THE FUTURE FIGHTER FORCE OUR NATION REQUIRES: BUILDING A BRIDGE

MITCHELL INSTITUTE for Aerospace Studies

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About the Author

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Cover design by Kamilla Gunzinger; photos: U.S. Air Force.

Contents

Executive Summary

This report analyzes the priorities, issues, and other dynamics that are shaping the Air Force's fighter force and recommends actions that will help the service build a bridge to a force that will meet the nation's security needs now and in the future. There are five major components to this analysis. The first addresses how the Air Force should manage its aging legacy fighters. The second issue the Air Force must come to terms with is the impact that acquiring the "new-old" F-15EX may have on the service's ability to transform its fighter force into one that is relevant to peer conflicts. Third, the service must address concerns with the capabilities and availability of upgraded F-35A aircraft as well as the overall affordability of the F-35 program. Importantly, the Air Force must revisit its decision to slow production rates to the point that it is insufficient to recapitalize its legacy fighters. Fourth, the service must ensure that capabilities needed for the air dominance mission are not gapped. To do so, the Air Force may need to extend the service life of its small F-22 force well into the 2030s. At the same time, it must remain fully committed to developing its Next Generation Air Dominance (NGAD) family of systems. Finally, the Air Force should initiate the development of an alternate stealthy fighter that could begin fielding in the early 2030s. In combination, these actions would help ensure the Air Force has a fighter force with the capabilities and capacity needed to meet *National Defense Strategy* requirements with a budget that is under stress to meet many other modernization needs.

The small inventory of aging legacy F-15C/D, F-16C/D, and A-10C aircraft that currently comprise the backbone of the Air Force's fighter inventory are a poor, if necessary, crutch to meet the demands of an increasingly dangerous security environment. The reason to maintain many of these aircraft in the force as a bridge to the future is simple: there is nothing else today that can provide America's warfighters with the fighter capacity they require to deter and defeat Chinese or Russian aggression. These legacy aircraft are also needed to defend the U.S. homeland, handle lower-tier combat operations like counterterror missions, and maintain the U.S. Air Force (USAF) pilot force. Although F-15C/Ds, the F-16C/Ds, and A-10Cs have all benefitted from service life extension and modernization programs, the fact remains that they cannot be upgraded to the point where they can survive in advanced threat environments.

The complexity of the global security environment requires fifth-generation fighters in numbers that the Air Force does not have today.

The complexity of the global security environment requires fifth-generation fighters in numbers that the Air Force does not have today. Not only are more fighters required to fulfill operational demands in multiple theaters, but U.S. military planners and commanders must now account for aircraft loss rates in a peer conflict that they have not had to contend with since the Cold War. Even though advanced fifth-generation aircraft are very capable, the increased lethality of state-of-the-art air defenses means there will still be losses. The size of the USAF's current fighter force does not account for this fact. Thirty years of operating in permissive environments have allowed defense leaders to thin out the fighter inventory to achieve efficiencies and reduce costs. Decisions to cut the size of the force were based on assumptions that every fighter would return to its base and would be able to quick-turn to fly the next sortie. Today's

reality of contested battlespaces means the Air Force must change these assumptions—even for its fifth-generation fighters—and the future force must have additional reserves available to ensure operational density and tempo do not suffer from fighter battle damage and attrition.

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Without a capable fighter force composed of modern fifth-generation aircraft to back up U.S. diplomacy, U.S. leadership will lose security options and reduce its credibility. This vulnerability has the potential to dramatically alter global norms and the rule of law that has benefitted the United States and most of the free world for the past century. Put another way, U.S. global leadership is underpinned by credible military strength, especially by the asymmetric advantage historically afforded by superior American airpower. A force lacking capacity and capability to project strength and counter multiple diverse threats simultaneously will encourage opportunistic aggression by actors who seek to undermine the diplomatic actions that might limit their adventurism. The nation simply cannot afford to gap its fighter force.

A Fighter Force Under Stress

The U.S. Air Force's ability to secure the sky is in crisis. The majority of its fighter aircraft—F-15C/Ds, F-15Es, F-16C/Ds, A-10Cs—were acquired in the 1980s and flown hard in multiple wars. Today, they are structurally fatigued and technologically obsolete in the face of advanced Chinese and Russian air defenses, including their next-generation fighters. Based on plans developed in the 1990s for modernizing the USAF fighter force, these legacy aircraft should have been phased out in the 2000s in favor of newer types like the F-22 and F-35. However, the Secretary of Defense terminated F-22 production at less than half its operational requirement in 2009, and F-35 acquisition rates are far below planned numbers thus far. With a rapidly aging force and high mission demand, the USAF requires a fundamental revector of its fighter modernization flight plan.

The USAF has long recognized this challenge and is exploring solution paths to adapt its fighter force flight plan to meet requirements. This is important not just to the USAF, but to joint force operations as a whole, for any form of power projection requires control of the sky. Only the USAF has the volume of fighter aircraft necessary to achieve this at scale. Naval and Marine Corps air superiority aircraft, while helpful, cannot meet the demands of combatant commands on their own in most contingencies.

Despite the serious nature of this problem, DOD leadership spent the 2000s and 2010s largely ignoring this issue due to wartime demands in Afghanistan and Iraq, as well as the fiscal pressures imposed by the Budget Control Act of 2011. As a result, the United States took tremendous fighter modernization risk at the very moment China and Russia accelerated their efforts.

The *2018 National Defense Strategy* finally recognized the need to focus on these sorts of threats, but the

challenges are pronounced. Making up for three decades of lost opportunities is far from easy. Investments that should have been gradually paced and sequenced must now be surged. In a quest to free up funding for future buys, the Air Force is on course to further *shrink* its fighter inventory through the 2020s and early 2030s before it accelerates its growth. This could break the small inventory, which is already stretched thin to meet burgeoning demands. Budget shortfalls, not mission requirements, are driving this decision-making. According to Air Force officials, simply replacing the existing inventory would require the Air Force to procure 72 new aircraft per year.[1] Simple math brings this rate into question, as a 20-year refresh cycle for the legislated minimum fighter force of 1,950 aircraft would require annual procurement of at least 97 fighters. Even this rate would fall short if the ongoing strategic competition requires more growth. Current funding affords a buy of 60 fighters—a recapitalization rate clearly well below what is needed.

This sort of divide between real-world requirements and budget speaks to the differences between a "planning force," which is the requisite capacity and capabilities the Air Force needs to fulfill the *National Defense Strategy* at a reasonable level of risk, and the "programmed force," which is the assets the service has the funding to acquire and sustain. The gap between these forces is a measure of risk. The Office of the Secretary of Defense (OSD), Congress, and the American public require and deserve better insight into this risk. Budget documents previously included planning force numbers to convey this level of risk, but that practice was terminated in the late 1990s. Given what is at stake, it is time to resume developing a planning force and including it in Air Force budget documentation. Problems cannot be solved unless they are acknowledged and quantified.

More than 20 percent of the Department of the Air Force's budget is "pass-through" funding, which is money that appears in the service's budget but is used for national security programs the Air Force does not control or have access to.

Understanding this risk is especially important given that the service presently lacks the capacity to fulfill the full range of combatant commander demands. Furthermore, as those demands only increase, fighter procurement will face budget competition from other modernization efforts such as nuclear command, control, and communications systems; the ground-based strategic deterrent (GBSD); the KC-46 aerial refueling tanker; the B-21 bomber; the MH-139 nuclear missile security and airlift helicopter; the Next Generation Air Dominance (NGAD) fighter; the T-7 trainer; the Advanced Battle Management System (ABMS) enterprise; an AWACS replacement; next-generation unmanned aerial vehicle (UAV) acquisition; and more. All these programs are essential.

A key factor driving this shortfall is that the Air Force does not have as much actual budget authority—real buying power—as generally believed. More than 20 percent of the Department of the Air Force's budget is "pass-through" funding, which is money that appears in the service's budget but is used for national security programs the Air Force does not control or have access to. Consider that in the Air Force's FY 2020 budget, over 40 percent of procurement funds in the Air Force budget were pass-through—a real impact of more than $22 billion dollars.[2]

F-35 Lightning aircraft at Eglin Air Force Base, FL on October 12, 2018.

Recent Air Force leader statements indicate that they anticipate building a future fighter force consisting of F-35A, F-15EX, F-16C/D, Next Generation Air Dominance, and A-10C aircraft. This is a concept they refer to as "four plus one."[3] Chief of Staff General "CQ" Brown also socialized the possibility of a new, non-stealth, general purpose fighter to replace the F-16 that would likely be fielded in the mid-2030s. Facilitating this new vision would see the Air Force divest early F-16C/Ds, all its F-15C/Ds, a portion of the A-10C inventory, and eventually, the F-22A.[4]

When it comes to building the fighter force of the future, the Air Force must focus finite resources on acquiring the attributes required to win tomorrow's engagements, not those of yesterday's wars. To this point, fifth-generation technology is the entry point for fighter operations against peer threats and nations where advanced air defense equipment exists. New-builds of older designs like the F-15EX are likely to find themselves relegated to limited defensive roles in an era where the Air Force fighter inventory is too small to pursue a tiered force design. In fact, that is why the Air Force has resisted further legacy aircraft buys since the early 2000s. The idea to buy the F-15EX came from OSD, not the Air Force. If the service is going to commit upwards of $80M or more for a fighter, the FY20 cost of an F-35A, then that aircraft must be able to fly through contested battlespace to meet mission demands, return safely, and regenerate for another sortie. This requires, at a minimum, attributes like stealth, which the F-15EX does not possess even though its FY22 unit procurement cost is nearly $20 million more an F-35A.[5] Given this reality, funding limitations, and modern mission demands, the Air Force should consider a reasonable termination point for the F-15EX. The budget planned for F-15EX could then be used to increase F-35 production and for the development of a new, stealthy fighter program.

A new-start fighter development program may afford the right long-term solution to provide capacity, capability, and affordability—attributes current USAF leaders are adamantly advocating. However, such an aircraft must possess stealth, information-age sensors and processing capabilities, as well as the ability to engage throughout an advanced battlespace. Anything less simply dilutes finite funding away from

the most pressing mission requirements. Also, given the proliferation of modern air defenses, the zone of application for anything lower tech than current fifth-generation aircraft is dramatically shrinking. This runs contrary to General Brown's statement suggesting that the Air Force might pursue a "fourth-and-a-half or fifth-gen minus" replacement to the F-16C/D. While the Air Force should absolutely begin a new fighter program to introduce more capacity and diversity of performance attributes into the service's force design, any new effort should move capability forward, not backward. This is especially true given the rapid pace of adversary threat systems.

Given that NGAD, the service's most capable future fighter, will involve highly advanced technology, the Air Force should begin pursuing a new design with a focus towards affordability, mass, and performance as inherent attributes. This is the same focus of design that yielded lightweight fighter prototypes of the Cold War era, which resulted in the F-16A/B. This new design could be a vanguard effort to demonstrate the potential for digital engineering to accelerate development and fielding while transitioning the Air Force to more rapid and iterative programs. Truncating the F-15EX buy at some point could provide the budget space for this important developmental effort. Such an aircraft would likely be fieldable in the later 2030s given current development and acquisition parameters.

When it comes to the top end of the air superiority mission, there is no question that NGAD will be the foundation of this future capability. NGAD is a vital imperative requiring concerted investment. How the service arrives at this juncture is open for discussion. Another imperative that is clear is that this mission can accept no gaps. The F-22A, which currently executes this mission, must be aggressively modernized and sustained in the inventory until NGAD is available in volume and at a full mission-capable level of readiness. Until the NGAD is flying operational sorties, there are a significant number of missions that only the F-22A can accomplish. This capability cannot be prematurely surrendered.

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The final major element defining the future fighter force is the F-35A. Air Force frustrations with this aircraft's cost and performance are widely documented. Such experiences match F-15A/B and F-16A/B history. Many solutions are already implemented, more are being developed, and there is no reason to doubt that the F-35A will ultimately meet and even exceed desired metrics. Service leaders, however, are keen to slow F-35A production until the latter half of the 2020s, when they will have greater confidence in the aircraft's capability, availability, and affordability. They are especially focused on waiting until the latest version of the type, known as Block 4, can be incorporated into production at the end of this decade.

This course of action is exceedingly high risk. The F-35 is the only fifth-generation aircraft currently in U.S. production. It represents the best option to reconstitute the Air Force's fighter inventory in an operationally impactful way that speaks to *National Defense Strategy* priorities for at least the next fifteen years. Budget resources will likely not be available to surge F-35A acquisition later when the "perfect aircraft" exists,

given the number of concurrent modernization programs. The USAF's only way to dig out of their fighter modernization bathtub is by maintaining concerted, steady acquisition rates of combat relevant aircraft. Robust buys could also accelerate the divestiture of older fighters that are costing more to maintain and offer declining combat value. Paying high sustainment bills and getting less operational return while trying to buy new aircraft in volume is unaffordable. Simply modernizing faster is more affordable in the long run.

Adding further weight to the argument to increase F-35A acquisition rates is the reality that every aircraft procured from the FY24 budget onward will have the required foundation of hardware to support Block 4. Maintenance and sustainment enhancements can also be applied to aircraft as part of their routine upgrades. This approach would drive subsequent modernization expense, but it is better for the Air Force to cross that juncture later than wish it had relevant capacity at a time when operational requirements demand modern capabilities. Reactively surging sophisticated fighter production during a crisis is simply not an option in the modern era. The only path forward is a concerted build over time.

As former Air Combat Command Commander General John Corley, USAF (ret) recently remarked, "If it's always about 'program next,' you'll never have a program at all."

If the Air Force does not adjust its vector in recognition of these factors as it builds its future fighter force, it risks seriously gapping its fighter capability and capacity until the late 2030s. This presents immense problems not just for the Air Force, but for joint force operations. Such a void increases the risk of opportunistic behavior and outright conflict by peer competitors. Holding out for the perfect solution of the future is an impossible goal, for an immaculate fighter has never been invented. As former Air Combat Command Commander General John Corley, USAF (ret) recently remarked, "If it's always about 'program next,' you'll never have a program at all."[6] It is time to get the fighter force healthy now. Past generations squandered previous opportunities to modernize this key mission area. Waiting another decade risks irreparable harm at a time when these sorts of capabilities matter the most.

