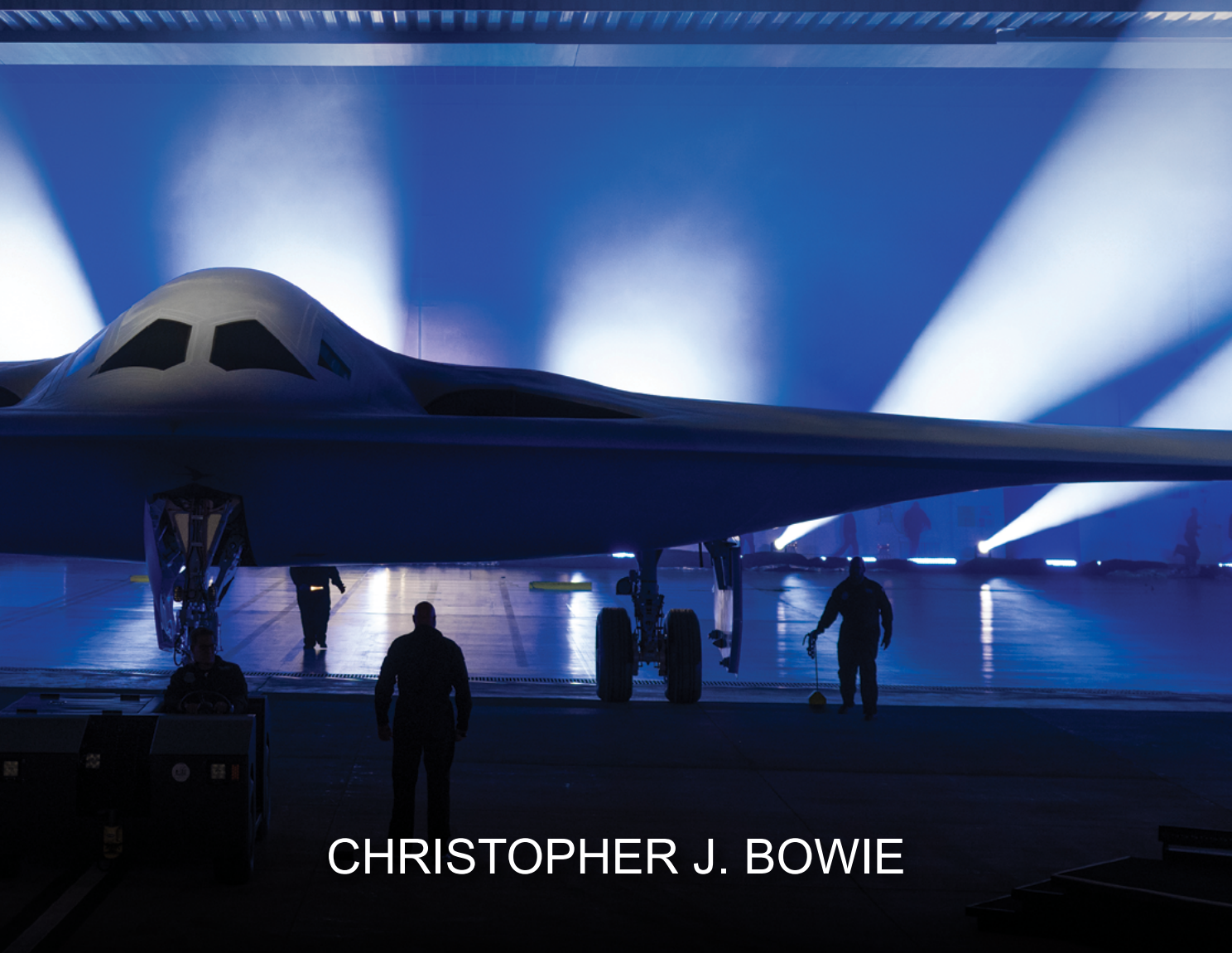
CSBA

Center for Strategic and Budgetary Assessments

AIR POWER METAMORPHOSIS

RETHINKING AIR FORCE COMBAT FORCE MODERNIZATION



CHRISTOPHER J. BOWIE

AIR POWER METAMORPHOSIS

RETHINKING AIR FORCE COMBAT FORCE MODERNIZATION

CHRISTOPHER J. BOWIE

CSBA
Center for Strategic and Budgetary Assessments

2023

ABOUT THE CENTER FOR STRATEGIC AND BUDGETARY ASSESSMENTS (CSBA)

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

ABOUT THE AUTHOR

Dr. Christopher J. Bowie is a non-resident senior fellow at the Center for Strategic and Budgetary Assessments. Trained as a historian, Dr. Bowie earned his B.A. magna cum laude at the University of Minnesota and his doctorate from Oxford University. Over the past four decades, he worked at the RAND Corporation as a senior analyst on air power issues, the Air Force (on the Secretary of the Air Force's staff group and as a member of the Senior Executive Service developing Air Force strategic planning), and at Northrop Grumman Corporation (where he served as Director of the Corporate Analysis Center). He retired in early 2021 to pursue independent writing, travel, reading, and his hobby of building model cars and aircraft.

ACKNOWLEDGMENTS

I would like to thank fellow CSBA staff members Dr. Tom Mahnken, Dr. Evan Montgomery, Dr. Carl Rehberg, and Dr. Christopher Bassler for their valuable critiques, comments, and feedback on earlier drafts of this paper. Much appreciation as well to Joseph Ross and James Mersol, who shepherded this paper through the publication process. The analysis and findings presented here are solely the responsibility of the authors. CSBA receives funding from a broad and diverse group of contributors, including private foundations, government agencies, and corporations. A complete list of these organizations can be found on our website at www.csbaonline.org/about/contributors.

Cover Graphic: The U.S. Air Force unveils the B-21 Raider at a ceremony in Palmdale, Calif., Dec. 2, 2022. Photo by Chad McNeely, Office of the Secretary of Defense Public Affairs.

