuses on procuring the Armored Multipurpose Vehicle (AMPV) and JLTV while continuing upgrades to the Abrams tank, Stryker, and Paladin. Bradley upgrades taper off after FY22 in favor of expected procurement of its replacement, the Optionally Manned Fighting Vehicle (OMFV). The most significant near-term and midterm upgrades to the Abrams fleet will comprise an active protection system and other survivability upgrades and an auxiliary power unit to operate systems with a reduced signature.³⁴³ The Army continues to upgrade its Stryker brigades with mine-resistant double V-hulls. After equipping its Europe-based Stryker brigade combat teams (SBCT) with up-gunned 30mm Strykers, it is also pursuing up-gunning three additional brigades in the near term, a multibillion dollar project.³⁴⁴

The Paladin A7 upgrade places the existing Paladin turret on a Bradley chassis with four times the power generation, a new engine, and an electrically driven gun. After FY23, select Paladins at the division level will also be equipped with the Extended Range Cannon Artillery, one of the Army's long-range precision fire initiatives to outrange adversary fire support and A2AD platforms.³⁴⁵ Also for these missions, the Army is retaining current rocket artillery launch platforms but upgrading munitions. The GMLRS receives a new warhead that ostensibly replaces phased-out cluster munitions. The Army also seeks to field its longer-range Army Tactical Missile System replacement, the Precision Strike Missile (PrSM), in 2023.³⁴⁶

In the near term, the AMPV, OMFV, and JLTV consume nearly a quarter of major Army modernization spending. First and foremost, the Army replaces its obsolete Vietnam-era M113 armored personnel carriers (that McMaster called a “death trap”)³⁴⁷ with the AMPV, a turretless Bradley, a \$14.5 billion program when complete.³⁴⁸ Second, RDT&E and low-rate procurement of the OMFV, which will replace the Bradley, grows to become one of the Army’s costliest programs by FY25. Lastly, the Army replaces its iconic but obsolete Humvees (HMMWVs) with the JLTV, a \$24 billion program at its currently planned size.³⁴⁹ The JLTV, AMPV, and Paladin A7 programs have experienced cuts to the planned procurement quantity for the past two years in favor of other modernization efforts. While the total procurement objectives remain unchanged, the slowed procurement rate pushes costs further beyond the FYDP and has led some to wonder if these programs will become sacrificial lambs for the Army’s other modernization priorities.³⁵⁰

Also worth mentioning is the Mobile Protected Firepower program, part of the NGCV initiative that aims to boost combat power available to infantry brigade combat teams (IBCTs) and SBCTs by giving them a light tank capable of destroying bunkers and obstacles. This capability has not been seen since the passing of the M551 Sheridan: a light, air-droppable direct-fire vehicle. (Think of a tank’s gun on a smaller, faster, and less-protected vehicle.) The Army intends to equip the first of 20 brigades in 2025.³⁵¹

Missile Defense and Support Systems, FY21–FY25. The Army is attempting to reinvigorate its three sections of air and missile defense—the Terminal High-Altitude Air Defense (THAAD) system, the Patriot medium-range system, and a bevy of new short-range point defense systems. The Army invests heavily in the FYDP in the Patriot (PAC-3) air and missile defense system, primarily through improving its interceptor missiles and tying it into a larger battle network, the Integrated Air and Missile Defense Battle Command System construct. This system ties together Patriot radars and launchers with other Sentinel radars and will eventually link up with the

Navy and Missile Defense Agency’s network, plus its THAAD launcher and AN/TPY-2 radar.

The Army’s experience watching the Russian Federation Armed Forces operate in Ukraine also resulted in numerous new equipment needs. Following the divestment of organic air defense formations after the Cold War, the Army has relied on the Air Force or theater Army assets to rid itself of airborne threats. After identifying point defense as a critical capability gap, the Army is rapidly moving to procure mobile short-range air defense (M-SHORAD) vehicles, a Stryker with Hellfires, Stingers, and a 30mm cannon. Originally planned for 2025, the Army now intends to field four M-SHORAD battalions by the end of 2023.³⁵² Similarly, the Indirect Fires Protection Capability Increment 2 (IFPC), which protects critical assets against mortars, artillery, rockets, cruise missiles, and potentially drones, is expected to be fielded in 2025.

Separately, the Army’s Integrated Visual Augmentation System (IVAS), high-tech goggles meant to enhance soldier lethality and borne out of the wreckage of the Army’s multibillion dollar Warfighter Information Network-Tactical (WIN-T) and Future Combat Systems programs,³⁵³ may have a future beyond its currently budgeted \$3 billion odd size over the FY21 FYDP. As the new “eyeballs” of the soldier, IVAS tech might rapidly become standard across the service for data storage, transport, and visualization, building out common infrastructure, or information technology “plumbing,” across the service.

Army Modernization Spending, FY26–FY31

As demonstrated in Figure 20, ground vehicle replacements and helicopter upgrades and replacements dominate post-2025 Army spending. For the ABCTs, current plans envision continued significant sequential upgrades to remanufactured Abrams, Bradleys, and Paladins. Yet, as noted below, these platforms cannot be merely upgraded indefinitely. The mid-2020s will see a significant uptick in Army procurement spending as research programs move

into procurement, leading to a massive crunch in the late 2020s and early 2030s resulting from full-scale replacement of its ground vehicle and helicopter fleets.

The Army has somewhat anticipated this crunch and notes the potential risks of sacrificing readiness and fielded capabilities for researching and developing next-generation platforms in its modernization strategy. And although the 2019 modernization strategy greatly clarified the Army's previously murky long-term acquisitions plan and created clear priorities, it remains to be seen how funds are actually allocated. Lt. Gen. James Pasquaretti, the Army's deputy chief of staff (G-8), commented on future programs in September 2019, saying:

We don't really have a clear picture of what those bills are right now. . . . The [long-term budget] program's what we think they're going to be, but I think as we fully transition from RDT&E [Research, Development, Test, & Evaluation] to procurement, there's unrealized bills out there that we're going to have to figure out how to resource. Right now, I think they're underestimated.³⁵⁴

Internal reforms and "night courts" allowed the Army to find funds to devote to modernization, but the availability of low-hanging savings and reforms will diminish right as Army modernization spending ramps up after 2025.