To this end, the Congress, OSD, and Air Force should:

Develop and publish a "planning force" to depict what the Air Force actually needs to execute the *National Defense Strategy.* This action will go a long way in educating the American public and the Congress in understanding Air Force fighter force structure requirements. It would also clearly provide a measure of risk that the Air Force, DOD, and the nation is taking if the DOD and Congress do not fully fund a program design to develop and acquire the planning force.

Extend legacy F-16s, while wholly divesting the F-15C/D, A-10C and F-15E inventories as the F-35 production ramps up. Extending legacy F-16s will provide capability and capacity in permissive environments, while also preserving irreplaceable enterprise elements. The F-15C/D, A-10C, and F-15E should be fully divested on a one-for-one replacement rate as F-35s come online, freeing up further funding for fifth-generation fighter production and next-generation fighter development.

Begin a new, stealthy, general-purpose fighter design to compliment the NGAD. The Air Force should seek to begin the development of an affordable, general-purpose, stealthy fighter program that will be relevant to the threats of the future. An option to fund this proposal may be to shift funding from the F-15EX by truncating the quantity bought at some point.

Immediately ramp-up F-35 production to offset F-15C/D, A-10C and F-15E retirements. F-35s procured now have the foundation for Block 4 capabilities; there should be no delay in immediately ramping up F-35 production. Increasing F-35 quantities now also provides some hedge for any potential NGAD delays.

Close the F-35 Joint Program Office and transition program management to the services. Transitioning F-35 program authority to the respective services and closing the JPO should begin immediately to enable the Air Force to better achieve its F-35 capability, availability, and affordability objectives.

Retain and continue to modernize F-22. The F-22 must be retained and modernized to continue to provide crucial air dominance capabilities. Given the challenges and capacity that could be demanded by both Pacific and European theaters, the Air Force should consider extending the F-22 until NGAD and other programs can ensure needed capacity.

Accelerate and remain steadfastly committed to the Next Generation Air Dominance program. NGAD is the foundation of the Air Force's future fighter force. While it remains highly classified, the Air Force must do all it can to accelerate it where it makes sense and remain wholly committed to seeing this program through. NGAD will not begin fielding until the next decade, but commitment to this crucial capability through this decade is critical to sustain to get to the other side of the bridge.

Remove pass-through funds from the Air Force budget. Pass-through funds distort the service's true level of resourcing, result in a significantly smaller real budget, and cause direct harm to the Air Force's ability to recapitalize its legacy forces. OSD and Congress should remove pass-through from the Air Force's budget as the first step towards honest and responsible resource decisions for the service.

Introduction

The U.S. Air Force's fighter force is in crisis. After three decades of canceled, curtailed, and delayed investment in fighter aircraft modernization, the nation now finds itself in major need of these capabilities with far too few advanced fighter aircraft to meet demand. This is not just an Air Force problem; it affects every aspect of U.S. national security. No form of power projection in any domain is viable without control of the sky. Ships at sea, forces on the ground, space control centers, cyber facilities, logistics hubs, and more are simply not survivable when subject to high-intensity attacks from the sky.

DOD leadership has not valued Air Force fighter recapitalization programs in recent decades because it did not foresee the current geo-political competition spurred by a rapidly rising China and revisionist Russia. From the massive budget and inventory cuts in the 1990s that followed the fall of the Soviet Union to Secretary Gates' short-sighted accusations of the services having "next-war-itis," support for developing next-generation capabilities has been lukewarm.[7] Over the past 30 years, DOD took extreme risk cutting and deferring key modernization programs to fund counterinsurgency operations rather than investing in future air dominance capabilities and other advanced aircraft programs that would have maintained U.S. global airpower dominance.

The asymmetric advantage afforded by U.S. airpower is a time-tested essential to achieving American security objectives.

The asymmetric advantage afforded by U.S. airpower is a time-tested essential to achieving American security objectives. U.S. airpower deterred armed conflict with the Soviet Union throughout the Cold War, delivered an overwhelming and decisive victory in Operation Desert Storm, and dislodged the Taliban in the opening phase of Operation Enduring Freedom. China and Russia have used the years since the end of the Cold War to modernize their air forces. Furthermore, China is on track to surpass U.S. economic, industrial, and military power, and Russia remains a highly disruptive threat in Europe. Both adversaries export advanced counter-air capabilities in the form of highly capable surface-to-air missiles and fighters. These challenges, especially when viewed from a capacity demand perspective, are complicated by nuclear-ambitious Iran and North Korea, non-state actor threats, and instability across the Middle East and Africa. The global security environment is growing more dangerous while the bulk of the aircraft in the USAF grow older and increasingly fragile. Fighters averaging 30 years in age are often older than the pilots flying them. Now is the time for an airpower reset.

Beyond being old, Air Force aircraft inventories are also too small. In 1990, the United States had 4,155 fighters.[8] Today, those numbers stand at 2,094, and they are falling.[9] A small inventory of aging fighters is surging harder than ever to keep pace with burgeoning demand; this presents extreme risk to our nation's security. Nearly four years ago, former Secretary of the Air Force Heather Wilson acknowledged this shortfall, bluntly stating that "the stark reality is the United States Air Force is too small to do all that the nation expects of it."[10] Capacity increases have not come to bear in the years since Secretary Wilson issued this warning.[11] In fact, an in-depth budget analysis found that "since the turn of the century, the Navy has

purchased more combat aircraft than the Air Force."[12] Defense analysts Mark Gunzinger and Carl Rehberg estimate that simply replacing existing inventory would require the Air Force to procure over 200 new combat aircraft per year.[13] Current buy rates are nowhere near this total.

Fifth-Generation Fighters

Jet fighters in the post WWII era are often defined by their generation, which is based on common attributes that reflect key technological advances. First-generation fighters are defined simply by having a jet engine. Their airframes often featured straight wings, and their weaponry was still reminiscent of WWII propeller-driven aircraft: guns with a basic gunsight, unguided bombs, and un-guided rockets. Examples of these aircraft include the F-80, F-84, F-94, and even the swept-wing F-86. For the most part, second-generation fighters had swept wings, could attain supersonic speeds, and had radar and other early sensors and avionics. The Century Series is a classic set of second-generation aircraft. Third-generation fighters were often designed to be multi-role fighters and had more advanced sensors. These aircraft could cue and fire guided missiles beyond visual range, and they could also employ early precision-guided bombs. The F-4 and F-111 are key third-generation fighters. Fourth-generation fighters have advanced sensors and digital avionics, datalinks, hyper-maneuverability often controlled by digital flight control systems or thrust vectoring, some use of composite structures, and radar absorbent coatings to mitigate signature. The legacy fighters that comprise the backbone of the Air Force fighter inventory—the F-15C/D, F-16C/D, A-10C, and F-15E—are all fourth-generation fighters.

A clear step beyond these legacy aircraft, fifth-generation fighters have all-aspect stealth, highly advanced active and passive sensors, digital avionics fusion, and sophisticated processors that can execute many sensor management functions autonomously. Their unique processing capability compares, correlates, and fuses data from multiple sensors into a coherent battlespace picture that provides pilots information advantage and decision superiority. This sensor fusion allows pilots to spend their cognitive capacity on tactical and operational decision-making and engagement management rather than sensor management. In combination with all-aspect stealth, this processing capability provides fifth-generation pilots a crucial combat advantage. Stealth is no longer a passive, defensive attribute. In contrast to previous generations of stealthy platforms, fifth-generation aircraft know the locations of both surface and air threats, and they know at what ranges and angles they can be detected. Because of this, fifth-generation fighters enjoy advanced battlespace awareness that allows their pilots to manage their signature by maneuvering to avoid detection, thus giving them the significant combat advantage of dynamic and offensive initiative.

The crisis facing the Air Force's fighter forces has been over 30 years in the making. Reagan-era spending did not aggressively pursue the development of new aircraft, instead ramping up production of the F-15, F-16, and A-10. These fourth-generation fighters were predominantly designed in the late 1960s and early 1970s, and that procurement surge effectively replaced and retired Vietnam and earlier-era aircraft. Through this turnover, the Reagan administration reset much of the Air Force. Those aircraft comprise the bulk of today's fighter force.

The buying wave of the 1980s came to a screeching halt as the decade came to a close. Eager to cut defense spending after the fall of the Soviet Union in 1991, the United States reduced force structure and delayed

the development of new aircraft. It slashed the planned buy for the F-22, a stealthy air dominance fighter designed to replace the F-15, from 750 to 381 aircraft. In 2009, Secretary of Defense (SECDEF) Robert Gates prematurely canceled the F-22 program at 187 aircraft—less than half its military requirement—stating that the F-22 was irrelevant to "the wars we are in today and the scenarios we are likely to face in the years ahead."[14] The rise of China and an aggressive Russia have proven otherwise.

As a result of Secretary Gates' decision, the Air Force could not retire its legacy F-15s as planned. Their service was extended well beyond their original design life. In 2007, one of the aging aircraft literally came apart in mid-air due to airframe fatigue. This incident grounded the entire F-15 inventory until each airframe could undergo lengthy inspection, with some ultimately requiring invasive structural reinforcements.[15] Today, these front-line fighters are restricted from operating across their performance envelope due to their age and associated structural fatigue.[16] In addition to the F-15, the Air Force has also retained the F-16 and A-10 well past their planned structural service lives.

For the last 30 years, defense leaders consistently deferred substantive fighter recapitalization because they believed such delays posed little risk. They believed that high-end threats to U.S. airpower remained problems for the distant future. Adversary investments in robust air defense capabilities, including fighters, mean that future is here today.

Combat operations in the Middle East following the September 11, 2001, terrorist attacks on the United States further eroded the health of these increasingly geriatric aircraft. Sustainment bills to keep them viable from a structural and technological vantage grew aggressively. With limited funds available, Air Force leaders could either fix the aircraft they had or buy new ones, but they could not afford to do both. The exigencies of combat operations and need for airpower resulted in extending legacy fighter types to the neglect of future capabilities.

Throughout this period, defense leaders constantly pointed to the F-35 as the future fighter that would finally restore the capabilities and capacity of the USAF fighter force. However, technical challenges, requirements changes, budget cuts, and alternate priorities delayed F-35 production and reduced the USAF's F-35 procurement rate. The Air Force further extended the service lives of legacy aircraft, which increased sustainment costs. This, in turn, put more pressure on funding available for new aircraft acquisition. In 2020, the Air Force should have had over 800 F-35As, yet it had only 272.[17] In FY 2022, the service only asked for 48 airframes, and projections for FY 2023 may see this number fall to as low as 30.[18] Such buys are woefully inadequate to refresh a fighter inventory badly in need of a reset.

The service's current plan will further reduce its fighter inventory over the next decade and slow its recapitalization in hopes that future resources will eventually allow it to reconstitute the force with next-generation capabilities. In the FY 2022 Air Force budget request, the service proposed divesting 137 legacy fighters, while procuring a mere 60 new ones. These requested fighters replace *less than half* of those being retired. This trend may well worsen in future years. According to one experienced defense reporter, the Air Force plans to mothball 421 fighters over the next five years, while procuring only 304—an overall

reduction of 117 aircraft.[19] Retiring legacy aircraft faster than new ones are procured shrinks the force and creates a capacity spiral that will prove difficult to reset the longer it continues.

For the last 30 years, defense leaders consistently deferred substantive fighter recapitalization because they believed such delays posed little risk. They believed that high-end threats to U.S. airpower remained problems for the distant future. Adversary investments in robust air defense capabilities, including fighters, mean that future is here today. The challenge for today's Air Force centers around managing near-term capacity demands while simultaneously investing in long-term solutions that will deliver necessary mission effects in future decades. There is no perfect answer or silver bullet. Budget realities require working with the art of the possible towards solutions that do not exceed moderate risk. A viable path forward will involve a range of investments where advanced capabilities and sufficient capacity are both vital attributes. Despite numerous questions regarding how to achieve this goal, there is no question that the time to reset the fighter force is now.

Credit: U.S. Air Force Photo

Two F-15E Strike Eagles sit on the flightline. The F-15E Strike Eagle is a non-stealth dual-role fighter designed to perform air-to-air and air-to-ground missions during the Cold War—missions it could no longer perform in the contested environments of tomorrow's battlespace.

Background: A Capability and Capacity Crisis Three Decades in the Making

Regardless of service or domain, actors at the strategic, operational, and tactical levels rely on air superiority for mission success. Additionally, fighter aircraft strike targets, can host powerful sensors, bring powerful processing capability deep into contested territory, and execute forms of electronic warfare. In many ways, they are best thought of as "sensor-shooters."[20] Senior-most policy officials will find themselves robbed of valuable options absent these capabilities.

Current Air Force fighter capability and capacity is insufficient to match, much less dominate, the scale and scope of the global threat environment challenging U.S. security interests.

Current Air Force fighter capability and capacity is insufficient to match, much less dominate, the scale and scope of the global threat environment challenging U.S. security interests. The Air Force has supported three decades of continuous combat operations with a fighter force that was predominantly procured before most of its pilots were born. In a real sense, America still relies on Ronald Reagan's airpower investment of the 1980s, and these legacy aircraft are stressed to their extremes every time they fly. They routinely exceed the speed of sound, they pull aggressive G-forces multiple times a mission, they carry heavy payloads that further stress structures, and they live outside in harsh conditions. To put it bluntly, America is facing a fighter force crisis, and it is well past time to double down on a solution.

Even though the Air Force's fighter forces have been used hard, leaders have repeatedly reduced their inventory numbers, leaving fewer aircraft and aircrews spinning harder to meet an unsustainably high operational tempo. Defense cuts in the 1990s culled 40 percent of the Air Force's fighter inventory.[21] Remaining fighters sustained Operations Northern and Southern Watch over Iraq and fought wars over Bosnia and Kosovo, all while fulfilling a broad range of training and operational requirements around the globe. Following 9/11, despite an even higher operational demand for airpower, leaders cut the Air Force's total inventory another 20 percent.[22] Cutting the inventory and asking more of the remaining aircraft to meet high ops tempos has dramatically accelerated the wear and tear on airframes. Aircraft were pushed to the limit with continuous combat operations in Afghanistan, Iraq, Libya, and Syria. The results are predictable: a broken fighter force.