Contents

FIGURES

TABLES

Executive Summary

This report aims to stimulate a discussion and debate over current Air Force modernization plans for its combat force. Given the central role of air power in future joint operations and the threats posed by our primary strategic competitor, a change in direction appears necessary to maintain an effective deterrent and warfighting force. The suggestions outlined in this study would yield a significantly different future combat force, one that appears better suited to the nation's geo-strategic needs while also offering significant operational, logistical, and budgetary advantages.

Changes in the geo-strategic environment are driving the need to alter course. U.S. national security strategy has identified China as the United States' primary strategic competitor, particularly after Russia's disastrous incursion into Ukraine, which has shattered assumptions of the combat effectiveness of its conventional military. For the past three decades, Chinese leadership has watched the United States project power in regional conflicts using a highly successful concept of operations—land-based and carrier-based fighters to gain control of the air, airlift and sealift to deploy ground forces, and fighters and bombers to strike from the air in coordination with ground force thrusts. The People's Liberation Army (PLA) has responded with a set of anti-access/area denial capabilities aimed at disrupting this approach. It is fielding a growing force of ballistic and cruise missiles combined with medium bombers and naval combatants to strike American and allied forward airfields, aircraft carriers, and surface ships. In addition, China is deploying advanced air defenses to defend against U.S. air power and fielding advanced fighters equipped with long-range missiles to attack our refueling and intelligence aircraft. This mix of capabilities threatens to undermine U.S. power projection capabilities and deterrence in the Western Pacific.

Given the vast distances and limited basing options in the Pacific, the Air Force must increase its long-range capabilities to enable operations from a wider array of bases located at greater ranges from Chinese offensive systems. This study outlines a proposed reshaping to increase long-range power projection capabilities in a "worst case" scenario; Air Force budgets remain flat over the next 15 years and all force structure trades take place within the Air Force. Increases in Air Force funding—either from larger defense budgets or an

increase in the Air Force's share of the budget—would support a wider range of options and reduce risk.

The USAF faced a similar threat in the mid-1950s from the Soviet Union and, in response, executed a significant restructuring of its force posture within a decade. To deter a Soviet nuclear attack during a crisis, the USAF in the mid-1950s planned to deploy hundreds of medium bombers to bases located on the periphery of the Soviet Union. Concern over the vulnerability of this force to a disarming strike led the USAF to reshape its force posture radically; the Air Force accelerated the procurement of heavy bombers, large aerial refueling aircraft, and ballistic missiles while retiring medium bombers, smaller tankers, and significant portions of the fighter force. The reshaping, which took place over roughly a decade, resulted in a 40% reduction in the size of the combat force, but provided significantly greater range/payload capabilities, reduced vulnerability, and increased strategic stability.

China's evolving threat to USAF forward bases in the Pacific poses a similar challenge and the need to rethink the USAF's combat force structure plans. The plans laid out in this report seek to increase USAF long-range power projection capabilities by leveraging the USAF's newest aircraft, the B-21 stealth bomber. The core change is a proposed doubling of B-21 production rates and plans for a larger B-21 force. The key characteristics of the next-generation bomber—range, payload, stealth, and an open systems digital backbone—could enable the B-21 to be potentially equipped with additional weapons and subsystems to conduct a wider range of missions in the new security environment. The aircraft will likely feature a large weapons bay or bays that can be fitted with a variety of payloads: strike weapons, anti-ship missiles, long-range air-to-air missiles, directed energy cannons, small unmanned aircraft, and Intelligence/Surveillance/Reconnaissance (ISR) and electronic warfare (EW) systems. Integration should be made easier using its open-architecture avionics. A large fleet of multi-mission B-21s could offer long-range strike, anti-ship, air-to-air, ISR, and EW capabilities to form a potent and formidable addition to the USAF's warfighting force.

To increase B-21 production rates and reduce unit costs, the Air Force has two options. It could require the current prime contractor to ramp up production (higher production rates should yield a reduction in unit price) or provide the design to a second contractor and open a second assembly line. The latter option could utilize the power of competition to spur cost reductions—each year, the two production lines would compete against each other for a larger share of the buy. Such a policy has been used with smaller acquisition programs, but not to date with modern combat aircraft.

Increasing B-21 production rates within static Air Force budget toplines, however, would require some difficult force structure trades. This study proposes the retirement of most of the non-stealthy legacy fighter force and reductions in the planned numbers of F-35s. Production of USAF F-35s would end as B-21 deliveries ramped up. Force levels for the F-22, the USAF's most capable fighter, are maintained. The versatile but aging F-15Es are replaced with the F-15X to provide forces for homeland air defense and operations against

less sophisticated adversaries. Plans to field unmanned systems and a longer-range next-generation fighter would also proceed. Based on historical experience, the new fighter will not enter service until the late 2030s or early 2040s; the proposed force provides additional long-range capabilities sooner. A multi-mission B-21 could operate with the new fighter and unmanned systems using novel weapons and concepts of operations.

The proposed plan would result in the following force structure attributes roughly 15 years (three Future Year Defense Plans or FYDPs) from now:

- Fighter-bomber ratios are a useful metric to illustrate what proportion of the force can conduct long-range operations. The fighter-bomber ratio since the 1970s onward has stayed at roughly 13 to one and has now increased to 15:1. Under current plans, these ratios will stay roughly the same. In the postulated force structure, the fighter/bomber ratio would shrink to 3:1—a ratio more in line with Air Force experience in the 1950s and early 1960s and one better matched to the new strategic environment.

- Operating and sustainment (O&S) costs for the smaller proposed force would be approximately 25% lower than the current force ($16.7B vs. $21.8B in $FY23). Logistical efficiencies could also be gained as the force goes from nine different types of aircraft to five. The O&S savings could be applied to procurement accounts.

- Although the new combat force is roughly two-thirds the size of today's force, its overall range-payload capability by the late 2030s will depend heavily on the unknown characteristics of the B-21. Assuming modest B-21 capabilities, the overall range-payload would be slightly lower than the current force, but significantly greater if the new aircraft features capabilities similar to current bombers.