Ground Combat Vehicles, FY26–FY31. According to McMaster, "The Bradley fighting vehicle and the Abrams tank will soon be obsolete, but they will remain in the Army inventory for the next 50 to 70 years."³⁵⁵ The Army's 2015 modernization strategy provides further detail, worth quoting at length.

Challenges to the Bradley fighting vehicle, in particular, are increasing. The Bradley lacks sufficient protection against underbelly threats. Many enemy combat vehicles outgun it, and it has lost mobility due to the increasing weight of theater-specific force protection upgrades. The M113 family of vehicles is obsolete, because of inadequate protection and

electrical generation capability. Evolving protection requirements have increased the Abrams' weight beyond the capacity of recovery and transportation assets, while increasing formation fuel demands.³⁵⁶

These critiques of the Bradley can be applied broadly across the Army's Ground Combat Vehicle and helicopter fleet. McMaster admirably cuts through the obsession with standoff weaponry that dominates the Beltway to discuss the dirty armored warfare of yore—and the necessary equipment to remain relevant in that area. On the ground, updating the armored BCT will be a massive, expensive undertaking that lasts into the next decades.

As noted, the backbone of the ABCT, the Bradley, faces larger immediate challenges than the Abrams tank or Paladin howitzer do. And let's be clear: While the incremental upgrade programs have succeeded wildly, senior Army leadership wants new vehicles. After the successive failures of the Future Combat System, Ground Combat Vehicle, and Future Fighting Vehicle programs, the Army canceled and then restarted its Bradley replacement effort in early 2020,³⁵⁷ issuing new guidance in April. The OMFV is now slated to first begin replacing the Bradley at the end of FY28, entering full-rate production in FY29.³⁵⁸ Between FY26 and FY31, fielding the OMFV to ABCTs will be one of the Army's largest bills.

Procurement of the aforementioned AMPV will likely last through the early 2030s, further adding to modernization costs. Similarly, Paladin upgrades are expected to continue through FY34 and JLTV procurement through FY41. The more these three programs suffer procurement quantity cuts in the current FYDP, the higher the costs to fully replace the Army's ground vehicle fleet after 2025. While the Army's eventual plan for replacing the M1 Abrams remains unknown, the service has disclosed that it is waiting until 2023 to study the OMFV and then decide on the matter.³⁵⁹ Depending on how much innovation and technology the Abrams' replacement shares with the OMFV, the costs of developing and procuring a replacement main battle tank could balloon the total costs of maintaining the ABCT's superiority into the 2030s.

Lest the light infantry be left behind, the Army plans to continue fielding the Mobile Protected Firepower light tank to the remaining 19 IBCTs and SBCTs from 2025 to the mid-2030s.³⁶⁰ The Army also continues to bat around the idea of up-gunning the remaining three Stryker brigades to match the three brigades already chosen to join the 30mm-equipped 2nd Cavalry Regiment. These additions—along with other potential upgrades to keep the Stryker relevant, such as additional power generation and active protection systems—could add several billion dollars to Army vehicle procurement beyond 2025.

One other initiative of the precision long-range fires cross function team (CFT) is the Strategic Long Range Cannon (SLRC), a mysterious program to create an artillery piece that fires over 1,000 miles and whose initial concept sketches look more like the antiquated railroad guns of World War II.³⁶¹ Intended as another option to defeat adversary A2AD systems from a distance, the details of the SLRC are not yet clear. What is clear is that the SLRC could be another fires platform bought alongside the Paladin A7 (expected to serve until 2050), the Extended Range Cannon Artillery, and PrSM in the next FYDP.

Army Aviation, FY26–FY31. Nor can the Army's helicopter fleet upgrade indefinitely, despite planned investments into the late 2020s that continue incremental upgrades on the Apache, Blackhawk, and Chinook. Abreast with SOCOM, the Army is also planning to outfit its Apaches and Blackhawks with directed energy weapons.³⁶² Based on current plans, the average age of the Army's helicopter fleet will hover around 15 years in the 2020s and 2030s, on par with the average since 1980.³⁶³ More risky is helicopter weight growth killing range, speed, and maintainers.³⁶⁴ To rectify this problem, the Army's Improved Turbine Engine Program (ITEP) is scheduled for a full-rate production decision in FY26, and it is intended to improve power generation by 50 percent and efficiency by 25 percent with new engines for Apaches, Blackhawks, and Future Attack Reconnaissance Aircraft.³⁶⁵ The eventual ITEP procurement cost is budgeted at close to \$500 million or above

per year through the 2040s and beyond, according to the program's 2019 Selected Acquisition Report.³⁶⁶

The Army's Future Vehicle Lift (FVL) helicopter fleet replacement program promises to rank among the largest in Pentagon history. The program will revolutionize Army rotary-wing operations through improved range and speed, as the V-22 Osprey did for Marine Corps operations. It will include significant foreign military sales and likely include the Marine Corps, Navy, and Special Operations Command. The Future Attack Reconnaissance Aircraft (FARA) will replace the role of the now-retired Kiowa helicopter and may be extended to eventually replace the Apache.³⁶⁷ The CBO expects FARA procurement to begin in 2028 and increase from there, with the majority of costs in the 2030s.³⁶⁸

The other major FVL project, the Future Long Range Assault Aircraft (FLRAA), will replace the Blackhawk utility helicopter. The FLRAA will likely see funding added to by Congress in the FY21 NDAA to speed its development.³⁶⁹ A Sikorsky-Boeing prototype is currently competing with a Bell prototype with the winner being announced in 2022.³⁷⁰ The Army wants to deliver the FLRAA to the first unit in FY30, and, along with the FARA, the CBO estimates Army spending on FLRAA to become significant in the 2030s.³⁷¹ Overall, the same CBO report predicts Army aviation procurement spending to reach \$4 billion per year in the early to mid-2030s as these programs mature.³⁷² While expensive, these combined leap-ahead capabilities will give the US Army something it does not currently have: power projection. Further, they will allow the Army to meaningfully support key missions in the Pacific Area of Responsibility, such as sea control.