Compounding these operational challenges, DOD and Congressional leaders sought to free up funds for combat operations in Afghanistan and Iraq by raiding Air Force accounts—including funds meant for fighter modernization. This resulted in the premature termination of the F-22 and repeated deferrals of funding for the F-35. Leaders at the time felt confident in taking these risks because threats to air superiority seemed a distant concern. Fixated on ground operations against low-tech adversaries in Afghanistan and Iraq, leaders generally understood China or Russia could develop advanced air capabilities at some point in the future, but they deemed such risks far in the future. SECDEF Gates echoed this sentiment when he justified canceling the F-22:

> To assess this risk, it is worth looking at real-world potential threat and assessing the capabilities that other countries have now or in the pipeline. Consider that by 2020, the United States is projected to have nearly 2,500 manned combat aircraft of all kinds. Of those, nearly 1,100 will be the most advanced fifth-generation F-35s and F-22s. China, by contrast, is projected to have no fifth-generation aircraft by 2020. And by 2025, the gap only widens.[23]

Gates was wrong on all counts. China shocked the world by rolling out two advanced fifth-generation class fighters a few years after Gates spoke to the contrary—one while Gates was visiting China. U.S. combat aircraft totals continued to decline and what little remained of fifth-generation aircraft production in the form of the F-35 lagged well behind original production plans. The United States now has a fighter force that is poorly equipped to meet pressing demands. Consider the point that in 2021, fifth-generation fighters represent only 20 percent of the Air Force's total fighter inventory. The rest are aircraft designs conceived in the late 1960s and early 1970s and produced in the 1980s and 1990s. We are asking pilots to fly and fight in the information age with jets that predate the invention of the world wide web.[24]

Critically, Air Force fighter capacity has fallen to half of what it was in 1990. The service now lacks the numbers of combat aircraft required to cover the vast geography and high operational tempo of a complex and multipolar world.[25] For example, there are only five physical squadrons of F-22s in the Air Force; five active-duty units and five associated Guard and Reserve units share the same jets. Additionally, as a rule of thumb, an inventory loses roughly 25 percent of its operational capacity to testing and training and to depot maintenance. That means that of the 186 Raptors available today, only 140 are operationally available. If these remaining aircraft have an 80 percent mission capable rate, then 112 are combat ready. Considering that at least 16 aircraft are required to execute a single lane of continuous air defense patrols, the current force of F-22s could not sustain robust combat operations of any duration, especially when combat losses and battle damage are taken into account. When it comes to facing the more advanced threats and peer adversaries of today at operationally effective concentrations and tempos, the U.S. fighter inventory is woefully outmatched.

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Despite the dramatic cuts to the Air Force's combat inventory in the face of known operational demand, defense leaders continue to promote the myth that advanced capabilities can either enable or justify an even smaller force structure. Such claims fail to recognize even basic realities about the need for additional fighters to compensate for losses over time. Five F-22s have been lost due to various accidents in peacetime, and that number pales in comparison to potential wartime losses. At some point, no matter how capable it may be, the Air Force will simply be too small to meet its national security commitments. The physical expanse of a region as large as the Pacific further exacerbates such realities, with distance literally stretching a small force thinner.

Assuming this sort of risk in the near to mid-term may incentivize opportunistic adversary behavior, which could result in outright conflict. Although the Air Force is focused on delivering advanced capability in the

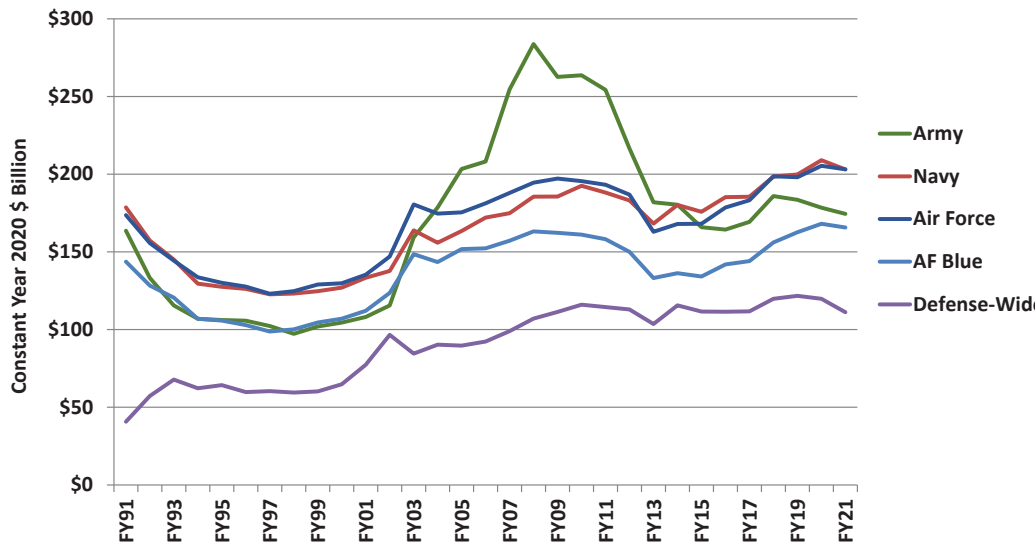
out-years, it should ensure that it has a fighter force that can credibly bridge to the future. Anything less may constrain U.S. leaders from taking an action that could solve a problem in the near term, allowing it to become an impossible future problem with much higher costs and consequences.

Budget Barriers to the Future Force

Getting smaller based on a distant notion of getting bigger and better at some distant point in the future is too risky to meet today's global threats.

As with everything in Washington DC, the real challenge comes down to resources. Air Force leaders are keenly aware of the need to modernize their combat air forces, but they do not have the budget to do so. As a result, they are divesting current force structure to fund recapitalization internally, or "out of hide." Such decisions may have been reasonable in the wake of the Cold War when inventories were larger, the average age of aircraft was far younger, and threats were more distant. Those days are long gone. Getting smaller based on a distant notion of getting bigger and better at some distant point in the future is too risky to meet today's global threats. This unviable approach was a main driver behind Congress enacting Air Force aircraft inventory floors and growth goals in the FY21 National Defense Authorization Act (NDAA).[26]

The resource challenge is made even worse by the fact that the current force structure is dominated by legacy fighters with an average age of over 30 years that are expensive to maintain and require costly service life extensions and invasive upgrades. According to Lt General David S. Nahom, Deputy Chief of Staff for Plans and Programs, "Right now we're wasting a lot of money on legacy capabilities that we could focus better on



Credit: The Mitchell Institute

Service Budgets Since 1991: The Air Force (dark blue) appears to be well funded when pass-through is masked within the Air Force budget. When pass-through is removed, as indicated by the light blue line, the Air Force quickly falls. During the 1990s, Air Force Blue nearly matched Army funding, but was a decade in which—unlike the other services—the Air Force conducted continuous and multiple deployed combat operations. Since FY02, the Air Force has been the least resourced military service. Pass-through monies from 1991–2021 total over $942 billion and represent a significant lost opportunity for recapitalization.

future capability."[27] A Congressional Budget Office study found that after a certain age, the sustainment costs of aging aircraft compounded at a real rate of between 2.7 and 6.8 percent.[28] The sustainment costs for these older inventories are now demanding a substantial portion of the Air Force budget, crowding out funds that might otherwise be available for new aircraft in the Air Force top line. Nahom characterized the weapon system sustainment costs as "skyrocketing," noting that "about 44 percent of the Air Force inventory is now flying beyond its design service life."[29] These high sustainment costs are the direct consequence of deferring recapitalization and represent both cost imposition and opportunity cost. Overall procurement in the Air Force's FY22 budget totals $22.87 billion dollars, of which only $5.96 billion of that goes to procure combat aircraft. By comparison, the service's request for O&M is a whopping $63.22 billion, of which $12.30 billion goes directly to weapon systems sustainment, not including other O&M activities.[30] Looked at another way, overall aircraft procurement barely tops weapon system sustainment costs.

CAF Redux: A Cautionary Tale for Air Force Programmers

The Air Force plans to gap its fighter forces over the next five to fifteen years, with the intention of using the "freed up" funding to build the future force our nation needs. Retired General James "Mike" Holmes, former commander of Air Combat Command and Deputy Chief of Staff for Strategic Plans and Programs (the Air Force's budgeteer), cheekily stated in a recent interview that, "amateurs talk about ideas, professionals figure out how to pay [for it]."[31] But retiring aircraft with no immediate replacement within the same fiscal year is a losing bet that the Air Force would be wise to avoid.

This gamble has not worked in the past, and it is not likely to work today. Current plans to gap the force mirror the 2009 combat air forces restructuring initiative, colloquially referred to as the "CAF Redux." As part of that initiative, the Air Force retired approximately 250 legacy fighters with the intention of using the savings from reduced operations and maintenance funds to procure fifth-generation fighters in the outyears.[32] Instead of those "savings" buying more aircraft, however, personnel and funding were shifted to increase remotely piloted aircraft operations and other ISR operations to support the immediate demand of overseas contingencies.[33] Sequestration further scuttled modernization plans, including upgrades to remaining fighter forces.[34]

The Air Force's failed efforts during the CAF Redux should be a cautionary tale. General Herbert "Hawk" Carlisle, commander of Air Combat Command at the time, reflected on the CAF Redux decision: "We [thought we had] a brief period where, given the counterterrorism fight and other situations in the world, … we can take risk in the fighter force structure to get to fifth-generation."[35] Carlisle looked back at this decision as short-sighted, stating that "We took that risk, we never got to fifth gen, and by the way, the world changed and is significantly more challenging and demanding today than… we thought it was going to be in 2010."[36] Especially when the force is already too small, divesting now in hopes of future recapitalization is too risky a gamble to take.

It is unrealistic to think that the Air Force would be able to bank near-term budget savings for future procurement. The Air Force submits a budget request, but the Office of Management and Budget, OSD, and Congress make the final decisions regarding the service's resources. Too often, this has seen budgeted savings disappear for competing priorities. So not only does the service accept risk shrinking current

capacity, but it lacks the money to acquire new aircraft. It is the worst of both worlds. CAF Redux remains a stark warning to those seeking to pursue this plan.

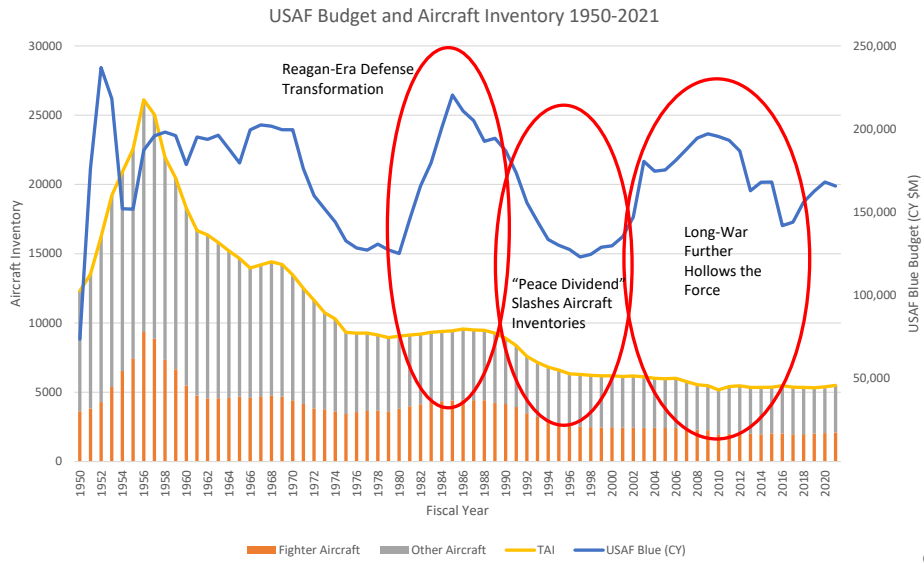
Pass-through, because of how it obscures real Air Force funding, is a direct and causal factor in the service's inability to transform its force into the future design our nation needs.

Another issue restricting the Air Force's ability to recapitalize is what is called "pass-through funding." The Air Force's total budget includes funds that do not go to the Air Force, its operations, or its programs at all. Pass-through funds do just as they imply—pass through the Air Force to other DOD agencies. Pass-through for FY22 is a full $39 billion, over 18 percent of Department of the Air Force's request.[37] So instead of $212.8 billion, the real budget for the Department of the Air Force is $173.7 billion. When considering that this real budget must also fund the Space Force at $17.4 billion, actual Air Force funding is only $156.3 billion—far less than the Army budget of $173 billion or the Department of Navy (which includes the Marine Corps) budget of $211.7 billion.

According to one study, "This $39 billion [of total annual pass-through funding] is equivalent to the last four years of total Air Force new aircraft procurement funding."[38] The long-term destructive consequences of pass-through funding on Air Force modernization and recapitalization should not be underestimated. Pass-through, because of how it obscures real Air Force funding, is a direct and causal factor in the service's inability to transform its force into the future design our nation needs. Leaders in the Department of Defense, Congress, and the public at large believe the Air Force is apportioned a significant percentage of money to which is has no access. In rough terms, this lost funding is the equivalent of over 400 F-35s a year.[39] While getting the pass-through out of the Department of the Air Force's budget would likely not see an influx of the same money for Air Force goals, it would at least allow for a balanced and honest conversation regarding funding apportionment and priorities in the Department of Defense, which is especially important given the joint implications involved with having a pronounced air superiority shortfall.

Continuing to cannibalize the force and defer recapitalization can only result in suboptimal Air Force core capabilities with long-term consequences for the nation.