The proposed force significantly increases U.S. power projection and deterrent capabilities. It poses a difficult defensive challenge for an adversary, which would need to deal with multiple potential axes of attack as well as enhanced air-to-air and anti-ship capabilities. A smaller fraction of our force would be forward-based and subject to attack.

That said, this plan is not without risk. The proposed force, though more capable, draws down the legacy fighter forces and overall fighter force levels, resulting in a combat force roughly two-thirds the size of today's force. The United States could maintain its deterrent posture in the Pacific theater by replacing legacy fighters in the Pacific theater with F-35s, F-22s, and bombers, but the shift would need to be managed carefully. U.S. allies around the world would need to assume more military responsibilities. An increase in the Air Force budget, due to either an overall defense budget increase or an increase in the Air Force's share of the budget, could be used to slow the drawdown of the legacy fighter force and extend F-35 production. Given the decline in Russian power and the importance of air and naval power in the Western Pacific, there are strong arguments for adjusting Service budget shares, but uncertainty surrounds prospects for success.

The risks generated by this option must be weighed against the risks of not adjusting our force posture. If the United States continues on its current course, it could end up with a force ill-suited to the challenges posed by China. Air Force planners in the 1950s faced a similar dilemma and took bold and decisive action. China has responded effectively after observing our concepts of operations since the 1991 Gulf War. The United States should be able to do the same starting now. At the very least, a debate over current plans and the future of the USAF combat force is warranted.

CHAPTER 1

Challenges in the Western Pacific Drive the Need for Change

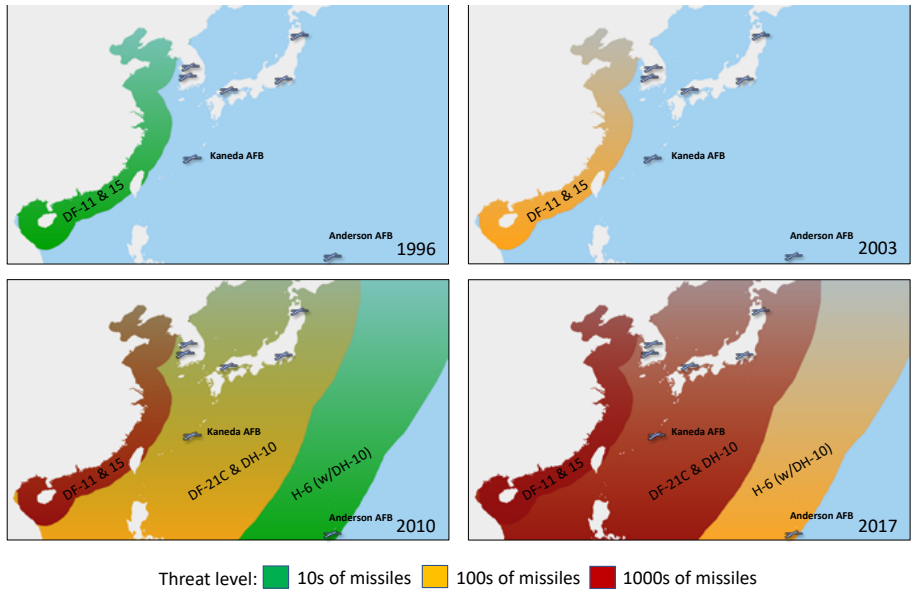
With the end of the Cold War, the United States emerged as the world's sole superpower. As demonstrated in the Gulf War in 1991, Serbia in 1999, Afghanistan in 2001, and Iraq from 2003 onward, no smaller power could defend itself against U.S. conventional military power. The United States demonstrated a remarkably effective style of power projection—land-based and carrier-based fighters to gain control of the air, airlift and sealift to deploy ground forces, and fighters and bombers to strike from the air in coordination with ground forces. Using this concept of operations in largely uncontested air environments, the United States was able to achieve military objectives with minimal losses.

Over the past 30 years, U.S. adversaries have been watching—and adapting. U.S. national security strategy identifies China as the United States' most challenging strategic competitor, particularly after Russia's disastrous invasion of Ukraine that severely damaged prewar assumptions of the operational effectiveness of its conventional forces.[1] China has developed what the Pentagon calls anti-access, area denial capabilities—basically, a mix of capabilities to prevent U.S. forces from being able to do to China what the United States did to enemy forces over the past three decades. China is fielding ballistic and cruise missiles combined with medium bombers and ships to strike forward airfields, aircraft carriers, and surface ships. Figure 1, developed by the RAND Corporation, illustrates the expanding reach of Chinese missile systems in the Western Pacific. In addition, China is deploying advanced air defenses to defend against U.S. air power and advanced fighters equipped with long-range

1 The White House, *National Security Strategy*, Washington DC, October 12, 2022, https://www.whitehouse.gov/wp-content/uploads/2022/10/Biden-Harris-Administrations-National-Security-Strategy-10.2022.pdf

missiles to attack U.S. refueling and intelligence aircraft. This mix of capabilities undermines U.S. power projection operations and deterrence in the Western Pacific.

FIGURE 1: EXPANDING REACH OF CHINESE OFFENSIVE FIREPOWER



Source: CSBA recreation of a graphic from David Ochmanek, Peter A. Wilson, Brenna Allen, Speed Meyers, and Carter C. Price, *U.S. Military Capabilities and Forces for a Dangerous World: Rethinking the U.S. Approach to Force Planning* (Santa Monica: The RAND Corporation, 2018) p. 10.

The emerging military environment requires a significant shift in the U.S. approach to power projection. No longer can the United States assume that it can quickly gain control of the air and then impose its will on an adversary using the joint force. A detailed analysis by the Center for Strategic and Budgetary Assessments concluded that fighters, even with refueling support, must be based within 1,000 to 1,500 nm of enemy targets to conduct sustained combat operations.[2] Regional base access constraints have continued to grow since the end of the Cold War, which could prevent the United States from basing short-range aircraft close enough to project power. Potentially more problematic, however, is that technological advances in precision-guided missiles and munitions may have increased the vulnerability of forward bases and aircraft carriers.