Missile Defense and Support Systems, FY26–FY31. In air and missile defense, the Army focuses on acquiring systems to counter next-generation threats. Major programs include a new Patriot radar and other upgrades for US Patriot batteries³⁷³ and the continued refinement of a smorgasbord of new point defense systems to defeat incoming precision-guided munitions and take down enemy drones. The Lower Tier Air and Missile Defense

Sensor began as a much-needed replacement for the Patriot's radar but has grown to be a vital component of the Army's Integrated Battle Command System network. Continued funding of the brain software and launcher or missile enhancement is a given. In the rich and growing area of point (think local) defense, IFPC and M-SHORAD will continue to expand and evolve to meet new threats and integrate into the Army's air defense network. The uncertainty attached to each prototype means that none of the Patriot modifications or new point defense systems possess real cost estimates beyond 2025. As such, we have largely based our FY26 to FY31 estimates on the FY21 FYDP cost profiles for each program, but these are certainly subject to change.³⁷⁴

Yet the organic air defense mission and growing need for counter-drone (UAS) systems mean heavy investment and procurement in this area over the next decade. The Army recently selected eight counter-UAS systems to be fielded across the DOD.³⁷⁵ Also on the table for future point defense are several defensive lasers, including a Stryker-mounted system successfully tested in 2018.³⁷⁶

Adding to known modernization costs will be new acquisition programs resulting from next-generation technologies as they mature. Currently, the Army is investing significant R&D funding into hypersonic projectiles, directed energy weapons, and unmanned ground vehicles. In concert with the Navy, the Army

is developing the Common Hypersonic Glide Body (C-HGB), an essential component of the future Long Range Hypersonic Weapon.³⁷⁷ In laser technology, the Army is moving to prototype 50kW, 100kW, and potentially larger weapons for testing in the early to mid-2020s.³⁷⁸ Another major domain for future development is unmanned ground vehicles. The NGCV CFT is working to test light and medium prototypes in 2021,³⁷⁹ but the larger unmanned vehicles will likely take longer to develop.³⁸⁰ These vehicles rely on advances in AI technology but could evolve into large next-generation procurement programs in the next decade.

So while the Army procurement crunch initially looks less menacing than the bills for its sister services do, the Army may face even more difficult problems in the late 2020s and early 2030s. The establishment of the Army Futures Command and the 2019 modernization strategy are great strides toward establishing the Army's modernization priorities and shedding light on the path ahead. Unfortunately, that path is expensive and will require prioritization and the management of near-term risk due to past modernization delays. As then-Deputy Chief of Staff for Army Programs Lt. Gen. John Murray aptly phrases it: "I'm more concerned about the cumulative risk than I am with one budget."³⁸¹ And what a mountain of accumulated risk the Army now faces.

Addressing the Modernization Crunch: Action to Take Now

Solving the modernization crunch will not be easy. Given the long-standing and rapidly growing need for rebuilding America's military, there are no magic wands to wave other than drastically downsizing US commitments and saddling American interests with an ever-burgeoning amount of risk. Nor does the need for modernization occur in a vacuum. Rectifying end strength shrinkage and atrophied readiness of the US military will require large, sustained investment. As Kathleen Hicks wrote at the Center for Strategic and International Studies in 2017, the obvious solution to the "iron triangle of painful tradeoffs" lies in reducing national ambition (mission) for the military or significantly increasing resources to match the high ambition that exists.³⁸² It is likely that both are required and neither likely.

Increase Funding to 3–5 Percent Real Growth.

There's no getting around that the modernization portion of the defense budget must still grow significantly for a number of years or the forces deployed each day around the world will lack adequate equipment to accomplish their mission. To address the strategy-budget gap created by years of anemic modernization accounts, Mattis testified in 2017 that the defense budget topline would require 3–5 percent real growth each year through 2023.³⁸³ That growth never fully materialized. In 2019, AEI scholars Gary Schmitt and Rick Berger assessed that between 2020 and 2021, 3–5 percent real growth would total \$40 to \$100 billion over the defense budget toplines set by the budget agreement reached by Speaker Nancy Pelosi and Treasury Secretary Steven Mnuchin to fix spending levels through the final years of the BCA.³⁸⁴

However, in its analysis of the FY21 defense budget request and associated spending plans, the CBO observed that according to the department's 2021 plan, "Total funding would be relatively flat through 2025, averaging about \$707 billion per year in 2021 dollars."³⁸⁵ Simply ignoring bills as they pile up is no way to manage a budget; willful denial is an unsustainable and irresponsible plan. Tackling the modernization crunch as early as possible reduces the number of difficult or genuinely impossible choices presented to the next generation of national security officials.

Further, there exists solid statistical evidence that the overall defense funding climate actually affects the cost growth of weapons more than whether the acquisition system itself is "good," "bad," "reformed," or "not." In an underappreciated study, David McNicol of the Institute for Defense Analyses analyzed the average cost growth of major defense acquisition programs in distinct periods of acquisition reform and constrained or accommodating funding. While the study was careful not to ascribe full causation, it concluded the correlation between higher average cost growth and periods of relatively constrained funding is significantly affected by poor decisions made in restrained funding environments such as "unrealistic cost estimates or programmatic assumptions . . . [or] such as failing to act promptly on test results."³⁸⁶ For instance, a program manager faced with negative testing results in a period of constrained funding might by necessity try to forge on without fully addressing the problem, leading to worse (and more expensive) problems down the road. Kendall similarly noted that cost growth for new programs is negatively correlated with the absolute size of the defense budget. In plain English, that

means weapons cost more when they're started amid shrinking and tight budgets, a similar insight to that of the Institute for Defense Analyses study.³⁸⁷

Make Upgrade Trade-Off Choices Early. During her confirmation hearing to be deputy secretary of defense, Hicks reaffirmed the time value of money and lamented the continuing kicking of the can of tough decisions to kill or keep various programs.³⁸⁸ The Pentagon and Congress simply must make early choices between continued upgrades and new investments in developing and fielding equipment. Of course, defense officials are loathe to do so, and Congress is loath to support them. Continual service life extensions and upgrades represent a low-risk equipment strategy that keeps the proverbial iron on the ramp back home, but many of the underlying systems are simply no longer viable based on capability or life cycle cost. Upgrade programs should be scrubbed to determine the extent to which they will deliver real value or merely constitute a short-term patch solution when a replacement program is the smarter investment.