The combination of a budget that is masked by the pass-through and insufficient modernization funding leaves the service without the resources it needs to dig its way out of its recapitalization deficit. Moreover, this deficit will grow in the 2030s when other critical modernization programs like the B-21, T-7, NGAD, KC-46, Bridge Tanker, and Ground Based Strategic Deterrent reach their procurement stages. If the Air Force does not accelerate the F-35 buy in the 2020s, the available budget in the 2030s will make for tougher procurement choices amongst these priorities. The Air Force cannot continue down the path of cutting force structure on the promise of yet-to-be-developed technologies in theoretical future year budgets. That is a high-risk gamble that the United States cannot afford given today's threat environment. An 80 percent solution guaranteed today is better than promises of a tenuous bridge to a perfect future. The concurrent pressures on the Air Force's procurement budget in the 2030s will worsen at the very time when defense leadership project China's power will match and potentially exceed that of the United



Credit: The Mitchell Institute

Living Off the Reagan-Era Investments: Defense spending in the 1980s did not dramatically increase Air Force aircraft inventories – it replaced older aircraft. Defense cuts in the 1990s reduced fighter inventories by nearly half. Today, over 60% of Air Force fighters are from the Reagan administration and despite budget increases, fighter inventory trends continue downward.

States. Decades of underinvestment have placed the Air Force in this untenable position. Continuing to cannibalize the force and defer recapitalization can only result in suboptimal Air Force core capabilities with long-term consequences for the nation. Instead of gapping the force through aggressive divestments and slow-rolling procurement, the Air Force should seek to bolster fifth-generation capabilities currently in production as a bridge to the future.

The Near-Term Need for Fifth-Generation Aircraft

Security challenges derive from a combination of an adversary's intent, capability, and capacity to harm U.S. interests. From that perspective, today's threat environment presents significant cause for concern and requisite action. Both China and Russia espouse goals fundamentally opposed to U.S. and allied interests, and both possess the means and willingness to act. Mid-tier states also pose a historically unprecedented global threat in the form of nuclear intercontinental ballistic missiles with the range to strike the U.S. homeland. Both North Korea and Iran remain fixed on building their nuclear arsenals, ballistic missile delivery vehicles, and associated military capabilities. Further down the threat ladder, mitigating risk from non-state actors and containing civil strife across the Middle East and Africa will continue to stretch available military resources thin. The United States will require fifth-generation aircraft to fulfill its security commitments amidst these challenges across the next decade.

China flexes its growing airpower capabilities.

Since last spring, China stepped up military exercises around Taiwan, aggressively flanking the island nation in what China calls "combat drills."[40] China continues to increase its incursions into Taiwanese airspace, sending a record number of military aircraft, including 28 fighters and nuclear-capable bombers

into Taiwan's Air Defense Identification Zone (ADIZ) in June 2021.[41] These demonstrations have not slowed down. Seven Chinese military aircraft, including an electronic warfare aircraft, a signals collection aircraft, an anti-submarine aircraft, and four fighters, violated Taiwan's ADIZ in early August of this year, and on September 5, 19 Chinese military aircraft repeated the violation, this time with 10 J-16s, 4 Su-30 fighters, 4 H-6 bombers, and an anti-submarine aircraft.[42] In addition to these actions, China has grown its aircraft inventory and advanced its capabilities rapidly with up to six stealthy aircraft in development and production.[43] Indications are that Chinese aircraft and weapons capabilities have reached parity with, and may be rapidly surpassing, U.S. capabilities.[44]

If the United States continues to yield to aggressive Chinese actions and fails to rebuild its first line of defense against them—its combat airpower advantage—it may well prove unable to deter future Chinese provocation or limit Chinese influence in the region. A U.S. failure to act could give China the strategic fait accompli it seeks.

One need not look far for worrying examples of the risks created by U.S. airpower capability and capacity gaps. Defense professionals view the faceoff between China and Taiwan with increasing concern, fearing that China could attempt to take Taiwan in a rapid military action in the next five to ten years. Admiral Philip Davidson, the Indo-Pacific combatant commander, stated in congressional testimony in March that, "We have indications that the risk [of a Chinese military takeover of Taiwan] are actually going up… The threat is manifest during this decade—in fact, in the next six years."[45] Recent exercises by the People's Liberation Army Navy (PLAN) in the offshore areas surrounding Taiwan and notable modifications to its diesel submarines are also clear signals intended to deter the United States and other nations from strengthening ties with Taiwan.[46] Aggressive Chinese flights around the southern tip of Taiwan increased dramatically, and while U.S. forces have been monitoring this situation and signaling their presence through exercises in the area and diplomatic protestations, China has shown no signs of slowing its provocative behavior. [47]

China's actions threaten more than Taiwanese sovereignty. China has illegally expanded its territory by transforming coral reefs in the South China Sea into artificial islands that house military bases with an inter-island network of advanced sensing, anti-ship, and anti-aircraft capabilities.[48] These military outposts are a complex specifically designed to deny U.S. military power freedom of maneuver or domain superiority. If the United States is unable to act in the face of Chinese provocations, it risks losing credibility as a reliable security ally and partner in the region. The diplomatic consequences of abrogating our security agreements with Taiwan might weaken offshore balancing, accelerate Chinese hegemony across the Pacific, and further encourage Chinese expansionism across Eurasia, the Middle East, Africa, and Europe. If the United States continues to yield to aggressive Chinese actions and fails to rebuild its first line of defense against them—its combat airpower advantage—it may well prove unable to deter future Chinese provocation or limit Chinese influence in the region. A U.S. failure to act could give China the strategic fait accompli it seeks.

Russian expansion remains a threat.

In addition to China's recent expansion, the past decade has also witnessed increasingly aggressive maneuvers from Russia, including the forced annexation of Crimea, which violated the sovereign borders of Ukraine.

Russia continues to maintain forces and equipment in Eastern Ukraine today, but even beyond its immediate neighbors, Russia has projected power through the employment of combat aircraft and bombing operations in Syria. Furthermore, the NATO alliance has significant concerns over Russian behavior well beyond its actions in Ukraine, including (but not limited to) the continued Russian occupation of territories in Georgia and Moldova; Russia's violation, non-implementation, and circumvention of arms controls; the use of nerve gas agents against individuals; and large-scale military exercises along NATO borders, which also violated allied airspace.[49] In addition, Russia continues its pursuit of advanced combat aircraft, recently debuting its proposed answer to the F-35, the Sukhoi Checkmate.[50]

Advanced air defense systems erode previously permissive operations.

A contingency does not need to meet the level of all-out war with China or Russia to demand the capabilities of advanced fifth-generation aircraft given proliferation of advanced systems across the globe. Syria is a case in point of a low-intensity operation that required fifth-generation fighters. Operation Inherent Resolve (OIR) could hardly be considered "peer conflict," yet the 2015 Russian military intervention in the Syrian civil war included the deployment of SU-27 and Su-57 fighters as well as the S-400 surface-to-air missile (SAM) system, changing the nature of that operation.[51] Only stealthy fifth-generation aircraft like the F-22 and F-35 were safe in the face of advanced Russian defenses; coalition air forces composed of legacy non-stealth systems operated at extreme risk. The odds of hostile acts against U.S. or coalition forces by the Russians may have been low, but the risk was undeniable. Fifth-generation aircraft yielded a powerful deterrent that could impose a cost upon Russian actors if they crossed key lines.[52] Fortunately, U.S. airpower performed well in this low-intensity engagement, but should more than one such conflict occur simultaneously, the limited number of fifth-generation fighters in the U.S. arsenal may well prove insufficient.

Given years' worth of force structure reductions, the Air Force is not sized to support that sort of numerically demanding force employment. Nor can it risk the attrition losses involved with that legacy paradigm.

The developments in Syria signaled a new era in threat environment calculations. If an adversary need only deploy an advanced fighter squadron or a SAM battery to complicate U.S. global force management and strategic calculus, then the United States has effectively ceded crucial strategic options. Committing fifth-generation aircraft to Operation Inherent Resolve, a small-scale contingency, meant that these limited high-value capabilities were not available to other combatant commanders. Clever adversaries could selectively deploy advanced defenses as strategic spoilers, effectively anchoring U.S. and coalition fifth-generation aircraft. This would then allow adversaries to create presence and power vacuums in regions of interest, ultimately causing U.S. forces to relinquish the operational initiative. The lesson of Syria should be clear: a smaller fifth-generation force is inadequate to solve the dilemmas that adversaries can impose on U.S. and allied forces; in fact, it may actually incentivize adversary aggression. Unlike land or maritime forces, airpower will be required in all major theater scenarios. The Air Force must have the capacity to address unexpected challenges; to continue deterring China, Russia, Iran, and North Korea; and to do so in more than one theater simultaneously. If the Air Force does not invest now in building a strong force of advanced fifth-generation fighters, such capacity may be out of reach, robbing planners of crucial options and undermining America's dominance in the skies.

Credit: U.S. Air Force Photo

The above is a fourth-generation F-16 shot down during Desert Storm. Even against the relatively unsophisticated air defenses in 1991, fourth generation USAF aircraft were vulnerable. Today's battlespaces are much more dangerous and adversary air defenses are modern and sophisticated, but nearly 80 percent of the fighters in the USAF inventory remain fourth generation.

Keeping legacy non-stealth aircraft alive amidst modern air defenses requires large defensive support packages—additive air superiority coverage, dedicated electronic jamming, and more. Even then, the risk of getting shot down remains high. These intensive mission packages drive high costs, especially when viewed from a cost-per-effect standpoint. Consider that in the opening night of Desert Storm, it took a strike package of over 40 non-stealth aircraft to get eight legacy aircraft over their targets to release their bombs. Given years' worth of force structure reductions, the Air Force is not sized to support that sort of numerically demanding force employment. Nor can it risk the attrition losses involved with that legacy paradigm.

Summary

The Air Force is grappling with a serious strategy-resource mismatch that poses significant liabilities to the nation's security over the next ten to fifteen years. Air Force leaders are right in wanting to retire old, vulnerable, and expensive legacy fighters, but now is not the time to divest overall capacity with no ready replacement. Doing so not only incurs strategic risk for the nation, but it also places the Air Force's future force in question. The Air Force must aggressively mitigate these problems for its fighter portfolio as it simultaneously invests in future capabilities that will not field until after 2030. Any prudent bridge to the future should focus on two key principles: capacity and relevance. Rapidly replacing—not simply divesting—Air Force legacy fighters in a cadence is critical to preserve capacity while ameliorating the high costs of legacy sustainment. These replacement fighters must be fifth-generation aircraft to ensure relevance to the current and future battlespace. Anything less will only extend the vulnerabilities of the legacy force into the future and incur an additional recapitalization burden on the Air Force. By adjusting their current plans, the Air Force can achieve both of these goals for the near- and mid-term fighter force while setting a path to secure the force the nation will need in the 2030s and beyond.

1. Extend the Life of Legacy Aircraft: A Problematic but Necessary Crutch

The Air Force currently plans to continue extending portions of its non-stealth F-16C/D and A-10C inventory well into the 2030s, and it may even keep its F-16C/D fighters on the ramp as late as 2040. These aircraft, which were originally designed and developed during the Vietnam War era, have borne the major burden of combat operations in the Middle East for decades but will not contribute meaningfully to future battles in contested environments. Nevertheless, USAF legacy fighters offer value as part of a bridge to the future force. Extending their service lives will preserve their pilot forces and training, maintenance, depot, and basing infrastructure as the Air Force builds a future force relevant to deter and defeat high-end peer threats. Plus, maintaining sufficient fighter capacity will ensure U.S. forces can strike large target sets as required by theater commanders, provide continuous defensive coverage of high-value aircraft like aerial refueling tankers and airbases, and still have an attrition and maintenance reserve. In peacetime, quantity ensures the Air Force maintains the ability to train its pilots and maintenance personnel, sustain its depot capacity and supply chains, and justify its basing. If these foundational elements of the fighter infrastructure decay or disappear, they will be difficult, expensive, and take time to reconstitute when the demand for combat capacity arises.

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As an example, the Air Force experienced enterprise-wide problems when its aircraft inventory was cut in half in the 1990s. Deep force structure cuts—the Air Force was reduced by half in terms of its number of aircraft—meant that these foundational elements of the combat enterprise also suffered. Pilot training bases were cut, as were pilot training slots. Operational bases were shuttered, and remaining wings were thinned of the aircraft they had. This made training and deployments less efficient and effective. Aircraft had to be flown more often, but drawdowns also meant the force had less maintenance capacity, both at home and in the depot. Inexperienced pilots could not get enough flying hours in their combat aircraft to progress in their qualifications, which led to what RAND has called "broken" squadrons.[53] The Air Force pilot corps has never recovered, and it continues to struggle with pilot shortages and imbalances to this day.

It is also this very infrastructure that makes divesting only a portion of the inventory expensive. Most of the cost of any aircraft inventory is this infrastructure bill, which is one reason why small inventories are perceived as so expensive, with less aircraft to amortize fixed costs. There are standing enterprise infrastructure requirements that cannot be scaled down even when an inventory is sized down. The only real savings the service can reap when downsizing an inventory is that associated from diminished manning and consumables, like fuel and oil. The service's plan to retire a portion of the oldest aircraft from each

inventory to generate savings that they can then redirect to other modernization demands just does not create meaningful budget space. To really harvest the savings of aircraft divestment, the entire inventory must be retired so that its supporting enterprise is no longer necessary as new aircraft types are fielded.

Building a Planning Force Enables a Quantitative Understanding of Risk

A "planning force" is the force structure and force size that a service requires to successfully execute its responsibilities under the *National Defense Strategy.* This force is not constrained by budget, nor does it entail caveats like "moderate risk." A planning force articulates what capabilities, force mix, and capacity are needed based on the "force planning construct," or guidance, to include tasking, threats, scenarios, and operational concepts. For example, the unclassified summary of the *2018 National Defense Strategy* (NDS) charged the DOD to:

Deter aggression in the Indo-Pacific, Europe, and the Middle East

Degrade and disrupt terrorist and WMD threats

Defend U.S. interests below the level of armed conflict

Defeat aggression by a major power, while simultaneously deterring opportunistic aggression elsewhere

Deter nuclear and non-nuclear strategic attacks

Defend the homeland[54]

Equipping, manning, and training the DOD to the defined planning force will enable it to successfully execute these responsibilities, and to do so simultaneously, if needed. The Air Force's 386 operational squadron construct is an articulation of the service's planning force. The difference between the "Air Force we have" versus the "Air Force we need" is a measure of the degree of risk that the nation is taking with respect to its national security goals. The Air Force of today stands at 312 operational squadrons as compared to the 386 in its planning force. This example focuses on force sizing, but mix, capability, and timing are just as important. It does no good to have "enough" fighters if they do not have the right capabilities at the right time to successfully execute their missions.