During the Cold War, the United States and its NATO allies conducted an extensive air base survivability program in Europe. The Western powers constructed hardened aircraft and personnel shelters, fielded additional operating surfaces, procured rapid runway repair equipment, developed additional airbases, and conducted multiple exercises to test

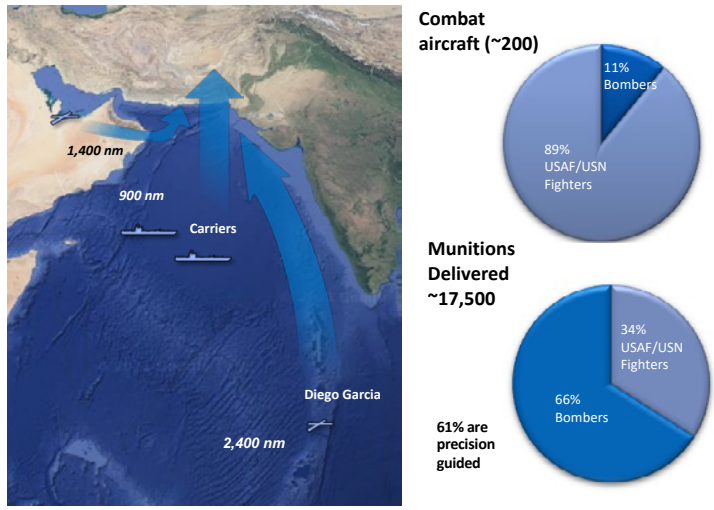
2 Christopher J. Bowie, *The Anti-Access Threat and Theater Air Bases* (Washington, DC: Center for Strategic and Budgetary Assessments, 2002), pp. 11–14, https://csbaonline.org/uploads/documents/2002.09.24-Anti-Access-Threat-Theater-Air-Bases.pdf.

these capabilities. The threat to these bases consisted primarily of Soviet fighter-bombers delivering sticks of unguided bombs (as well as a limited number of ballistic missiles). Adversaries equipped with precision-guided weapons, however, raise questions over the long-term viability of operating combat aircraft within the range of such weapons. Levels of hardening in the western Pacific are much lower than in Europe during the Cold War—nor are airbases available in similar numbers. Without shelters, aircraft are vulnerable to attack by missiles fitted with cluster munitions. But even if the United States and its allies executed an aggressive base resiliency program along the lines pursued in Europe, hardened shelters cannot move and thus can be targeted and destroyed. U.S. forces demonstrated this very effectively in operations against Iraq and Libya. Improving airbase resiliency would force an adversary to expend more weapons to damage airbases, but it appears that U.S. combat air operations are at risk of significant disruption. Chinese offensive forces may also pose a significant threat to U.S. aircraft carriers, which may need to pull back to conduct operations at reduced risk.

For the Air Force, the threat posed by China in the Western Pacific thus heightens the value of longer-range systems that can operate from more distant locations. The air campaign operations against Afghanistan in 2001 after the 9/11 attacks serve as a useful illustration. The United States possessed no significant bases in Afghanistan or neighboring nations. Accordingly, both land-based and carrier-based aircraft were forced to transit long distances to reach target areas. As highlighted in Figure 2, USAF fighters flew from bases in the Gulf, naval aircraft from carriers outside the Persian Gulf, and bombers from CONUS and Diego Garcia. The long-range aircraft, although comprising a small percentage of the overall force, delivered about 2/3rds of the total ordnance.[3] The advent of all-weather precision-guided weapons such as the Joint Direct Attack Munition (JDAM) enabled planners to take advantage of the bomber's large payload (a capability first demonstrated in combat with B-2 strikes against Serbia in 1999).

3 See William Arkin, "Weapons Total from Afghanistan Includes Large Amount of Cannon Fire," *Defense Daily* 213, No. 42, March 5, 2002, for munition totals. The total number of bombers includes 8 B-1Bs and 10 B-52Hs. Two B-2s were only used for the initial strikes. See http://www.globalsecurity.org/military/ops/enduring-freedom-ops-air.htm. The exact number of fighters deployed for OEF is uncertain; a RAND report by Ben Lambeth suggests there were upwards of 175 to 275 combat and combat support aircraft deployed for the opening months of OEF. Benjamin Lambeth, *Air Power Against Terror* (Santa Monica: The RAND Corporation, 2006), p. 65. Based on these sources, I calculate that the 18 bombers represented roughly 11% of the combat strike force.

FIGURE 2: AIR OPERATIONS AGAINST AFGHANISTAN



Source: Benjamin Lambeth, *Air Power Against Terror* (Santa Monica, The RAND Corporation, 2006) p. 65 and William Arkin, "Weapons Total from Afghanistan Includes Large Amount of Cannon Fire," *Defense Daily* 213, No. 42, March 5, 2002.

Operations in the Pacific theater are likely to feature similar characteristics. Nearby bases may be unavailable for political reasons or because of adversary strikes, thus forcing land-based aircraft to operate from very long ranges. Carrier aircraft may also be forced to operate at extended ranges due to threats against the carrier itself. Accordingly, long-range aircraft will become the primary means to project power. Unlike Afghanistan, however, U.S. forces will also have to deal with formidable defenses, such as advanced surface-to-air missiles and modern fighters, which will place a premium on survivable aircraft.

The overall thrust is that the Air Force needs to increase the number of survivable, long-range air power forces so that it can operate from more bases at reduced risk from Chinese offensive systems. The longer the distance, the greater the number of potential bases from which to operate. In addition, operating from longer ranges reduces the number of missiles that can threaten bases. To travel over longer ranges, missiles must be larger and thus more expensive, resulting in smaller inventories. In addition, the missile would be subject to more defensive "shot opportunities" during its flight.