There are several case studies of these types of trade-offs. In 2018, the Army announced it would substantially cut the Bradley upgrade program and restart the Bradley replacement program, the OMFV.³⁸⁹ For small-deck amphibious ships, the Navy wants to invest in the more capable LPD-17 Flight II, rather than continue upgrades to the LSD-41/49 ships.³⁹⁰ The Air Force is purchasing one-for-one replacements for F-15Cs slated to retire in the early to mid-2020s rather than continue to upgrade C-model airframes with exponentially increasing maintenance costs.³⁹¹

These choices are crucial to make early since the continual deferment of modernization priorities does not save money. Money simply shifts from procurement to O&M as a result of not making faster tough choices. For some programs on the margin of necessity, a deferral followed by cancellation can represent real savings. But the more common continual deferment of necessary programs merely repeats development program spending, often without any benefit, and results in dozens of inefficiencies related to the ultimate purchase: changing

requirements. By pursuing modernization in fits and starts, requirements devolve into disjointed, siloed messes that create ripple effects for dozens of other programs, particularly in platforms that operate closely with others.³⁹²

Publish Better Long-Range Forecasts. The Pentagon should make transparent much more data about its long-term modernization plans. Defense officials often cite operational security concerns to bat away these criticisms, but it's increasingly hard to believe that the remarkably capable cyberespionage units fielded by our peer and near-peer adversaries do not already possess most of this information. The attractiveness of secrecy is no longer worth the degradation in congressional trust and understanding of the scope of the problem. The Pentagon is only fooling itself. Preventing Congress from appreciating the scope and scale of upcoming modernization challenges hampers the necessary debate and oversight that published plans would engender, undermining the trust that must exist between Congress and the military to carry out such plans.

People are skeptical of long-term plans. There's a kernel of truth in that the best-laid long-term procurement plans of mice and men go often askew. Yet one can merely look to the impressive debate spurred on by the analysis of the 30-year shipbuilding plans completed annually by Labs at the CBO to understand the value of such long-term data.³⁹³ Similar CBO analysis by Ed Keating on long-term military aviation procurement plans shows great promise in framing choices for decision makers.³⁹⁴ Likewise, while the FYDP remains imperfect—and its accuracy is often overestimated—it remains a valuable signpost for framing policy discussions about budget decisions that will inevitably reverberate for years. Just because a blueprint changes on the margins over time doesn't mean it should be abandoned.

Ambitiously, the services should supplement these existing sources by undertaking their own long-term programming efforts—like the old aviation plan and existing shipbuilding plan, but with more detail—to spell out the challenges they face. The current mish-mash of service- or platform-specific plans should be

fed into an under secretary of defense for acquisition and sustainment-led department-wide programming document. The report should identify joint force acquisition priorities and choices at numerous funding levels.

Demand More Conservative Cost Estimates.

The Pentagon and Congress should consider instituting a more conservative cost estimation regime. In the simplest terms, the military tends to underestimate how much weapons will cost and therefore request too little in procurement spending. McNicol shows that a significant portion of what's commonly called "cost growth" or "cost overruns" is the simple product of overly optimistic or overly risky cost estimation methodology.³⁹⁵ Cost estimates are hard, and the CAPE office has driven great improvements over the past decade. But structural incentives remain to underestimate the total cost of modernization programs to avoid being forced to choose between programs. While this keeps more programs alive for the moment, it leads to suboptimal outcomes—and often fewer programs—in the long run, destroying trust among the Pentagon, Congress, and the public. Once again, Hicks acknowledged the importance of addressing this issue during her confirmation hearing at the start of 2021, observing that "the incentive structure is built around budget share" for the services in relation to program decisions and each service focuses on protecting its programs as a result.³⁹⁶ Hicks counters that "the incentive is about serving the joint warfighter."³⁹⁷

A complicating factor is that cost estimators are dealing with numerous large programs with no antecedents, which means the cost estimates are particularly uncertain. For instance, the *Columbia*-class nuclear ballistic missile submarine program originally had a cost estimate "well below the 50th percentile confidence level," which means it could still experience cost growth of tens of billions of dollars *even if nothing necessarily goes wrong*.³⁹⁸ Similarly within the nuclear triad modernization, the official GBSD cost estimate was originally below the independent CAPE cost estimate, which itself was a lowball estimate.³⁹⁹

The GAO has warned about the risks posed by such knowledge gaps for the past several years, most notably in its defense acquisition annual assessments, particularly as the services drive to deliver capabilities faster and faster.⁴⁰⁰ As Wong cautioned in December 2020, "Prioritizing program schedule almost by definition comes with consequences for the other two parts of the acquisition triad: cost and performance."⁴⁰¹

There are other wrenches in the cost estimate process. For example, new weapons programs must still be manned, though these dollars are not reflected in RDT&E and procurement accounts. Still, if the estimates are too low (or too optimistic) for new platforms, rising unforeseen manpower costs alone—not to mention maintenance and training costs—could pull dollars away from the modernization programs that advance in the second half of the 2020s. As such, the DOD needs to avoid estimation failures like the ones that plagued the LCS, a program characterized by manpower planning that the Project on Government Oversight described as "wildly unrealistic."⁴⁰² Indeed, between 2003 and 2016, GAO found that crew size for the LCS grew by 31 percent.⁴⁰³ Further, while the Navy originally suggested that the extensive use of automation elements would reduce manning requirements for the LCS, by 2014 GAO determined that "the LCS may exceed or closely align with the costs of other multimission surface ships with larger crews," a finding it sustained in 2017.⁴⁰⁴

In practice, these factors mean that a great number of current acquisition programs are likely operating on overly optimistic cost estimates, given that they became programs of record in what McNicol terms a period of relative fiscal constraint in the defense budget. The Office of the Secretary of Defense decides how much risk to accept in cost estimation. As a first step, a focus on improving the accuracy of program cost estimates can and should coincide with hard fielding schedules, throwing out two-decade time frames and uncertain future fielding dates for schedules measured in months or years.⁴⁰⁵ Only strong civilian leadership from that office can end this damaging cycle and adjust the Pentagon's weapons cost estimates to a more realistic standard.

Improve Defense Resourcing Practices to Engage Congress as an Informed Stakeholder.

Rationalizing and improving program cost estimations is just one part of the equation for convincing Congress of the substantial modernization spending need signal that will continue flashing evermore intensely through the 2020s. Another critical element is revamping defense budget processes, procedures, and reporting, so that Congress receives radically improved and timely visibility on program changes when they occur. Congress is responsible for overseeing the defense budget—and providing members with the details they need to make informed and responsible investment decisions should be a priority for the DOD.