But budget constraints mean that the services are rarely equipped to their planning force. Without a clearly articulated planning force, Congress, the administration, and the American public lack the ability to fully understand the full consequences of programmatic decisions. Prematurely canceling the F-22, for example, did not simply terminate what was wrongly perceived as an expensive, exquisite stealthy fighter. It meant that the F-15C would not be retired, leading to costly service life extensions, structural failures, and increased sustainment burdens. Because the F-15C is unable to fully execute its air dominance role across the entire range of threats, the Air Force must redirect other resources and capabilities to compensate, and joint and coalition operations must assume greater risk in the modern battlespace. The Air Force should publish both classified and unclassified planning force requirements with every *National Defense Strategy* so that senior leaders across the administration and Congress can understand the level of risk they are assuming when they fail to fully fund or execute programs to the planning force.

Shadows on the Ramp: Replacing the Legacy Fighters

As the Air Force seeks to recapitalize its fighter force, it must consider how it replaces older aircraft in both quantity and rate. Recapitalizing fighter capability does not mean that older inventories should be replaced with the exact same number of new aircraft. Instead, planning force numbers should drive programmed quantities of new fighters. Changing threat circumstances, new operational concepts, or other emerging technologies may decrease or increase planning force numbers. Today, the nation faces two peer threats that will demand significant capacity and capability, and the Air Force is likely to find that its planning force is greater than their current force size. The rate at which a new aircraft type is fielded also matters. This should be done at a one-for-one rate, meaning that older aircraft are only retired as new ones are available to take their place. This mitigates strategic risk through the transition because mission capability and capacity are not gapped. As the Air Force seeks to recapitalize its fighter force, it should replace aircraft one-for-one to force planning quantities as quickly as possible.

When the F-22 program was established, the Air Force planned to replace 750 F-15A/B/C/Ds on a one-for-one basis. The fall of the Soviet Union reduced this plan to 443 F-22s. Delays to the F-22 program slowed the retirement of the F-15A/B/C/Ds, and the peak rate of production of the F-22 was 32-a-year—barely enough to fill out a squadron. When the F-22 was prematurely canceled at only 187 aircraft, this low replacement rate left the F-15C/D in the inventory. The defense community now regrets that the F-22 was canceled at such a small quantity, and several studies have examined the value of an F-22 restart. Fortunately, the Air Force did not prematurely divest F-15C/Ds during the F-22 program. Had they done so, the Air Force might have been left with even less air dominance capability than it has now.

The Air Force must balance its need to preserve the underlying support enterprise for future fighter capacity as it retires its legacy iron. Reducing the size of its legacy inventories while slowing the influx of new aircraft increases the total enterprise burden because the Air Force must support duplicative support enterprises across smaller inventories. The best way to minimize this burden is to aggressively replace whole aircraft inventories on a one-for-one basis—they cannot gap combat capacity, or frankly, Air Force bases, units, and their supporting enterprise. The Air Force does not need another base realignment and closure round—it needs to aggressively replace its aged inventory and, frankly, grow its fighter force.

Defense observers may cite the A-10C fight as evidence that the service should not attempt to retire legacy aircraft. After all, the Air Force has been consistently blocked from retiring the A-10C. In 2013, the Air Force proposed retiring the A-10C in response to the extreme fiscal pressures of the Budget Control Act.[55] Congressional members with A-10s in their districts proved anxious for the continued viability of bases and jobs in their district. They were also skeptical about the capacity of the Air Force to meet the volume of close air support demands in Iraq and Afghanistan. Congress has since successfully prohibited the Air Force from retiring any A-10Cs. In the Senate's markup of the Air Force's FY22 budget request, the Senate Armed Services Committee again restricted the Air Force from retiring the A-10C.[56] Their reluctance is understandable, given that the Air Force proposed retiring 42 A-10Cs with no clear and immediate replacement for the bases affected. While this represents a political reality, it is also smart management.

After all, the Air Force needs both combat and enterprise capacity. Instead of divesting aircraft with no clear replacement, rapidly replacing inventories at a one-for-one rate achieves both objectives.

Replacement efforts should not be split across aircraft types—the Air Force should seek to wholly recapitalize one inventory before moving to the next, and to do so as quickly as possible.

Replacement efforts should not be split across aircraft types—the Air Force should seek to wholly recapitalize one inventory before moving to the next, and to do so as quickly as possible. The F-15C/D is the smallest and most broken of the legacy fighters. It must be replaced first. While the F-35 is not optimized for air superiority, it does have a strong air-to-air capability that will prove more capable than the F-15C/D against modern adversary fighters. F-35s rolling off the production line should be prioritized to replace the entire F-15C/D inventory. Next should be the A-10C, and then finally the F-15E. While the F-15E is the youngest of all the legacy, it also is the most expensive of the fourth-generation fighters, and it is not survivable without excessive force protection in a contested environment. The F-16C/D is the least expensive, healthiest, and most numerous of the USAF legacy forces, which is why it should be last to retire. Extending legacy fighters is fundamentally a triage strategy for the crisis the Air Force finds itself in and is crucial to both preserving combat and enterprise capacity—a temporary stopgap measure until the Air Force can replace this inventory with fifth-generation fighters.

Summary

Maintaining legacy aircraft for the purpose of enterprise capacity and sheer numbers may sound like the tail wagging the dog, but these are essential elements of the combat infrastructure that cannot be quickly, cheaply, or easily rebuilt, and they are the foundation of generating combat capability. For this reason alone, the Air Force's decision to continue to extend the life of select legacy aircraft makes sense. This does not, however, imply that these legacy aircraft are viable contributors to combat capacity in contested battlespace. Although workhorses in low-end operations with permissive environments, no legacy fighter is survivable nor mission-effective in peer-level conflict. The Air Force should seek to retire whole inventories in sequence, replacing them at a one-for-one rate with fifth-generation aircraft to ensure combat and enterprise capacity is maintained.

2. Considerations for the F-15EX and the Bridging Force

When it comes to mitigating strategic risk, not all production lines are equal. The F-15EX will replace the Air Force's F-15C/D, the oldest and most troubled of its fighters. In FY21, the Air Force procured eight F-15EXs.[57] According to the FY22 budget request, the Air Force intends to procure twelve more F-15EXs, and it included an additional twelve in its unfunded priorities list.[58] Defense reporting also indicates that the F-15EX may be relied on further to replace the F-15E and F-22 inventory.[59] Air Force justification states that the F-15EX is needed because the service's "F-15C/Ds are beyond their service life and have serious structures risks, wire chafing issues, and obsolete parts."[60] Parts obsolescence, failures, and fatigue are problems that plague all of the Air Force's aging aircraft, but buying "new" legacy aircraft involves jeopardizing the resources to build fighter aircraft for which the Air Force has the greatest deficiency—stealthy fighters capable of prevailing over a high-tech peer adversary.

The F-15EX is essentially an F-15E Strike Eagle with enhanced avionics. Based on the Qatari F-15QA configuration, the F-15EX has a highly advanced electronic warfare and threat identification system, a more powerful radar and mission processor, new cockpit displays, and an open mission systems architecture.[61] The F-15EX will be fielded with the Eagle Passive Active Warning Survivability System (EPAWSS), which will enable the F-15EX to monitor, jam, and deceive enemy air defenses. EPAWSS will provide the F-15EX some offensive counter-air capability using stand-off weapons. Well-known for its weapon-loadout capacity, the F-15E may have the potential to carry large hypersonic missiles that would not fit inside the weapons bay of a fifth-generation fighter and may have clearance issues if hung externally.

Whereas the F-15EX will be far more capable than the legacy the F-15C it is to replace, even senior Air Force officials acknowledge that its non-stealth structural design means the F-15EX cannot survive in contested airspace without dedicated force protection. They have described the F-15EX as a defensive counter-air platform only, conducting base and homeland defense missions outside any advanced theater threat envelope. This would restrict the F-15EX to locations such as Hawaii, Alaska, and inside the continental United States. With its high weapons carriage capacity, long-range, and high endurance, the F-15EX is a fighter aircraft tailored for the Air National Guard mission of homeland defense and strike missions in permissive airspace.

The Air Force is particularly interested in using the F-15EX to pioneer open mission systems (OMS) software architecture in an operational platform.[62] Such an architecture could allow the service to break out of "vendor lock," where the service is beholden to a single contractor for all upgrades. Even more significantly, OMS has the potential to enable rapid and asynchronous integration of new sensors, weapons, and other capabilities without complications imposed by the proprietary nature of a more tightly coupled software architecture. This means that any company could potentially integrate a new system or sensor on the F-15EX without having to wait on long modernization cycles. Because information and processing are now a critical advantage in the battlespace, accelerating adaptation cycles will be a competitive advantage in combat. The F-15EX could provide the Air Force the OMS architecture it seeks, but it would be wrapped in a 50-year-old design that cannot enter contested airspace.

How the F-15EX Became a Program of Record

In 2018, the Office of the Secretary of Defense imposed procurement of the F-15EX on an Air Force that had, for decades, uniformly opposed procurement of any non-fifth-generation fighter. Leaders in the Department of Defense had grown increasingly frustrated with an F-35 program hampered by delays in fielding upgraded capabilities, operational costs above planned figures, and sustainment concerns. This, in addition to their desire to keep Boeing's St Louis plant active, led OSD to pressure the Air Force to buy new-build versions of aircraft that had been in production since the early 1970s. The St. Louis facility faced imminent closure due to the eventual cessation of both F/A-18 and F-15 production, and OSD leadership was keen to preserve this industrial capacity and competition. As one OSD official explained, "For the future of the Department of Defense, it's going to be good to have multiple providers in the tactical aircraft portfolio… and that's what led our way into the F-15EX decision."[63] OSD sought to take advantage of a hot production line that was manufacturing 1960s-era aircraft for foreign military sales, with the intention that the legacy airframe could create cost savings through infrastructure commonality with the aircraft it would replace. In other words, the F-15EX decision was not mission-based.

OSD positioned the F-15EX as a replacement for the service's troubled F-15C inventory, which had been programmed to be replaced by the F-22 in the 2000s. The F-22 was prematurely terminated, leaving the F-15C to face major structural problems, operational limitations, and sustainment challenges, including extremely high costs and the likelihood of additional issues as the jets continue to age. In addition to redressing the F-15C replacement, OSD and some in the Air Force saw the F-15EX as an opportunity to pressure Lockheed Martin's lock on F-35 modernization and sustainment. The F-15EX, in this view, would provide an alternate fighter production line, and thus negotiating leverage. Yet the F-15EX is not inexpensive, and most sources place its acquisition cost above that of the F-35.[64]

Many in the defense community were shocked by the F-15EX procurement decision. As then-Chairman of the Senate Armed Services Committee Jim Inhofe (R-OK) remarked in a hearing, "It seems to me that we're getting back into the fourth generation that we're hoping to be out of. Sometimes we forget what happened to our F-22s. Started out that was going to be 750, ended up being 187, and we paid dearly for that ever since then. That was a huge mistake, should not have happened."[65] In addition to the F-15EX not being a stealthy aircraft, Senator Inhofe recognized the potential for F-15EX to siphon off F-35 funding, placing the F-35 program in danger of the acquisition "death spiral." Smaller production rates increase all program costs, decreasing available procurement funding even further, until the program is wholly canceled—like the F-22. Procuring new but less capable fighters puts the larger force and recapitalization plan at risk. Then-Chief of Staff of the Air Force General David Goldfein responded firmly to this concern in the same hearing, remarking that "If we ever get to a point where we are trading F-15s for F-35s, that is a bad choice. The F-15 is not an F-35, it will never be an F-35."[66] Contrary to General Goldfein's statement, that trade is already playing out, with the Air Force's FY22 budget decreasing F-35s while increasing F-15EXs. More importantly, the F-15EX will never possess the stealth capabilities required to succeed in future peer conflict. With the potential of declining defense budgets, continued procurement of the F-15EX may put the resources necessary for required advanced fighters like NGAD at risk.

Solving Supplier-End Problems, Not Buyer-End

At first blush, the F-15EX appears to be a reasonable path for the Air Force to solve some of its recapitalization challenges. In addition to carrying large weapons and hosting an open architecture, the F-15EX has programmatic advantages. Because it is based on the legacy F-15E airframe, the F-15EX does not need to conduct certification and airworthiness testing. Those activities can take years to accomplish. Instead of standing up a new production line, the F-15EX leverages active production for foreign military sales. Furthermore, the infrastructure already exists to support the type, from ground support equipment and depots to pilot training. Defense reporting indicated that the decision to buy the F-15EX was also largely driven by industrial base considerations.[67] DOD's decision on F-15EX procurement was in large part to avoid an effective monopoly by maintaining more than one viable fighter aircraft production company.

While the F-15EX provides answers for some of these not-insignificant supplier-side issues, the problem is that these are largely advantages of convenience and management, *not* combat effectiveness and "user" issues. Airworthiness and certification matter little if the aircraft is not survivable in combat. The same goes for the convenience of an existing production line. It may be easy to piggyback off active manufacturing, but if the aircraft design is not relevant to the high-end threats these aircraft must face, then it is a questionable investment.