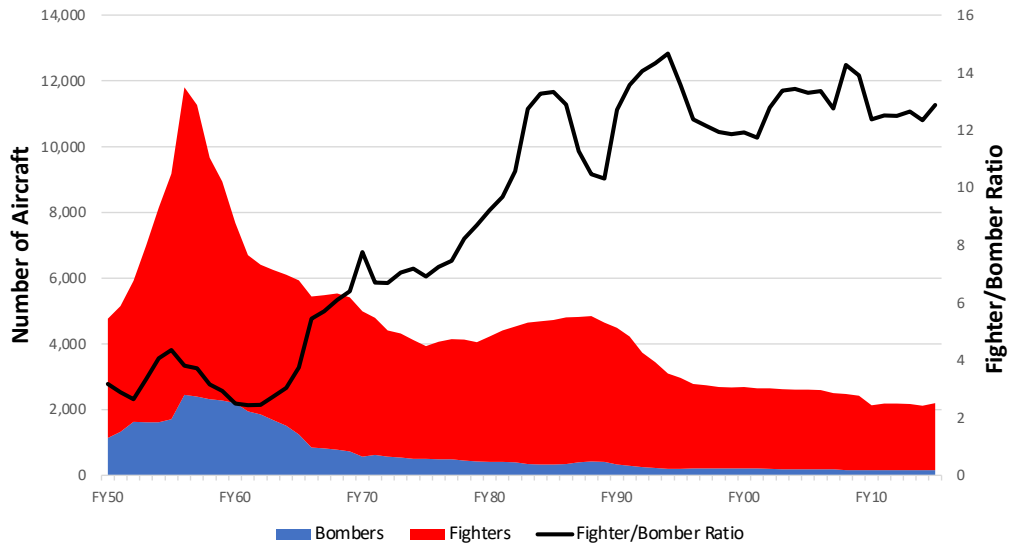
USAF Fighter-Bomber Ratios

The USAF currently fields a fighter-centric force structure. Although the strategic environment increases the value of long-range systems, it appears little will change under current plans. Figure 3 provides an overview of USAF fighter and bomber force levels from 1950-2016. The solid line shows the ratio of fighters to bombers over this same period—a useful metric to illustrate what proportion of the force can conduct long-range operations.

Fighter-bomber ratios on the order of 3:1 characterized the force structure until the mid-1960s.[4] The increasing emphasis in subsequent decades on shorter-range fighters made strategic sense given the pressures of the Vietnam War, where a large number of bases within fighter range were available for operations. As strategy in the 1970s and 1980s focused on deterring Soviet aggression against Western Europe, the relatively short distances and plentiful basing options in this theater led to increased investment in fighter forces. Tactical aircraft also featured higher survivability compared to the bombers of the period, and extensive base hardening reduced threats to theater bases.

As a result, the ratio of fighters to bombers began to increase steadily starting in the mid-1960s to reach a ratio of 10-14 fighters per bomber by the mid-1980s. These ratios have been roughly maintained through the present day even as overall force levels drew down. The current ratio is over fifteen fighters per bomber, illustrating a continued emphasis on short-range forces.[5]

FIGURE 3: USAF FIGHTER AND BOMBER FORCE LEVELS AND RATIO (1950-2016)



Source: Data drawn from James Ruehrmund and Christopher Bowie, *Arsenal of Airpower: USAF Aircraft Inventory 1950-2016* (Arlington: Mitchell Aerospace Institute, 2018).

Uncertainty surrounds force structure estimates a decade or more into the future, but the following provides a rough perspective. The USAF plans to replace its 1,666 non-stealthy legacy fighters (A-10, F-15C/D, F-15E, and F-16) with 1,763 F-35s and some number of

4 Data drawn from James Ruehrmund and Christopher Bowie, *Arsenal of Airpower: USAF Aircraft Inventory 1950–2016* (Arlington: Mitchell Aerospace Institute, 2018), https://mitchellaerospacepower.org/arsenal-of-airpower-usaf-aircraft-inventory-1950-2016/.

5 Based on the 2022 Almanac edition of *Air Force Magazine*, the USAF fields 141 bombers and 2,153 fighters.

F-15EXs.[6] For other elements of the fighter force, it plans to maintain a reduced number of F-22s and develop a new air superiority fighter and unmanned systems. Based on F-22 and F-35 development timelines, the new fighter will not enter service until the late 2030s or early 2040s.[7] For the bomber force, current plans are to re-engine 76 B-52s and retire 45 aging B-1Bs and 20 B-2s, replacing them with 100 B-21s. Accordingly, fighter/bomber ratios are likely to remain similar to current ratios well into the 2030s and beyond.

Based on the requirements of the future security environment, the USAF should consider a more significant shift in the ratio between short-range and long-range systems. The Air Force needs to field more long-range bombers, which appear to offer significantly greater utility and reduced basing vulnerability compared to short-range fighters. In essence, USAF fighter-bomber force ratios should consider moving back toward the ratios seen in the 1950s and 1960s so that a greater proportion of the force can operate from more bases at reduced risk while still delivering a powerful offensive punch.

Is such a force structure metamorphosis possible? Air Force history would answer in the affirmative. In the mid-1950s, facing similar concerns over the vulnerability of its theater-based combat forces, the Air Force executed a radical restructuring of its force structure within a decade.

6 1,763 F-35s is the official planned acquisition, but whether this total number will be acquired remains uncertain.

7 F-22 development began in 1981. The first combat ready aircraft was delivered to Langley Air Force Base in 2005—24 years after the start of development. The F-35 entered development in 1993 and entered service in 2015—22 years after the start of development.