Currently, Congress receives yearly public defense budget justification materials and program-specific data via thousands of pages of documents released with the annual budget request each February, along with supplementary information such as the service-specific “Unfunded Priority Lists,” reprogramming requests, Selected Acquisition Reports (usually released in December), and hundreds of other congressional reporting requirements. In practice, that means that if analysts want to understand how much the B-21 program will cost over the next 10 years, they need to look in about 10 different places to collect all the relevant information. And that’s just for one program. Congress is responsible for overseeing hundreds of appropriations like the B-21 (though a minority are quite as substantial or complex). Further, as McCusker has described, each appropriation comes with different constraints and restraints.⁴⁰⁶ That Congress is still frustrated by its lack of transparency into the DOD’s funding decisions—despite the time and treasure spent by the department on an avalanche of reporting each year—is damning evidence that the system is still frustratingly inefficient.⁴⁰⁷

McCusker advises applying lessons learned from the department’s current audit efforts and the resulting “incremental integration of financial, contracting, and other data sources to support enterprise-wide data analytics tools” to develop reasonable options for “updating appropriation structures and budget justification materials.”⁴⁰⁸ In short, the DOD should

share more comprehensive and easily accessible defense budget information with Congress so that the committees of jurisdiction can conduct their jobs more effectively. Consolidating, reporting, and communicating data effectively is doubtless associated with some form of technology solution, likely driven by new data analytics software.

Still, that’s only one part of the fix. If the data provided are insufficient, incomplete, or unhelpful, then new tools will have limited utility. Consider the example raised by the Senate Appropriations Committee in its explanatory statement for the FY21 defense appropriations bill: changes in advanced procurement for the Navy’s CH-53K King Stallion heavy-lift helicopter.⁴⁰⁹ Advanced procurement is a type of funding that Congress provides for certain programs that will take a long time to complete. Advanced procurement funding helps maintain procurement schedules. In its FY20 budget request, the Navy said it would procure 12 CH-53Ks in 2021, so it received \$215 million in funding for the CH-53Ks that would be built in 2021. However, in its FY21 request, the Navy asked to procure only seven CH-53Ks, instead of the originally planned 12. The service asked for \$813 million to fund those seven helicopters. Among many reasons detailed, the Senate appropriators were frustrated because this change of plans represented a decrease of \$515 million and five aircraft from the original 12 helicopters that Congress had originally supported with \$215 million in FY20. Senate appropriators also said they did not receive a clear rationale for the reduced purchase. As a solution, the appropriators asked for reams of new reporting for any program for which advanced procurement funding is provided—including the quantity of items the funding supports, the unit cost of each item, and the schedule for the production of the items. Just finding and applying better data analytics tools will not fix miscommunications and issues like this. Determining and implementing sustainable and improved practices for data *sharing* between Congress and the DOD are also crucial.

Improve Defense Program Management Flexibility. Beyond facilitating Congress’ oversight duties, the DOD also stands to gain from improving program

budget transparency with lawmakers. Department officials can better make the case for increased program flexibility if they can reassure Congress that such efforts have utility and are likely to reduce costs if defense budget management reforms are implemented in association with improved reporting.⁴¹⁰

This isn't a new idea. Congress itself established an advisory panel on reforming defense acquisitions in the FY16 NDAA under Section 809: "with a view toward streamlining and improving the efficiency and effectiveness of the defense acquisition process and maintaining defense technology advantage."⁴¹¹ The panel received the rather enervating title "Section 809 Panel," and it has subsequently released a tremendous analysis of existing defense acquisition governance, culminating in its third volume containing recommended reforms in 2019. Recommendation 36 on transition from a program-centric execution model to a portfolio execution model merits particular attention because the DOD's implementation attempts were smacked down by congressional appropriators in 2020.⁴¹²

At the risk of extreme oversimplification, portfolio-centric management is the result of consolidating multiple programs into a single related group (or "portfolio"). In that portfolio, the logic follows, priorities and funds could be shifted quickly between different programs by program executive officers without the usual congressional approval requirements to save time responding to fast-changing global conditions, avoid inefficiencies, and increase the speed of acquisition—supporting struggling programs, funneling more dollars to promising initiatives during a fiscal year, and more.

To reiterate why such reforms would be helpful, in July 2020, Eric Lofgren described the byzantine labyrinth of the Army's 2021 defense budget request, with "182 RDT&E program elements (PEs) that are ultimately subdivided into 2,883 budget program account codes (BPACs) in the budget justification documents, detailed across 5,203 pages."⁴¹³ Lofgren further expounds, "Congress controls the transfer of funds at the PE level, which for Army RDT&E had a median value of \$28 million and a mean of \$69 million in the 2021 request."⁴¹⁴ Lofgren advised that the first

phase of budget reform could start with consolidating RDT&E program elements. Roper also advocated for such reforms for the Air Force and Space Force.⁴¹⁵

Unfortunately, congressional appropriators rejected the smallest possible step in this direction this year. The Air Force had taken the lead by proposing lumping together a number of programs into newly consolidated program elements—for example, by bundling together five research programs on electronic warfare into one larger program. However, the House and Senate Appropriations Committees both roundly rejected the Air Force's proposals—guaranteeing they would not make it into the final defense appropriations bill for FY21.⁴¹⁶ Commenting on the proposal's failure in November 2020, Cancian said,

Congress in general has never liked the idea of portfolios—or anything like that—that sort of has the flavor of slush funds . . . that DoD can move the money around on its own authority without controls by Congress.⁴¹⁷

As such, if the DOD wants to get Congress on board with acquisition reform, it needs to make the case that Congress' oversight abilities will not be compromised. That starts (though certainly does not finish) with transparency.⁴¹⁸ As Chris Brose, staff director of the Senate Armed Services Committee from 2015 to 2018, bracingly summarized, the fundamental failure to equip the US military with bleeding-edge technologies "has not been the sole fault of the Department of Defense, Congress, or the defense industry."⁴¹⁹ Rather, "it has been a systemic failure that involves all three, on a bipartisan basis."⁴²⁰ Brose concludes, "Washington sacrificed speed and effectiveness in the military-industrial complex for the hope of cost savings and efficiency, and it ended up with neither."⁴²¹ Congress and the DOD need to begin addressing and amending these stultifying processes with a sense of urgency.