Contrary to the intent of OSD, the F-15EX purchase may undermine the Air Force's desire to expand its fighter industrial base and create a strategic hedge through design diversity—there is no new design to develop. As a continuation of a production line that originated in the late 1960s and early 1970s, the F-15EX does little to enhance the expertise of engineering teams to design sixth-generation aircraft in the coming decades. The skills and technologies needed to build the future force may include anything from digital engineering and digital threads to advanced material sciences, adaptive shaping, and other sensor, weapon, and processing technologies. Extending legacy franchises does nothing to enhance or cultivate the long-term engineering and design expertise of companies in the aerospace industry. Growing the industrial base's engineering intellectual base, skilled production capacity, and expertise will provide our nation the competitive edge in the long game. Any new-build aircraft should be focused on combat effectiveness in future warfare.

DOD's decision on F-15EX procurement was in large part to avoid an effective monopoly by maintaining more than one viable fighter aircraft production company. But if the aircraft design is not relevant to the high-end threats these aircraft must face, then it is a questionable investment.

F-15EX versus Life Extension

What differentiates the decision to extend the F-16C/D and A-10C from buying the F-15EX is cost and expectation. Operational costs for the F-16C/D and A-10C—$8,000 and $6,000 per flying hour respectively—are far less than the projected $29,000 per flying hour for the F-15EX. This makes the F-16C/D and A-10C far more affordable for the kind of low-end, permissible operations that any legacy design will be constrained

to.[68] In other words, why procure a new legacy aircraft with a higher unit cost than an F-35A that is less capable than an F-35A? Furthermore, planned F-15EX buys could lead many to believe that a significant portion of the Air Force fighter inventory has been recapitalized. This would endanger the Air Force's ability to transform its fighter force to next-generation capabilities. In contrast, the extension of legacy aircraft can preserve enterprise capacity at less cost than the F-15EX and handle low-end mission sets, all the while preventing the misperception that capability and capacity shortfalls have been resolved.

F-15EX and Fifth-Generation Fighters

Regardless of how advanced its avionics may be, the F-15EX will require fifth-generation aircraft to protect them if they are to operate in contested battlespace. In contested battlespace, the vulnerabilities of fourth-generation aircraft will prevent fifth-generation fighters from performing at their full operational potential.

Regardless of how advanced its avionics may be, the F-15EX will require fifth-generation aircraft to protect them if they are to operate in contested battlespace. In contested battlespace, the vulnerabilities of fourth-generation aircraft will prevent fifth-generation fighters from performing at their full operational potential. Today's tiered force requires fifth-generation aircraft to protect, support, and defend fourth-generation aircraft. These dynamics might be advantageous in large force exercises, but they are simply not sustainable in a prolonged peer-level conflict. In that kind of contested fight, fourth-generation aircraft create a vulnerability that adversaries could exploit. Tiering the force is not a reasonable strategic option without significant excess capacity in the inventory and the enterprise. So long as fifth-generation aircraft remain such a small percentage of the overall force, the development of tactics and operational concepts will likely continue to focus on protecting and enabling legacy platforms. Buying new F-15EXs will perpetuate these dynamics and prevent the Air Force from developing the full potential of fifth-generation capabilities.

Summary

The pressure the Air Force is facing to recapitalize their old, worn-out legacy fighters is understandable. As General Mark D. Kelly, commander of Air Combat Command recently stated, "As a nation, if we're pivoting to great power competition, [we] also have to pivot [our] resourcing to great power capabilities."[69] The F-15EX does not have the same survivability of stealth aircraft to make it as useful in contested battlespace, except as a stand-off weapons platform. That means that the missions it is supposedly replacing—like air superiority—will go unfilled in the very scenarios where they are most needed. While a yet-to-be-determined final number of F-15EXs are currently part of the Air Force plan as a contribution to the bridging strategy, truncating F-15EX procurement at some point is an option that should be considered to free up funding for an aircraft design relevant to fights involving modern threats. In a September 27, 2021, editorial, Chief of Staff General Brown said, "We must act with deliberate speed and a clarity of purpose not seen in a long time." Such clarity of purpose may be best served by shifting funding from the F-15EX to new designs of fighter aircraft that can directly contribute to General Brown's desire to "win in this new strategic environment."[70] A fighter aircraft with a 50-year-old structural design may not be that aircraft.

3. A Controversial Proposal: Develop an Alternative Air Force Fighter

Earlier this spring, General Brown stated that "I want to be able to build something new and different that's not the F-16—that has some of those capabilities, but gets there faster and features a digital approach."[71] The notion that a clean sheet design could be part of the Air Force's future fighter flight plan, and one specifically built to replace the F-16C/D, shocked the defense community—after all, the F-35A is the designated replacement for the F-16C/D. Although the announcement of the possibility felt disruptive, there is the potential for this "multi-role-X" (MR-X) initiative to positively contribute to transforming the fighter force. So long as several key principles are adhered to, a new-start fighter program loosely modeled on the original Lightweight Fighter (LWF) and F-117 program may be a good idea. If the service wants recapitalization options other than the F-35A and NGAD for the 2030s, it must begin a new-start fighter competition now.

If the service wants recapitalization options other than the F-35A and NGAD for the 2030s, it must begin a new-start fighter competition now.

The challenge that Air Force leadership is seeking to meet with the MR-X is finding the right balance between cost and operational capabilities. General Brown has described the MR-X as "four-and-a-half or fifth-gen-minus" in the belief that the service must compromise on capability to achieve operational affordability.[72] The truth is that both are important. The lack of capability is expensive in terms of attrition and mission failure, while not getting the operational affordability right may impose unsustainable costs. These do not need to be incompatible tradeoffs. While there is some truth to the fact that the more advanced the capability, the more it costs to develop, procure, and employ, these costs do not need to be unsustainable. Most importantly, the service should not procure less than a full stealth capability. If the Air Force pursues its next clean-sheet design as less than a stealthy fifth-generation airframe purely as a means to achieve affordability, it will miss a key opportunity to build the force it needs. Instead, the Air Force should use principles from the Lightweight Fighter program of the 1960s and 1970s—which ultimately became the F-16A/B/C/D and F-18A/B/C/D/E/F—and the F-117 to guide a new design and production effort. Both the LWF competition and the F-117 programs achieved affordability in part due to limiting the appetite of designers for invention and complexity. These programs sought to advance specific performance elements, like maneuverability or stealth, while limiting the number and scope of new developmental efforts.

If the Air Force pursues its next clean-sheet design as less than a stealthy fifth-generation airframe purely as a means to achieve affordability, it will miss a key opportunity to build the force it needs.

The following principles could guide a successful new-start fighter program that could affordably meet mission requirements and help build the capability and capacity bridge to the mid-2030s and beyond. By keeping these in mind, a new clean sheet design would allow the Air Force to affordably develop an aircraft that optimizes targeted physical performance attributes, limits technological adventurism, leverages mature and common subsystems, and incorporates open system architectures.

Target specific physical performance attributes

The physical design of any aircraft is the product of a series of tradeoffs. Speed, range, altitude, payload, maneuverability, and endurance are all traditional elements of an aircraft's physical design. These attributes exist in a complex system of tradeoffs that optimize one element at the cost of another. An aircraft that is highly maneuverable is not likely to have a large payload, and increased range often comes at the cost of an aircraft's operating speeds or payload capacity. These attributes must be scoped for both the aircraft's intended missions and the physical realities of the battlespace, with an awareness of how they impact cost. The brilliance of successful aircraft design is how engineers balance or even overcome these aerodynamic and structural relationships. For example, the vast operational ranges in INDOPACOM poses serious design challenges to any aircraft, and especially to those that originate from outside the first island chain. The realities of this theater imply a requirement for range and payload, which in turn would require a larger airframe that costs more to build and operate. As the Air Force seeks to affordably field any new fighter in meaningful numbers, it will need to find the sweet spot between operationally relevant designs, the operational plans and concepts it will enable, and operational affordability.

Design choices today must also go beyond the traditional attributes of an aircraft's performance envelope. Any future design, importantly, cannot sacrifice stealth, and it must optimize size, weight, power, and cooling (SWAP-C) capacity. Stealth is the cost of entry into any modern battlespace, and the cost of that stealth has greatly decreased over time. The physical shaping, which accounts for a large portion of an aircraft's signature, is eminently achievable with modern computing and processing. As the Air Force moves even more into digital design, designing for stealth should become even easier. Stealth materials have also dramatically improved in capability, cost, and maintainability. SWAP-C, likewise, has been an oft-neglected set of physical attributes that can no longer be an afterthought in future aircraft design. The challenges of space and where to locate processors for both software updates and tech refresh, wiring, generating sufficient electrical power, and the ability to cool all systems on the ground, in the air, and with battle damage are very real physical design problems. In the informationized battlespace, stealth and SWAP-C considerations are non-negotiable.

Limit technological excess and leverage common and existing subsystems

Although limiting technological excess will be key to a new fighter aircraft's speed and affordability, this does not mean that a new fighter must be "four-and-a-half or fifth-gen-minus." Instead, designers must focus on a single or very small set of technological advancements that provide a competitive edge in the mission space. A corollary to this principle is also limiting the complexity of the fighter as an overall weapon system. Complexity should be similarly managed for the purposes of development as much as for sustainment and operational considerations. Minimizing complexity may also mean limiting just how "multi-role" the MR-X would be. Deliberately and tightly bounding the technological innovation and complexity of the aircraft would allow the program to have a laser-focus on designing just the aircraft it needs to achieve its specific advantage in the battlespace.

Leveraging common and existing subsystems from other similar aircraft could help limit complexity and development risk, cost, and schedule. Not everything on the aircraft, from its airframe to its engines to its sensors and avionics, need be new. Instead, the MR-X could benefit from mature and highly advanced

capabilities already resident on other platforms. Programs like the F-117 used this principle of design, and it allowed the program to focus on the tightly scoped technologies of stealth and precision laser-targeting guidance. Furthermore, incorporating existing subsystems and other components takes advantage of existing supply chains, economies of scale, and known design parameters. These benefits can accelerate design, testing, and fielding to deliver more affordable weapon systems.

Employ open system architectures

Any new major weapon system should use an open system architecture construct for its sensors, processing, and operational functions. Fourth-generation aircraft have federated architectures, which may make it easier to modify and add elements to the system, but it makes it more difficult to operate the aircraft as new capabilities are added on. Fifth-generation aircraft have tightly coupled and fused architectures, which increases the operational effectiveness of the system, but it makes it far more difficult to modify or change any component. An open system architecture bridges these two approaches to deliver high quality mission effectiveness and enable greater agility. This architecture approach would allow MR-X to maximize its use of existing sensors and specifically developed technologies while keeping options open for the rapid and asynchronous integration of future capabilities.

Summary

Even more than being budget conscious, any new-start program must be mission focused. This is not about replacing the F-16C/D with something cheaper and less capable than the F-35A—it is about ensuring the mission and roles that the F-16C/D has come to play in the broader force design are appropriately fulfilled. The F-16C/D has been the backbone of fighter capacity in combat operations for the last 30 years at an operational cost that is sustainable for prolonged conflicts. These combat roles and attributes must be met by any new-start fighter program. This likely means taking different design approaches and accepting an even greater diversity of aircraft in the force. The Air Force needs a clean-sheet fighter alternative than can be both operationally effective in a peer-level fight and achieve a level of affordability that facilitates recapitalization and high-tempo utilization. Adhering to some key principles, identifying tradeoffs, and tightly scoping objectives in the design process can build toward a future force in an affordable way.

The Air Force needs a clean-sheet fighter alternative than can be both operationally effective in a peer-level fight and achieve a level of affordability that facilitates recapitalization and high-tempo utilization.

This said, Air Force documents indicate that the MR-X may not join the force until the mid-2030s at the earliest.[73] Experience indicates that this is an optimistic timeline, even with Air Force efforts to accelerate acquisition and production through new policies and digital engineering. As such, the Air Force must look to other elements of its fighter plan to get through the hazards of the next decade. Extending the life of the F-16C/D is a course of action that does more for the enterprise than it does for combat operations. Given a realistic schedule of any new fighter program, the only option the Air Force has to mitigate near-term risk is to accelerate the procurement of the F-35A.

4. The F-35A: Love the One You're With

The F-35A is the only fifth-generation aircraft currently in production. Despite its many critics, quickly and immediately ramping up the F-35A production rate is the best option to reconstitute the Air Force's combat fighter force in an operationally meaningful way. Yet the Air Force asked for only 48 F-35s in its FY22 budget request and did not include additional F-35As on the unfunded priorities list it submitted to Congress. Furthermore, reporting indicates that the Air Force intends to decrease its annual buy in the FYDP to only 43 a year.[74] Recent announcements that the F-35 Joint Program Office reached an agreement with Lockheed Martin to "smooth" F-35 production do not solve the Air Force's recapitalization requirements.[75] To meet the demands of the *National Defense Strategy* as rapidly as possible, the Air Force should ramp up and maintain high rates of F-35A production to replace its legacy inventory as rapidly as possible.

Air Force leadership is generally focused on three priorities with the F-35A: its capability, availability, and affordability. Capability refers to the suite of sensors, avionics, and weapons the F-35A must possess to successfully execute combat operations across the range of military operations. Availability is the general readiness of the F-35A inventory—how many aircraft are fully mission capable across the span of a year. Affordability is the cost of ownership and operations—the sustainment costs of the F-35A force. These three issues appear to be the major factors driving Air Force decisions on F-35A procurement rates.

F-35A Block 4 Capability.

Senior Air Force leadership has connected Block 4 F-35 capability coming off the line to F-35 acquisition decisions.[76] At issue is when the F-35A will be delivered in a full Block 4 configuration. Block 4 is a suite of mostly classified hardware upgrades, technologies, and software drops that radically enhances F-35 combat effectiveness. The F-35 was planned and produced around a concept of spiraling more capabilities into production aircraft. Early Block 1A and 1B versions of the F-35 were fielded with basic capabilities and limited flight envelopes to facilitate testing and training. Subsequent blocks added capability and flight performance. The Air Force declared initial operational capability with Block 3F of the F-35A, and this is the version that has been conducting combat operations in the Middle East. Operational analysis has indicated that the even-more-advanced Block 4 configuration is necessary to be effective in a conflict with China. However, challenges with maturing all of the Block 4 technologies has slid delivery of the full Block 4 suite to at least 2029, and this is a significant factor in the Air Force's decision to slow F-35A procurement.