CHAPTER 2

Radical Changes in USAF Force Structure: 1955–1965

After World War II, the advent of nuclear weapons drove U.S. planners to focus on deterring nuclear conflict. In a crisis, the Air Force planned to deploy hundreds of medium bombers to overseas bases around the perimeter of the Soviet Union. In this concept of operations, the aircraft would be refueled, armed with nuclear weapons, and placed on alert. Thousands of air defense fighter aircraft in North America and in other theaters, combined with Army surface-to-air missile (SAM) systems, would provide defense against Soviet bombers.[8]

A ground-breaking study by the RAND Corporation in the mid-1950s revealed that the plan unfortunately threatened to undermine the stability of the nuclear balance by increasing the incentives for the Soviets to launch a disarming first strike. The forward bases were vulnerable to a knockout blow by the adversary—in fact, the Air Force was making it easier for Soviet forces to strike at these locations by moving the aircraft within range of more Soviet strike assets.[9] In some ways, the vulnerability of forward-based assets was similar to the position the United States now faces in the Western Pacific. In addition, the launch of the Sputnik satellite in 1957 showed that the Soviets would soon be fielding Intercontinental Ballistic Missiles (ICBMs), which U.S. forces could not defend against. In short, these developments undermined U.S. deterrent capabilities and the stability of the nuclear balance.

The realization of U.S. vulnerability led in turn to radical changes in the USAF force structure within a decade.[10]

8 Christopher J. Bright, *Continental Defense in the Eisenhower Era: Nuclear Antiaircraft Arms and the Cold War* (London: Palgrave Macmillan, 2012).

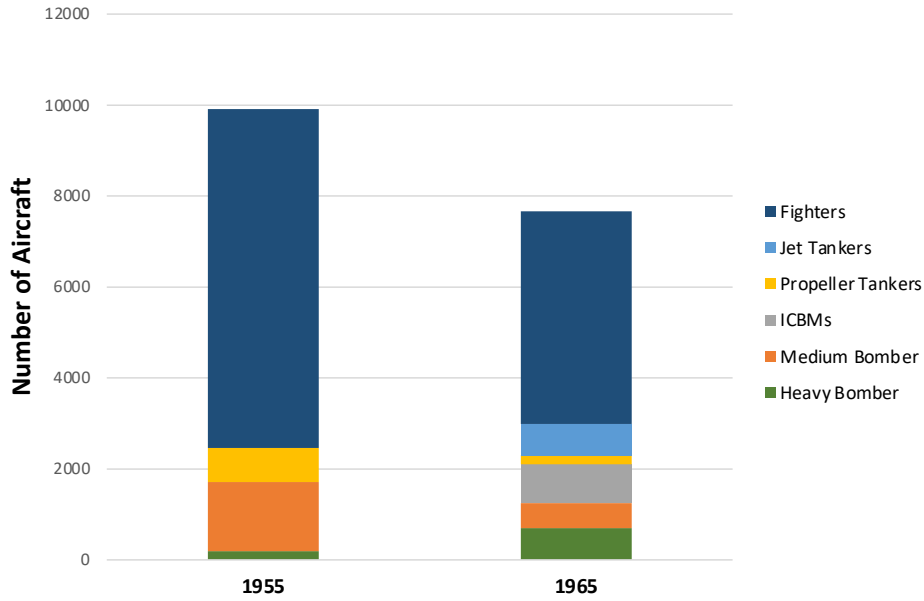
9 For an analysis of the R-266 RAND study led by Albert Wohlstetter, see Fred Kaplan, *Wizards of Armageddon* (Palo Alto: Stanford University Press, 1983), pp. 97–110.

10 Changes in force structure drawn from Ruehrmund and Bowie, *Arsenal of Airpower*.

- The USAF decided to emphasize heavy bombers bedded down on a large number of bases in the Continental United States or CONUS to maximize the distance from the Soviet Union (and thus gain increased warning times from ballistic missiles). One-third was placed on alert status to minimize vulnerability to a "bolt from the blue" and enhance strategic stability.
- B-52 heavy bomber production was ramped up to increase intercontinental strike capability. From 1955 to 1965, the heavy bomber force almost tripled in size, going from 191 aircraft to 702, all of which were B-52s.
- The heavy bombers required refueling support to reach many targets when operating from the CONUS. The medium tanker force, consisting of propeller-driven aircraft, was cut by over 70% (from 745 to 205) and replaced by the new KC-135 jet tanker, which numbered 785 strong in 1965 and offered roughly double the fuel offload of medium tankers like the KC-97.
- The medium bomber force (primarily B-47s) was cut by 2/3rds, declining from 1,520 aircraft to 542. As highlighted by the RAND analysis, placing large numbers of aircraft close to Soviet striking power was viewed as a strategic error.
- A crash program to develop and deploy ICBMs resulted in the USAF going from no ICBMs in 1955 to over 800 ten years later—most of which were Minuteman solid-fuel missiles housed in hardened silos in the CONUS. The ICBM force posed a nearly insurmountable obstacle to deter the Soviet Union from launching a disarming first strike.
- The fighter force (primarily those providing CONUS air defense) was cut in half, going from 7,509 in 1955 to 3,880 in 1965. In essence, this meant retiring over five wings each year--360 fighters per year on average from 1955 to 1965.

Figure 4 provides an overview of the changes, which decreased combat force levels by 40 percent, but reshaped the USAF force structure for the capabilities needed in the new strategic environment.

FIGURE 4: CHANGES IN USAF FORCE STRUCTURE: 1955–1965



Source: Data drawn from James Ruehrmund and Christopher Bowie, *Arsenal of Airpower: USAF Aircraft Inventory 1950–2016* (Arlington: Mitchell Aerospace Institute, 2018).