Ensure New Programs Are More Upgradeable—Particularly for Software—so the Next Bow Wave Is Not as Bad. Generally, upgrades add new capabilities to existing weapons platforms. Two

realities complicate such efforts across the DOD: (1) The military invests in hardware that lasts decades with ever-rising sustainment costs, and (2) the software linked with or incorporated in that hardware is constantly evolving.⁴²² The DOD needs to be creative in accounting for these interlocking factors in future weapons systems while finding workable solutions for legacy platforms today.

Some systems simply will not have the growth margins (in space, power, weight, and more) to operate in the future force. These margins are the traditional means by which a platform's upgrade capacity is generally considered or inform their condition as an adaptable system. However, as Andrew Hunter at the Center for Strategic and International Studies outlines, to capitalize on rapidly advancing technologies, the military must increasingly rely on nontraditional approaches to designing adaptable systems.⁴²³ As Hunter details, "It is becoming increasingly clear that the characteristics of adaptable systems can also be achieved more cheaply and more successfully in the defense sector through writing new software rather than building and adding new hardware."⁴²⁴

While Hunter identifies five options for improving the adoption of such adaptable systems, consider two promising examples: (1) Modular Open Systems Approach (MOSA) and Adaptable Architectures and (2) contracting mechanisms that allow for increased acquisition flexibility.

First, the key premise of MOSA is that hardware should be easily built to incorporate new software for a "plug-and-fight" design. Section 805 of the FY17 NDAA established MOSA as a baseline for system design.⁴²⁵ To build such a flexible architecture, common standards are required. In February 2019, all three service secretaries signed a memorandum requiring such shared standards of information sharing in future weapons systems, with the goal of enabling MOSA. According to the press release accompanying the memorandum, the Air Force announced that it is already pursuing MOSA "with platforms such as its next-generation bomber, the B-21 Raider, while the Army is using these principles to modernize its ability to communicate among its maneuver units."⁴²⁶ Similarly, the release continued,

"The Navy has seen great benefits to its submarine force by employing such approaches."⁴²⁷

Second, more flexible acquisition processes such as Other Transaction Authority (OTA) agreements—which waive or renegotiate certain onerous government contract requirements and have allowed the services to work with more nontraditional contractors—are becoming a "core element of the Department of Defense's approach to technology acquisition."⁴²⁸ Section 815 of the FY15 NDAA expanded the range of instances in which OTAs could be used, particularly for R&D prototyping.⁴²⁹ As a result, according to research from Rhys McCormick, also at the Center for Strategic and International Studies, OTA obligations across the DOD have increased by 712 percent since FY15.⁴³⁰ These are encouraging trends that should receive congressional support.

Third, in the short term, the Pentagon can still think creatively about how to derive the most utility from existing legacy systems to serve future modernization priorities and solve immediate capability deficits. The Pentagon cannot expect to field massive fleets of entirely new weapons systems overnight. It can, however, continue incorporating new technology in old hardware as a stopgap measure. Chairman of the House Armed Services Committee Adam Smith recently summarized this line of thinking: "It's not necessarily about whether it's a legacy platform or it's a new platform. . . . If you make systems that can survive, that's what we're looking for."⁴³¹

To be sure, eventually that's a moot point. As discussed, many legacy systems simply do not have the growth margins required to sufficiently enhance their survivability or combat effectiveness for the next decade. Still, on the current trajectory, over three-quarters of the fighting force today will be the same forces fighting in 2030, so immediate solutions are still important investments.⁴³²

To that end, policymakers should invest in two approaches. First, prioritize solutions with shorter fielding timelines with proven technologies. For example, as discussed with John Ferrari, the Army could consider using driver-assisted technology from the commercial sector in some of its legacy vehicles, instead of waiting for brand-new platforms such as

the OMFV to reach the force.⁴³³ Second, broadly apply the lessons learned from successful recent technology development efforts to field economical solutions that meet mission requirements. To this end, the Army's IVAS program is a strong point of reference. Once again, one of the factors behind the fast and powerful innovation that launched IVAS was the Army's ability to link developers with soldiers in the field to design the system.⁴³⁴ Engaging end users early in future innovation efforts will help contribute to the efficacy of new technologies that will augment or replace legacy systems.

Field Innovative Technologies Faster by Shortening Contracting Cycles. Ambitious defense acquisition reforms must also focus on shortening defense acquisition contracting cycles to deliver new capabilities to the force (in theory) at the speed of relevance. In May 2019, Pete Modigliani and Dan Ward at the MITRE Corporation wrote that “contracting is often one of the longest lead items in the [defense] acquisition life cycle, and one of the riskiest.”⁴³⁵ This is because “traditional contracting methods can take 18 months to three years to compete and award a contract.”⁴³⁶ While GAO has delineated variation in that time frame, Modigliani and Ward explicitly concluded this contract award time “increases the risk of the program delivering products that are operationally irrelevant, technologically obsolete, or both.”⁴³⁷ Imagine buying a Ferrari when really you needed a Jeep for off-roading—and it will now take you seven years to buy a Jeep. After a contract is awarded, GAO further estimated the average cycle time for an MDAP to deliver initial capabilities is a little over 10 years (126 months) and “more MDAPs than not have experienced or anticipate experiencing schedule growth that results in delays delivering initial capabilities.”⁴³⁸

Part of the solution is to at least shorten the time it takes to contract for new defense acquisition programs and deliver them. As discussed, OTAs generally help defense contractors avoid more time-consuming elements of the preliminary requirements process. For example, when compared to alternative methods, Greenwalt and Benjamin Schwartz recently examined in a new report the utility of OTAs and noted that

OTAs can shorten the time from a request for a white paper to a contract award to around 120 days instead of 12–18 months.⁴³⁹

Another option involves embracing the Middle Tier of Acquisition (MTA) approach, authorized in Section 804 of the FY16 NDAA, which focuses on using rapid prototyping and rapid fielding pathways to deliver capabilities to the force in two to five years.⁴⁴⁰ While the DOD since recommended against using MTAs for major systems “intended to satisfy requirements that are critical to a major interagency requirement or are primarily focused on technology development, or have significant international partner involvement,” the approach still should be fully used where and when possible.⁴⁴¹

As with much of this report, the challenge of accelerating the defense acquisition process is not new or unexpected. Back in 2014, Kendall admitted that he was “struck very quickly by the modernization program of China in particular, and to a lesser extent Russia, and how aggressively modernization was proceeding and how strategically focused it was on the objective of defeating the United States, if necessary.”⁴⁴² When Ellen Lord became acquisition chief in 2017, she also identified a need to speed the award of defense contracts by as much as 50 percent.⁴⁴³ Greenwalt and Schwartz argue the US defense acquisition system must produce faster, better, and cheaper military capabilities. They are correct.