Although the full suite of Block 4 capabilities will not mature until the late 2020s, *every F-35 bought in FY24 and after will be able to fully host every Block 4 capability*. There are three hardware requirements necessary to host Block 4: TR-3, a more powerful central processor; the next-generation distributed aperture system (DAS); and an additional technology. This foundation of hardware enables the suite of the Block 4 technologies, which comprise a mix of hardware and software upgrades. The 98 Air Force F-35As bought in FY21 and FY22 (Lots 15 and 16, respectively) have the TR-3 processor and next-generation DAS—they will need to be retrofitted with the additional hardware. The same is true for the 48 F-35As

in the FY23 (Lot 17) Air Force budget request. Industry representatives indicate that this modification is not overly intrusive.[77] More importantly, F-35s bought in FY24 (collectively referred to as production Lot 18) and forward will be delivered with this full Block 4 foundation of TR-3, next-generation DAS, and the additional hardware. Retrofitting these aircraft through a mod-line that operates concurrently with production will be the fastest way to deliver Block 4 capabilities in meaningful numbers to the warfighter.

Every F-35A that is not bought between now and the end of the decade is one less Block 4 aircraft in the Air Force's 2030 inventory. Aircraft production is not a water faucet—lines cannot go from a drip to torrent in one year. Facilities must be reconfigured, tooling manufactured, workers trained, and suppliers energized. Even for an established production line, it takes three years to go from raw materials to a shiny new jet off the line. Standing up bases, establishing spares and supply chains, training maintainers, and training pilots takes years, too. All this means that there is a lag from when the Air Force funds an aircraft to when it becomes available for combat operations. If the Air Force chooses this delaying course of action, it will be the middle of the 2030s or later before Block 4 F-35As in the operational force reach a number that matters.

The nation cannot wait until 2030 to begin replacing its legacy inventory with new stealthy aircraft. While modifications will be needed to bring the F-35s bought in the interim up to full Block 4 configuration, every F-35 procured in the FY23 budget and onward will have the required foundation of hardware to support Block 4 capabilities. Delaying procurement also ignores the reality that Block 4 can be incrementally fielded, providing an improvement in capability over what the F-35A has now. Warfighters should not have to wait. "Better" is better than perfect. One Air Force pilot familiar with the F-35 program described Block 4 capabilities as "eye-watering" and said, "It makes the jet a totally different aircraft. It shouldn't even be called the F-35, it's so revolutionary."[78] Even a partial Block 4 capability in meaningful numbers can go far in managing risk in the near and mid-term. The Air Force should not wait to ramp production on the F-35A.

F-35A Availability.

Availability is another issue causing serious consternation for the service that is used as a rationale to suppress F-35A buy rates. While F-35A mission-capable rates are still below the service's performance targets, they are increasing—and are generally in line with or above other fighters in the Air Force portfolio. Challenges facing the F-35 center around the supply chain, flight line maintenance, the software information system that supports and manages its operations, and engine issues.[79] Of these, the first three can be considered serious but improving. Aircraft readiness is adversely affected by either a lack of or long wait times for spare parts, insufficient depot throughput capacity, and lack of technical data and support equipment. Issues with the F-35's Autonomic Logistics Information System (ALIS) continue to persist, with difficult user interfaces and even inaccurate and missing data. Even so, F-35A mission-capable rates continue to move in the right direction. For example, the break rate of the F-35A is 5 percent, meaning that 95 percent of time, the jet is ready to relaunch without needing critical fixes. This is the lowest break rate in the Air Force, and, over half the time, the breaks that do occur with F-35As can be repaired in a single maintenance shift.

The most problematic issue facing F-35 availability is the Pratt and Whitney F-135 engine. This advanced

engine is experiencing a greater-than-planned maintenance demand, with potentially serious long-term consequences. According to the GAO and Air Force officials, line aircraft had their engines removed for unplanned power module maintenance at a much higher rate than anticipated. Complicating this is the lack of depot throughput at Oklahoma City Air Logistics Complex, the primary engine repair facility for the F-135 engine. Due to more extensive repairs, a lack of technical data and support equipment, and insufficient proficiency of the depot workforce, engine repairs are taking much longer than scheduled. This backlog of unscheduled maintenance will collide with scheduled repairs at the end of 2021, further compounding the problem. Recent GAO testimony suggests that unless these issues are resolved, the total F-35 inventory would be down by 800 engines by 2030—over 40 percent of all F-35s world-wide.[80] Air Force leaders appear to want to match F-35A buy rates to engine availability, adding to their rationale to decrease F-35A procurement.

Failing to replace older, legacy aircraft burdens the Air Force with high sustainment costs and no capability reward.

The F-35 sustainment enterprise may be complex, but this should not deter the Air Force from procuring the aircraft that it needs. As frustrating as it may be to have aircraft that do not have the desired block capabilities or wrestle with unforeseen maintenance issues, every F-35A the Air Force does not buy is a fighter that is wholly unavailable for training and real-world contingencies. Even worse, failing to replace older, legacy aircraft burdens the Air Force with high sustainment costs and no capability reward. The Air Force should still buy the F-35A at high rates even if it means buying F-35 airframes without engines. That said, of course the Air Force, Congress, and Pratt and Whitney can and should take aggressive action to mitigate the engine shortfall. These engine shortfall issues are currently projected to resolve in two years due to focused efforts by both Pratt and Whitney and depot operations. When the engine enterprise returns to health, it will provide aircraft that will be able to immediately boost combat forces. This situation is not unlike what faced the F-15A/B force in the 1970s. Many aircraft sat on the ramp without engines for years. When President Reagan increased defense resources, the engines were bought and installed, and the combat readiness of these aircraft was rapidly realized.

F-35A Affordability.

Affordability is perhaps the biggest challenge facing the F-35 program. Perceptions that the F-35 is too expensive across the board—from development to procurement, modernization, and sustainment—have long plagued the program. In fact, concerns over cost projections threaten to keep overall F-35 production rates low and curtail the total quantity the Air Force can buy with its insufficient budget. It is vital to understand that nowhere in the critics' concern over F-35 cost is the consideration of cost-per-effect or combat capability included. Merely assuming a combat advantage of two-to-one of the F-35 over other aircraft alternatives in these discussions would evaporate cost concerns. The combat advantage that the F-35 yields, in fact, is far greater than two-to-one. A conservative estimate is it an order of magnitude more effective than any other fighter aircraft alternative except the F-22.

Describing "Cost-Per-Effect"

Most cost analyses for major weapon systems focus either on acquisition cost or cost-per-flying hour, but neither of these approaches consider the operational elements of their capability. They completely ignore the cost of employing these systems in actual combat operations to achieve specific desired effects. If defense leaders focus only on peacetime unit costs, they will miscalculate the costs of war, thereby procuring ineffective weapon systems or under-sizing the force due to arbitrary budgetary constraints. Cost-per-effect captures the total cost to achieve a specific mission outcome, to include not just the aircraft executing the actual task, but also aerial refueling tankers, electronic jamming platforms, air superiority cover, suppression of enemy air defenses, and other enabling capabilities. When calculated from this perspective, the total force burden of legacy aircraft in a modern, contested battlespace with advanced air defenses would provide leaders with a better understanding of the combat costs of their force than a projection of cost derived from peacetime spending.

For more on cost-per-effect, see David Deptula and Douglas Birkey, *Resolving America's Defense Strategy-Resource Mismatch: The Case for Cost-Per-Effect Analysis* (Arlington, VA: Mitchell Institute for Aerospace Studies, 2020).

A problem that continues to haunt Air Force programmers is that original F-35A costs were based on the F-16C/D. As a result, cost projections did not account for differences in consumables, low-observability materials, maintenance, or how the integrated sensors are included in program costs.[81] The assumptions for the initial accounting were faulty, and they have continued to vex the Air Force's development of F-35A affordability targets. The simple fact is that fifth-generation operational costs are higher than fourth-generation costs due to their advanced capabilities, complexity of the composite nature of the aircraft that enables stealth characteristics, and other technologies. Operational costs have consistently risen with every generation of aircraft, from early jets to today.

Of course, it is prudent to seek to manage cost in developing, fielding, and operating new fighters, but force structure decisions should not be dictated by accountants that do not include mission effectiveness as part of their equations. This notion of "affordability" in peacetime and not cost-effectiveness in combat is entirely the wrong measure upon which to base procurement decisions.

For instance, the GAO estimates that by 2036, the Air Force will experience cost growth for an inventory of 1,192 aircraft of $4.4 billion in that year.[82] Most of this growth is a result of quantity, but the GAO does not credit the program by amortizing fixed costs across this larger inventory. Analysts project that this annual exceedance will only increase as the inventory expands further, ultimately becoming unaffordable. Consequently, the GAO recommends basing F-35 procurement decisions on achieving what it calls "affordability constraints," a budget number that represents how much the service can afford to spend on the F-35.[83] But limiting production now as the result of long-term prognostications is a deeply flawed approach. This would shut down crucial strategic options with little way to credit the Air Force or the contractor for actions taken to address these issues. The GAO's logic follows a buy-to-budget type approach, where the service only buys as many aircraft as it can afford to sustain within a fixed and arbitrary budget.

Higher projected sustainment costs translate directly into diminished procurement and even, potentially, a truncated total buy.

A more effective way to understand the value and costs of the fighter force structure is through cost-per-effect. This approach analyses the "sum of what it takes to net a desired mission result, not just a single system's acquisition and support costs without context surrounding the capability's actual use."[84] Current methods of accounting for individual weapon systems cost, from procurement through sustainment and operations, are devoid of this necessary combat context. Retired Lt General David Deptula describes how the Air Force and DOD approach weapon system costs as "only address[ing] one facet of the kill chain without taking into consideration the mission-effectiveness of the particular system (an 'output' measure)."[85] Cost-per-effect, in contrast, analyzes the cost to execute a mission. This operationally oriented approach becomes even more important when comparing legacy and fifth-generation aircraft. Legacy aircraft require significant support packages to execute their missions, including fifth-generation escorts in some cases, imposing a greater cost to execute combat operations and sustain a larger force structure. Fifth-generation aircraft enable more cost-effective options from this operational lens because they do not require the same mission support packages.

Affordability initiatives will continue to be crucial for the Air Force across its entire portfolio. The F-35 should not be exempt from these efforts, especially as related to sustainment. But inventory is not the only way to lower costs. It is crucial that the Air Force and OSD reorient their perspective on cost. If they do not, they risk being penny-wise and pound-foolish.

Other F-35 Program Considerations

There are additional considerations surrounding the F-35A program that are important to restoring the health and combat credibility of the U.S. Air Force's fighter force. The first is total quantity, and this is not simply about buying to scale to drive down cost. Numbers should reflect planning force requirements—what is needed to achieve operational and strategic effectiveness. The total Air Force F-35A procurement target remains at 1,763 aircraft, a number that was based on literally replacing every F-16C/D and A-10C when the F-35 first became a program of record. Some defense leaders suggest that the "real" F-35A buy objective should be truncated to a much smaller number. Although their reasoning may publicly be that we can make do with less because the aircraft is so capable, these suggestions are motivated primarily by cost concerns. In short, some have deemed the projected lifecycle cost for 1,763 aircraft over seventy years as too expensive to complete the total buy.[86]

Again, affordability alone should not drive quantity decisions. Instead, the force sizing of F-35As should be based on the numbers required to meet the demands of the *National Defense Strategy*. Although the 1,763 F-35A objective is based on the number of F-16C/Ds and A-10Cs in the inventory after the draconian cuts of the mid-1990s, fighter inventories during the Cold War—our nation's last period of competition with a peer adversary—numbered well above 4,000. It seems reasonable to believe that, even with more advanced capabilities, the peer adversaries and global security environment of today demand greater numbers of

F-35As than predicted during the mid-1990s. Furthermore, programmers should also plan to replace earlier F-35As with later Block models. The Air Force has historically replaced the earliest versions of aircraft with more modern models to manage configuration, take advantage of modifications and technology insertion, and ensure combat effectiveness—even at formal training units. The F-35A should be no different.

The Problem of the Joint Program Office

Finally, it should be noted that the Air Force does not have as much authority as it should to develop and implement F-35A affordability initiatives, because the F-35 Joint Program Office (JPO) has more authority in program execution than any of the individual services. This lack of authority will remain a major barrier for the Air Force in achieving its F-35A capability, availability, and affordability goals. As the office responsible for managing all elements of the F-35 program for all customers, the JPO holds authority and responsibility under the Office of the Secretary of Defense for all decisions on F-35 management and program execution. The JPO adjudicates everything from negotiation of production and sustainment contracts and maintenance and depot execution to capability and modernization requirements. What is unique in the JPO structure is that none of the three U.S. services, the partners, nor foreign military sales customers have any real authority or control within the F-35 program. This lack of authority was by design: the structure and rules that govern the program deliberately remove agency from the services and partners in order to mediate different interests and keep the consortium together.

The JPO uses a byzantine series of rulesets and voting procedures to govern everything from determining what capabilities will be included in the next modernization cycle to who gets what spare parts. The JPO, for example, is structured and incentivized to maintain as much commonality in the F-35 family as possible. Every nation has a number of votes to shape the modernization agenda of the F-35, with the intent that the majority vote will keep everyone's configuration aligned. But since the services and individual countries began employing the F-35, their interests have diverged. What the Air Force—or any other partner, for that matter—may see as an important priority may not make it above the "cut line," and ultimately may not become part of the modernization path. Program partners not only pay for what might not have been their top priority, they then must "pay to be different." It is not surprising that senior Air Force officials have expressed frustration in the lack of the JPO's responsiveness in delivering needed capabilities. This is especially evident in what the officials characterized as an apparent lack of urgency in the JPO to fully field Block 4.[87]

The same goes for availability. Neither the services nor partners control their own F-35 spares. Participating nations pool their funding in the F-35 program to achieve economies of scale and efficiencies in execution. It is the JPO that determines how many of what kind of parts to procure for the global spares pool. Inventories are optimized for efficiencies and to avoid excess capacity. Spares are then allotted based on predetermined priorities and rulesets. These priorities are intended to ensure that spares are highly available for F-35 operational missions and deployments, but they are often at the cost of formal and routine training. U.S. services do not receive any special treatment or have any influence in this system.