CHAPTER 3

A Multi-Role B-21 Concept

The only system currently available to increase USAF long-range combat capabilities is the B-21, which is beginning testing and production. The new jet is planned to provide conventional strike capabilities and form the backbone of the nuclear Triad's penetrating air-breathing leg.[11] One hundred B-21s are planned at a production rate of roughly 15 per year.[12] The core change recommended here would be a doubling of B-21 production rates and an increase in the planned number of new bombers. Future B-21 force-level goals will depend on the success of proposals outlined below that leverage its potential to conduct a wider range of missions. The key characteristics of the new generation bomber—range, payload, stealth, and an open systems digital backbone—could enable the B-21 to be potentially equipped with additional weapons and subsystems to conduct a wider range of missions in the new security environment.[13]

To increase B-21 production rates and reduce unit costs, the Air Force has two options. It could require the current prime contractor to ramp up production (higher production rates should yield a reduction in unit price) or provide the design to a second contractor and open

11 The air-breathing leg of the nuclear Triad (joining land-based intercontinental ballistic missiles or ICBMs and submarine-launched ballistic missiles or SLBMs) helps enhance the stability of the nuclear balance. The high survivability of bombers promises an aggressor than at attack would be met with devastating retaliation, while its relatively slow speed compared to ballistic missiles means it does not pose a credible first strike threat. Because the force can be generated, dispersed, and launched under positive control, the bomber, unlike the other legs, provides the nation's leaders with a highly flexible means of sending unmistakable messages to an adversary to stabilize crises. Survivable penetrating bombers offer important advantages on in the nuclear role, such as the crew's capability to assess whether sites have useful targets present and whether high priority locations targeted by more than one weapon require a follow-up attack.

12 Current plans are to procure approximately 15 B-21s per year. John A. Tirpak, "The Raider Takes Shape," *Air and Space Forces Magazine*, December 1, 2019, https://www.airforcemag.com/article/the-raider-takes-shape/.

13 Brian Wang, "B-21 Stealth Bomber Will Be Built for Easily Upgradable Software and Hardware," *Nextbigfuture*, https://www.nextbigfuture.com/2017/04/b21-stealth-bomber-will-be-built-for-easily-upgradable-software-and-hardware.html; J.J. Gertler, *Air Force B-21 Raider Long Range Strike Bomber*, R344463 (Washington, DC: Congressional Research Service, September 2021), p.6.

a second assembly line. For the latter option, cost reductions could be spurred by competing the two production lines against each other yearly—whichever company made the best offer would receive a larger share of the annual production, thus maintaining continuous competition during the life of the procurement cycle.[14] Competition in the production phase has been used successfully in fourteen missile programs, the Tomahawk cruise missile, and the F-15/F-16 engine procurement to improve performance and reduce cost.[15] That said, such an approach has not been used to date with a modern combat aircraft.

For conventional strike operations, the B-21 offers many advantages to support U.S. power projection operations in the emerging security environment. The aircraft's long range enables it to operate from more bases at a reduced risk from enemy strike systems, hold the full range of adversary targets at risk, and threaten multiple penetration axes to complicate an adversary's defensive challenges. When facing the lethal air defenses of the future, its stealth characteristics minimize the chances of an adversary detecting and engaging. Stealth also allows the aircraft to get closer to enemy targets without detection and thus employ less expensive, shorter-range precision weapons to strike more targets per sortie.

But technological advances offer the potential for the B-21 platform to do even more. An innovative analysis of air-to-air combat by Dr. John Stillion indicates that the lethality of air-to-air missiles means the Air Force should explore new concepts in its approach to air superiority.[16] Fighters have traditionally offered the advantages of speed and maneuverability to gain the upper hand in air combat. But advanced long-range missiles, which have greatly increased in capability, have emerged as the dominant kill system in modern air engagements. Speed and maneuverability have limited utility when evading modern missiles and generate a cost in terms of airframe weight, radar signature, and range. Stillion's analysis notes that the advantage of speed has declined significantly due to the advent of infrared search and track (IRST) sensors; even stealthy supersonic aircraft at high speed generate a significant heat signature. Stillion concludes that trends in air-to-air combat indicate that the Air Force should consider a larger, sub-sonic aircraft as part of its future air superiority force. Such a vehicle could be equipped with larger sensors to locate low-observable adversaries at longer range—and carry larger, long-range missiles to kill those adversaries before they can engage. The combination of such an aircraft working in coordination with air superiority fighters offers many intriguing operational possibilities.

14 During the tanker competition between Boeing and EADS in 2009-10, some analysts suggested the Air Force procure both aircraft. Each year, the Air Force could launch a competition between the two companies—whichever company made the best offer would get a larger share of the annual buy. For the B-21 program, another possibility would be for one company to focus on fielding the strike version while the second company developed the multi-role variant.

15 For analysis of such competitions, see Jacques Gansler, William Lucyshyn, and Michael Arendt, *Competition in Defense Acquisitions* (College Park, MD: Center for Public Policy and Private Enterprise, 2009), https://dair.nps.edu/handle/123456789/2429. This analysis indicates that the additional costs of establishing a second production line are outweighed by the reduction in costs spurred by competition.

16 John Stillion, *Trends in Air-to-Air Combat: Implications for Future Air Superiority* (Washington, DC: Center for Strategic and Budgetary Assessments, 2015).

Indeed, factoring in the demands of future strike capabilities and Stillion's analysis of future air-to-air operations, it appears a myriad of technologies has come together to field a single platform that can be configured to conduct a wide variety of missions. The Air Force has revealed almost nothing about the B-21 aircraft, so the following observations must necessarily be speculative. The B-21 was designed from the outset with an open-architecture digital backbone, which increases the speed at which new capabilities can be incorporated. Since it is designed as a bomber (and official depictions show a platform similar to the B-2), the aircraft will likely feature a large weapons bay or bays that could be fitted with a variety of payloads: strike weapons, anti-ship missiles, air-to-air missiles, directed energy cannon, small unmanned aircraft, and Intelligence/Surveillance/Reconnaissance (ISR) systems.[17] In addition to its long-range and small signature, the B-21 will likely be equipped with a new generation of multi-function sensors (similar to those currently deployed on the F-22, F-35, and upgraded F-16s and F-15s). If fitted with the appropriate software, these apertures can provide radar detection and targeting, electronic jamming, signals intelligence (SIGINT), and communications.[18]

Accordingly, it is possible to envision a B-21 fleet capable of conducting the following missions:

Strike: The aircraft's current primary role. The B-21 will be able to carry a mix of direct attack precision munitions (thus enabling striking a large number of aimpoints per sortie), medium-range stand-off weapons (to further increase the aircraft's engagement swath when penetrating or dealing with heavy defenses), and nuclear weapons (to maintain the penetrating air-breathing leg of the nuclear Triad). As was done with B-52s in previous years, B-21s could also be equipped with anti-ship missiles to augment naval strike capability, something that will no doubt be in great demand during conflicts in the western Pacific.