As Greenwalt and Schwartz pointed out in their report on the value of OTAs, China's military modernization is a powerful case study for what can be accomplished when there is extreme coordination between the public and private sector (or true “civil military fusion,” regardless of how it is accomplished).⁴⁴⁴ Chinese defense planners never need to figure out how to encourage and incentivize innovative companies to contract with the government. And those companies never need to wait in limbo for new rounds of funding. China's military partners easily and rapidly with private industry—a dynamic that has partly facilitated the extraordinary growth of China's military over the past 20 years in both capacity and capability. In that time, the PLAAF alone shifted from a fleet of largely second- and third-generation Soviet aircraft to

a fourth-generation force,⁴⁴⁵ with yet another jump to the fifth-generation J-20 (which looks remarkably like the F-22) and its new B variant.⁴⁴⁶

Of course, there are risks associated with going faster, and they should be managed. Again, as Wong cautioned in December 2020, “Overdosing on speed (so to speak) can shortchange sustainment concerns, incentivize short-sighted design, or create other problems that may eventually trigger scrutiny from Congressional overseers.”⁴⁴⁷ We do not recommend, endorse, or advise prioritizing speed at the cost of delivering practical capabilities. We strongly support frequent prototype demonstrations when possible, for example, and similar best practices. However, finding the perfect balance of acceptable program risk when weighed against speed must account for external variables—namely, China’s willingness to make evermore ambitious defense investments. Lawmakers must begin to complete this full equation.

In the Short to Medium Term, Reduce Mission Demands on the Force. Even if the DOD receives the funding it needs over the next four years to modernize for the 2030s and secure US deterrence through the next decade, it will take time to fully rebuild the force for a number of reasons, including the limitations of the defense industrial base and fielding schedules for new programs. In the interim, it is unacceptable to merely suggest that existing personnel and equipment should be spun faster to meet unrealistic demands. That is no way to preserve the strained readiness of the existing force.

As originally argued in *War on the Rocks* in November 2020, before determining if a mission is essential, leaders should first answer the question, “Essential to what?”⁴⁴⁸ The US military’s attention should increasingly revolve around fulfilling a stated objective of the 2018 National Defense Strategy, accounting for the guidance and critiques delivered by the 2018 National Defense Strategy Commission.⁴⁴⁹

To this end, as advised with Colby and Roger Zakheim in September 2020, “The Pentagon should reevaluate the utility of extended peacetime presence missions, even if the initial savings from doing so are modest.”⁴⁵⁰ The Navy should reallocate assets away

from less important missions such as counter-piracy efforts in the Horn of Africa, particularly as it begins to focus more on the Pacific and continues to dedicate forces to the Persian Gulf, North Arabian Sea, and Gulf of Oman, as recently demonstrated by extended stationing of the USS *Nimitz* (CVN-68) and its carrier strike group in the region.⁴⁵¹

Other missions that can be reallocated to other departments and agencies should be redistributed as quickly as possible. The US Coast Guard, US Customs and Border Protection, and the Drug Enforcement Administration should take over drug interdiction efforts. Similarly, election security—however important—is not the US military’s job.⁴⁵² Rather, it should be left to those departments with domestic mandates—including the Cybersecurity and Infrastructure Security Agency (which already handles election infrastructure security), the Department of Homeland Security, and others with related competencies.⁴⁵³

When the DOD cannot shed missions, cheaper methods of achieving them must be advanced. For example, Security Force Assistance Brigades could substitute for more expensive forces and methods. As flagged with Colby and Zakheim, “In the Middle East, the military continues to use high-end fighters at great costs in low-end missions, even though a light attack aircraft could accomplish reconnaissance, close air support, and strike missions in relatively uncontested environments.”⁴⁵⁴

Overarching these recommendations is a fundamental need to manage and curb the force demands of combatant commanders. Functional combatant commands that provide capabilities worldwide (such as Transportation Command) and geographic combatant commands (such as European Command) submit force requests to the services that are responsible for training and equipping the force. Unfortunately, more often than not these force requests are unrealistic. Combatant commanders have recently asked for a number of submarines that will not be available for decades from the Navy, extreme operational tempos from the Army, and an increasingly unsustainable number of aerial refueling tankers from the Air Force, and they maintained a generally high number of Air Force sorties, despite ever-fewer aircraft.⁴⁵⁵ The US

military should not justify missions it cannot complete without continuing to carve away readiness—and with an older, smaller force, these operating margins will only grow tighter.

Restore Readiness Selectively. At a fundamental level, the US military is maintaining a tempo of operations that is unsustainable. The solution is to cut missions and selectively increase the readiness of specific platforms and units in the existing force. The DOD defines readiness as “the ability of military forces to fight and meet the demands of assigned missions.”⁴⁵⁶ Readiness is generally considered a function of DOD O&M spending. To meet the modernization bow wave, O&M dollars should not be prioritized over the RDT&E and procurement accounts (even though O&M will inevitably increase in association with the costs of a larger force).

The readiness consequences of failing to cut missions are already becoming apparent across the force. The National Commission on Military Aviation Safety released a report in December 2020, finding that between 2013 and 2018, more than 6,000 noncombat military aviation mishaps occurred, 198 service members and civilians died because of those mishaps, 157 aircraft were destroyed, and the nation lost \$9.4 billion in damages.⁴⁵⁷ The numbers didn’t improve in 2019. While the Army’s and Air Force’s mishap rates did not change significantly, the Navy and Marine Corps experienced significant increases.⁴⁵⁸

Separately, analysis conducted by Megan Eckstein from the US Naval Institute News pointed out that in 2020, due to maintenance backups, scheduled periods of refueling and complex overhaul, and acquisition delays, “just four continental US based carriers able to shoulder the burden of deployments and pre-deployment workups . . . straining four ships to do the work of 11 carriers.”⁴⁵⁹ As Eckstein summarized, “A top concern is better future readiness—of the ships, the aircraft and the sailors—to meet current global demands.”⁴⁶⁰ On top of a restricted force, the carrier fleet was also taxed in 2020 by its increasing activity in the Middle East. Between 2018 and 2019, the Navy was able to draw down forces in the region from 25 to 16 percent of the carrier fleet, in

accordance with the 2018 National Defense Strategy prioritization of China and Russia, but 2020 reversed the drawdown.⁴⁶¹ In 2020, the Navy returned to where it was in 2016, with total carrier days in the Middle East reaching 328 again and requiring back-to-back “double-pump” deployments to sustain the grueling presence requirement.⁴⁶²

To meet the modernization bow wave, O&M dollars should not be prioritized over the RDT&E and procurement accounts.