The Problems with the JPO

A study on the F-35 Joint Program Office commissioned by the Under Secretary of Defense for Acquisition, Technology, and Logistics found severe problems with the way the office worked. It reported the following:

> JPO Organizational Structure Makes it Difficult for the U.S. Services to have Adequate Insight and Voice into Internal JPO Processes, Strategies and Decision Making: Because the JPO largely operates, culturally and geographically, outside the Systems Commands and standard processes of the Military Departments, over time the JPO has become a rather insular and opaque organization where the U.S. Services do not have adequate insight or voice into the daily processes, strategies and decision making used to translate requirements into delivered capabilities. This has resulted in a JPO workforce that is disconnected from the functional expertise and relational guidance of their home Services.[88]

So long as the JPO is the primary manager of the F-35A, the Air Force will be unable to satisfactorily meet its objectives of capability, availability, and affordability.

A study directed by the FY17 NDAA and commissioned by the Under Secretary of Defense (USD) for Acquisition, Technology, and Logistics (AT&L) described this very disconnect between service needs and JPO responsiveness. It recommended a phased restructuring of the F-35 program management that would empower each U.S. service to assume all responsibility for managing their F-35 variant. In this plan, the management of each F-35 variant would migrate to its U.S. lead service, such that separate service-run program management offices would report to their service program executive offices and service acquisition executives. For example, the Air Force would take over program management for all F-35A models, to include F-35A international partners and FMS countries. Despite oft-cited concerns that disbanding the JPO would decrease economies of scale and negotiating power—thus increasing costs for the services and partners—the study projected that this management scheme could result in up to 3 percent saving in lifecycle costs.

With no movement on the part of OSD, it now appears that Congress will take action on these recommendations. The Senate Armed Services Committee (SASC) markup of the FY22 NDAA directs DOD to transition F-35 sustainment from the JPO to the Air Force and Navy.[89] Proposed language further directs DOD to submit a plan in February 2022 describing how it will execute and complete the transfer of F-35 sustainment authority to the respective services.[90] The House Armed Services Committee (HASC) did not include similar language in their markup. While the FY22 NDAA is yet to be finalized, this language is a positive indication of where F-35 program management and execution needs to move.

So long as the JPO is the primary manager of the F-35A, the Air Force will be unable to satisfactorily meet its objectives of capability, availability, and affordability. Although the JPO promises these objectives as its focus, its very structure, governance, and incentives prevent it from delivering. As each service and nation operationalizes their F-35s, they will develop unique requirements that the JPO, by nature, will drive to conformity and commonality. Although the three variants are now only considered 20 percent common (from initial objectives of over 90 percent), the JPO is still focused on enforcing commonality.

Credit: U.S. Air Force Photo

Four F-35A Lightning IIs over Alaska on August 17, 2020 as part of the Red Flag-Alaska exercise during which fourth and fifth-generation fighter aircraft trained together.

Summary

There are no other credible fifth-generation fighter aircraft currently in production anywhere in the free world to manage the increasingly dangerous risks posed by China and Russia. The Air Force should aggressively ramp up F-35A production now while it solves the challenges of capability, availability, affordability, and program management. These are indeed important issues for the Air Force to solve, but they should not drive procurement decisions. Force sizing for strategic demands and recapitalization requirements should be the primary considerations for F-35A buy rates. Given strategic realities, a peer-threat environment, and production practicalities, ramping up F-35A production is the Air Force's only viable option for recapitalizing its fighter inventory.

Given strategic realities, a peer-threat environment, and production practicalities, ramping up F-35A production is the Air Force's only viable option for recapitalizing its fighter inventory.

5. Extend the F-22 into the 2030s to Preserve Air Dominance

Air Force leaders have stated their intent to retire the F-22A, suggesting that it would be replaced by the Next Generation Air Dominance suite of systems. A service spokeswoman was quick to clarify that there was no plan to retire the F-22A force in the near-term, and senior leaders hinted at the end of the decade as a more likely timeframe. Lt General Hinote stated that the Air Force is treating the F-22A "as the bridge to NGAD capability."[91] This is a reasonable plan if NGAD is in production and able to assume the mission role of air dominance with sufficient capacity. Like legacy fighters, the F-22A and its unique mission capabilities cannot be gapped. If, however, the strategic context at the time demands a larger planning force than NGAD is capable of fielding, the Air Force may need to extend the F-22A longer than it currently plans.

The Air Force is eager to replace the F-22A because of its high costs, mixed configuration, and low mission capable rates. Because F-22A production was prematurely terminated, the F-22A inventory is small and has high operational "cost-per-tail" and configuration challenges. Fixed enterprise infrastructure is amortized over a smaller denominator, and early jets were never replaced by newer models. For example, the jets used to train new F-22A pilots are of such an early model that their central processors cannot be upgraded or support the same software as later production aircraft. This requires operational squadrons to conduct some training events in combat-coded aircraft that cannot be accomplished in the oldest of the F-22As. The more basic training operational units must do to "top-off" new pilots, the less complex combat training they are able to accomplish, which decreases their overall readiness levels. The small F-22A inventory also suffers from a smaller supply base, diminished or no manufacturing sources for some components, and labor-intensive low-observable coatings. These and other factors result in the lowest mission capable rate of all the Air Force's fighters at just above 50 percent. It is not surprising the Air Force is eager to retire the F-22A.

Despite these challenges, this most capable fighter aircraft in the world remains essential to future air dominance, and the service may find it must retain the F-22A past NGAD initial fielding. General Hinote is right to think of the F-22A as a bridge because air dominance cannot be gapped. Demand for the F-22A is only growing because there are missions that only it can accomplish. Consequently, the F-22A and the pilot force that flies them are wearing out. If the F-22A is divested too early—before NGAD gets past the early teething issues of new aircraft, before NGAD gets past the dangers of small inventory dynamics, before NGAD receives its first upgrade of capability—the service risks repeating the mistakes with NGAD that plagued the early F-22A. This is the real consideration: retaining and modernizing F-22A long enough to mitigate the mission gap between operational demand and force capacity. In essence, retaining the F-22A would act as an operational reserve to prevent overstressing a young NGAD force.

The basic geographic demands of the Pacific require quantity, and if Europe requires simultaneous presence, NGAD will need to replace the F-22A at a far greater quantity than 187. Rigorous and honest planning

Credit: U.S. Air Force Photo

F-22 Raptors in an Elephant Walk on March 26, 2019, during a Polar Force exercise at Joint Base Elmendorf-Richardson, Alaska.

force numbers based on robust threat scenarios are essential to understand the full force requirement for NGAD. Although NGAD remains highly classified, there are indications that it may be a family of systems with greater range and payload than the F-22A. All this means that the system will not be inexpensive. The Air Force must remain unwavering in its commitment to the full development and fielding of NGAD to the planning force.

Summary

Despite the higher costs and the challenges of managing and operating the F-22A, it should be aggressively modernized throughout the 2020s and only retired as NGAD is produced in sufficient quantities to ensure there is no gap in the mission capacity requirements. In fact, it is far more likely that strategic analysis will reveal a much greater requirement for air dominance capacity, necessitating the need to further extend the F-22 as it grows its NGAD inventory. The Air Force must do all it can to responsibly execute the development and fielding of NGAD as soon as possible, as well as to maintain a force size that can ensure air dominance for joint and coalition forces in a peer conflict.

Recommendations and Conclusion

The strategy-resource mismatch that exists between the *National Defense Strategy* and the USAF's insufficient modernization budget has forced the service to "free up" funds for recapitalization by divesting many of its current aircraft and slowing production of the F-35A. The Air Force rationale is understandable given the sustained underfunding of the Air Force for over two decades. Older aircraft are expensive to sustain, operate, and upgrade, and aircraft early in their production cycle that experience teething problems associated with immaturity can easily be scapegoated. However, this force design approach is not a vector to success. Past decisions to skip a generation of technology may have appeared both prudent and visionary, but they have now effectively widened the force's capability and capacity gaps.

Despite the promise and hope for future programs to do more and cost less, Air Force leadership must avoid the temptation to slow or scrap fifth-generation production in the unilateral pursuit of "program next." Canceling or even slowing present fighter production to chase future generations of unproven and immature technology will invite the risk that the Air Force's aging legacy fighters, which make up the bulk of the inventory, could run out of life before sixth-generation aircraft can replace them. This approach also assumes that developmental programs will miraculously meet schedule, performance, and budget targets better than current production—a dubious hope that invites failure against adversary forces in the near to mid-term.

The Air Force's continuing message to its airmen and industry is to "accelerate change or lose." If the Air Force cannot rapidly transform its force design away from legacy weapon systems that limit future operational concepts, then U.S. combatant commanders will be at high risk of losing in any future conflict. On the other hand, divesting legacy platforms with no immediate and clear replacement will shrink the force and increase strategic risk to our nation. Stop-gapping with a new-build legacy F-15EX and deferring F-35A full rate production is not accelerating change.

It is time to get the fighter force healthy now. Past generations squandered previous opportunities to modernize this key mission area. Waiting another decade risks irreparable harm at a time when these sorts of capabilities matter the most. The following actions would help secure our nation's airpower and bridge to a future force capable of meeting the complex needs the global security environment.

- **Develop and publish an Air Force "planning force" to depict what the service actually needs to execute the *National Defense Strategy*.** This action would go a long way in educating the American public and the Congress in understanding Air Force fighter force structure requirements. It would also clearly provide a measure of risk that the Air Force, DOD, and the nation is taking if senior leaders decide not to fully fund, acquire, or execute a program to the planning force.

- **Extend legacy F-16s, while wholly divesting the F-15C/D, A-10C, and F-15E inventories as the F-35 production ramps up.** Extending legacy F-16s will provide capability and capacity in permissive environments while preserving irreplaceable enterprise elements. The F-15C/D, A-10C, and F-15E

should be fully divested on a one-for-one replacement rate as F-35s come online, freeing up further funding for fifth-generation fighter production and next-generation fighter development.

- **Begin a new, stealthy, general-purpose fighter design to compliment NGAD.** The Air Force should seek to begin the development of an affordable, general-purpose, stealthy fighter program that will be relevant to the threats of the future. An option to fund this proposal may be to shift funding from the F-15EX by truncating the quantity bought at some point.

- **Immediately ramp-up F-35 production to offset F-15C/D, A-10C, and F-15E retirements.** F-35s procured now have the foundation for Block 4 capabilities; there should be no delay in immediately ramping up F-35 production. Increasing F-35 quantities now also provides some hedge for any potential NGAD delays.

- **Close the F-35 Joint Program Office and transition program management to the services.** Transitioning F-35 program authority to the respective services and closing the JPO should begin immediately to enable the Air Force to better achieve its F-35 capability, availability, and affordability objectives.

- **Retain and continue to modernize F-22.** The F-22 must be retained and modernized to continue to provide crucial air dominance capabilities. Given the challenges and capacity that could be demanded by both Pacific and European theaters, the Air Force should consider extending the F-22 until NGAD and other programs can ensure needed capacity.

- **Accelerate and remain steadfastly committed to the Air Force's Next Generation Air Dominance program.** NGAD is the foundation of the Air Force's future fighter force. While it remains highly classified, the Air Force must do all it can to accelerate it where it makes sense and remain wholly committed to seeing this program through. NGAD will not begin fielding until the next decade, but commitment to this crucial capability through this decade is critical to sustain to get to the other side of the bridge.

- **Remove pass-through funds from the Air Force budget.** Pass-through funds distort the service's true level of resourcing, result in a significantly smaller real budget, and cause direct harm to the Air Force's ability to recapitalize its legacy forces. OSD should remove pass-through from the Air Force's budget as the first step towards honest and responsible resource decisions for the service.

The Air Force faces a crucial transition. Senior Air Force leaders are doing their best to recapitalize multiple core mission areas while staying within serious budget constraints, but decades of deferred and canceled procurements have pushed the service to the point where any further delay in modernizing key capability portfolios threatens the service's ability to fulfill its national defense responsibilities. This has led to a two-fold dilemma: the service is too old and too small to meet all the mission requirements the nation demands of it, yet it does not have the budget top line to procure the new weapon systems it needs. Past

efforts to cannibalize its force to pay for new aircraft have not worked, and the Air Force does not have the combat aircraft capacity required to cover the vast geography and high operational tempo of a complex and multipolar world. Current Air Force plans to defer F-35A full-rate procurement, cannibalize the legacy fighter force, buy the 50-year-old structural design F-15EX, and begin a non-stealth fighter program are not a sound means to build the fighter force the nation needs. While the Air Force's current fighter flight plan is well intentioned, it only widens the gaps in foundational Air Force capabilities that come at a time when the global security environment is increasingly complex and dangerous. Fighter aircraft recapitalization cannot be put off any longer if leaders expect an Air Force capable of meeting 21st century challenges.

The decade of the 2020s offers the Air Force a unique period of opportunity to create a bridge of fighter capability—a force that can credibly mitigate strategic risk before advanced fighters like NGAD mature to initial operational capability. Furthermore, the service must take action to replace its fighter force before other recapitalization bills come due in the 2030s. Most importantly, the Air Force should accelerate procurement of the only fifth-generation fighter that is in production now, the F-35. This will enable the service to retire legacy platforms, build capacity and capability to mitigate strategic risk in the near to mid-term, and create the budget wedge needed for NGAD in the 2030s. The Air Force can successfully transform its fighter force from an expensive and aged one to a future force that can prevail in a peer conflict by implementing the actions recommend in this report. turn of the century, the Navy has purchased more combat aircraft than the Air Force."[92] Defense analysts Mark Gunzinger and Carl Rehberg estimate that simply replacing existing inventory would require the Air Force to procure over 200 new combat aircraft per year.[93] Current buy rates are nowhere near this total.

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