With these factors in mind, the focus over the next four years must be on keeping certain units at a high level of readiness while accepting risk in other areas to fund modernization programs. To their credit, Gen. Brown and Gen. Berger are beginning to make the public case for a similar conversation about striking a balance between current readiness, modernization, and near- versus long-term risk.⁴⁶³ While these prioritizations should be made as the result of dedicated studies, wargames, and trade-offs made in the DOD with Congress, certain platforms and units are likely to receive higher rankings, including “first-to-fight” forces such as tactical fighters and enablers, attack submarines, and potentially amphibious ready groups. These forces will need high mission capable rates and high aircraft availability rates, along with the appropriate amount of training hours and other key metrics of readiness that should be closely monitored.

Notably, the House and Senate Armed Services Committees already incorporated helpful legislation to further this goal as part of the 2021 NDAA. Section

147 of the conference report details that at least the secretary of the Air Force is required to provide an independent study that will address key questions such as the “number of weapons systems required to meet a specified mission goal” and the “number of personnel required to meet a specified mission goal.”⁴⁶⁴ The results of this study will help assess cost per effect for key mission areas of the Air Force. It will also be a useful guidepost for helping lawmakers prioritize mission sets and consider the type of force the nation will require in the future to achieve a range of evolving missions. For today, Congress and the DOD can begin to discuss where readiness funding should be directed and which missions can be scaled back, handed off, or ended entirely.

Evaluate the Option of Creating Working Capital Funds for Various Defense Modernization Priorities.

President Biden has delivered a third economic stimulus, following the Coronavirus Aid, Relief, and Economic Security Act and the subsequent \$900 billion stimulus bill Congress passed in December 2020. The president’s new plan is a nearly \$2 trillion relief package, including additional stimulus payments for households, extended unemployment benefits, and tax credits. Reporting suggests the Biden administration will subsequently advance another \$3 trillion tax and infrastructure package.⁴⁶⁵ Fundamentally, this package will be about launching economic growth in 2021 after the COVID-19 vaccines are more widely available across the United States. Accordingly, the new Congress and White House should evaluate the potential benefits of using the infrastructure spending package to jump-start appropriations to establish additional defense working capital funds (DWCFs) to support the following: (1) defense infrastructure and installation improvements to take pressure off conventional modernization programs, (2) a separate fund for nuclear modernization, (3) another fund for conventional modernization programs, and (4) a shipbuilding fund aimed at addressing the Navy’s insufficient shipyard infrastructure.

This proposal should not be taken lightly or undertaken without appropriate study and debate. It is also

unlikely to be particularly popular with a new administration that will be facing understandably enormous pressure to invest in other drivers of economic recovery. The proposal is still worth considering for several reasons, but the most basic is this: Delaying attempts to meet the modernization bow wave will only increase costs and consequences in the long term, and efforts to begin addressing it now could contribute to rapid economic growth desperately needed by the US economy.⁴⁶⁶ Kill two birds with one stone.

At the risk of yet another oversimplification, working capital funds are helpful for defense spending—and general federal spending—because they generate efficiencies. Direct appropriations are used to start or increase the size of a DWCF once it is established. DOD commands, organizations, offices, or other elements can pay into the fund after it is created. The fund then serves to coordinate subsequent purchases across the so-called “customers” (purchasers across the DOD in this case). At an extraordinarily basic level, let’s say the Air Force and Army both need a specific type of new insulation for their respective bases as part of an installation upgrade program. If they ordered the new matériel and construction via a DWCF, they could realize efficiencies by purchasing that insulation matériel in bulk. While a hypothetical example, the DOD had an “unfunded backlog of deferred maintenance and repair work exceeding \$116 billion” as of 2018.⁴⁶⁷ Given the chronic underfunding of the military construction Facilities Sustainment and Restoration and Modernization account, that hole is unlikely to be filled anytime soon—creating yet another competing defense spending priority for the already squeezed defense modernization programs.

Further, DWFCs have the added benefit of funding consistency. Since they do not necessarily depend on regular fiscal year appropriations, unlike most defense spending programs, they are less likely to suffer from the deleterious impact of regularly occurring stopgap funding continuing resolutions, which delay program starts, delay existing acquisition schedules, and more.⁴⁶⁸ Accordingly, a concerted effort should be made to evaluate its viability in advance of an infrastructure-related stimulus bill.

Most Importantly, Decide What the United States Wants from Its Military. The external security of the United States cannot be mortgaged for its domestic safety when both are necessary. Domestic threats and challenges such as pandemics, natural disasters, election security, and economic growth are crucial concerns that unquestionably deserve serious and concerted attention and engagement. However, addressing these priorities will neither solve nor mitigate the United States' eroding competitive military advantage. As stated in the 2018 National Defense Strategy, "The Department of Defense's enduring mission is to provide combat-credible military forces needed to deter war and protect the security of our nation."⁴⁶⁹ The 2020 Democratic Party Platform argued that America "can maintain a strong defense and protect our safety and security for less."⁴⁷⁰ This report finds this claim is simply not true.

The 2017 *Repair and Rebuild* report argued that regaining technological superiority was not enough to ensure conventional deterrence in the future. Today, the US military is backed into a corner, increasingly investing to maintain the readiness of today's force while facing the looming bow wave of the 2020s that has until now largely remained unaddressed and unattended. This report is intended to force a confrontation with the unvarnished reality of how much it will cost to modernize our armed forces to protect the United States' security in an era of intensifying competition with peer competitors. While reasonable people may disagree about the judgments and calculations included herein (which we welcome the opportunity to discuss), the macro-level trajectory of our military's degrading comparative strength is indisputable. Time and money are no longer on our side; too much of both have been wasted already.

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