Air-to-air: A bomber's inherent range and endurance also offer significant advantages in sustaining combat air patrols efficiently. As suggested by Stillion, a B-21's large payload bay or bays could be fitted with long-range air-to-air missiles to "out-stick" U.S. adversaries. The Chinese, for example, are developing the PL-15 air-to-air missile with a range estimated at around 200 nm. The smaller size of F-22 and F-35 weapon bays forces the use of smaller missiles, which do not feature the kinetic energy and range offered by larger missiles. For example, the Navy's ship-launched SM-6 comprises ten times the mass of an advanced medium-range air-to-air missile (AMRAAM); a variant of such a missile launched from a B-21's bay could reach out significantly farther than the AMRAAM or even the PL-15.

The Air Force would need to conduct detailed combat simulations of stealthy bombers equipped with long-range missiles to determine the true potential and flesh out operational concepts for this mission. For example, a mix of F-35s and F-22s backed by B-21s carrying

17 Gertler, *Air Force B-21 Raider Long Range Strike Bomber*, p.4.

18 "Need Insight Into the Whole Electromagnetic Spectrum? Multifunction Sensors Deliver," Northrop Grumman, https://www.northropgrumman.com/what-we-do/air/multifunction-sensors-see-across-electromagnetic-spectrum/

longer-range missiles could offer a formidable air defense capability. The fighters could provide targeting information to the B-21's long-range weapons and then kill any remaining stragglers. Additional possibilities could be developed to harness the potential of unmanned aircraft and the new sixth-generation fighter as that system takes shape. A wide range of potential operational concepts using such a mix of capabilities should be explored.

The B-21's weapons bay or bays and electrical power could potentially enable it to carry a laser cannon should this technology bear fruit in the next decade or so.[19] Laser armaments would potentially enable a B-21 to shoot down missiles shot at the bomber for self-defense and potentially pose a serious air-to-air threat to enemy fighters. Larger aircraft like the B-21 would be able to carry more powerful directed energy weapons than fighters due to larger internal volume and greater electrical power, thus gaining and maintaining a long-term advantage.

Intelligence/Surveillance/Reconnaissance (ISR): The B-21's multi-function apertures could provide significant ISR capabilities. The aircraft could sense using the radar mode and/or listen to electronic signals in a passive mode. That said, should larger, more specialized devices (such as electro-optical cameras or more advanced SIGINT capabilities) be needed, these could potentially be housed in a weapons bay with the appropriate apertures.

Electronic warfare (EW): The B-21's multi-function apertures could potentially be used for electronic combat (though it must be recognized that emissions would help an adversary locate the aircraft). Again, size matters. A larger aircraft with larger apertures and more electrical power has more potential capability than a smaller aircraft. Large EW payloads could also be carried in a weapons bay to enable more powerful electronic warfare support if needed.

Other missions: The B-21's weapons bay could be filled with smaller unmanned systems to engage adversary fighters, confuse defenses, conduct ISR, and execute other missions. Being able to launch small unmanned systems at long range would help address the problem of basing for small UAVs with limited range.

A large fleet of B-21s would be a potent and formidable addition to the USAF's warfighting force. A multi-mission B-21 could offer long-range penetrating strike, anti-ship, air-to-air, ISR, and EW capabilities. The aircraft's long range significantly increases the number of potential basing options, reducing the need to operate from vulnerable, close-in bases. It could also require less refueling support would be needed compared to fighters, so there might be operational efficiencies there as well.

19 The Air Force is currently developing a laser weapon for fighter aircraft under the Self-Protect High Energy Laser Demonstration program. See Valerie Insinna, "US Air Force delays timeline for testing a laser on a fighter jet," *Defense News*, June 30, 2020, https://www.defensenews.com/air/2020/06/30/us-air-force-delays-timeline-for-testing-a-laser-on-a-fighter-jet/.

CHAPTER 4

A Potential Path Forward

Increasing B-21 production rates and the planned buy, however, will require some difficult force trades. To illustrate the issue, this study assumes a "worst case" scenario where Air Force budgets remain flat over the next 15 years (three Future Year Defense Plans or FYDPs) and that all force structure trades occur within the Air Force. Increases in the defense budget or successful Air Force efforts to gain a large share of the defense spending would obviously enable more flexibility and less drastic reductions.

The recommended policy in military and business affairs when retiring capabilities is to execute the drawdown as quickly as possible to avoid expending resources on capabilities slated for retirement and invest instead in the future.[20] This study accordingly retires almost all the non-stealthy legacy fighter force (F-16s, F-15Cs, and A-10s) over the next five years to free up operations and sustainment (O&S) dollars. These legacy forces consume approximately $10B (FY23) per year in O&S, which could be shifted into the procurement of other systems.[21] As older fighters in the Pacific are drawn down, in-theater force levels could be maintained with F-35s, F-22s, and bombers to bolster deterrence. U.S. allies in other parts of the world would need to assume more military responsibilities. The legacy fighter drawdown could be slowed if concerns over the signal this could send to adversaries outweigh budgetary pressures.

Current plans are for the Air Force to acquire 1,763 F-35 fighters over the next two decades. In this proposed plan, the Air Force would increase F-35 procurement rates to 100 per year through 2028, then stop as production of the B-21 ramps up. These rates would yield a force of over 800 F-35s. Production for the Navy, Marines, and allies would keep the line open, though at a reduced rate, should additional production be needed.

20 For an analysis of this issue, see Paul Hill, Tom Glennan, and Susan Bodilly, *Obstacles to the Termination of Air Force Activities*, R-3033-AF (Santa Monica: The RAND Corporation, 1986).

21 See Appendix B for details on force sustainment cost calculations.

The proposed force structure retains the flexible and relatively long-range F-15Es, which, as these aircraft age out, are replaced with the newly developed F-15EX, which features significant upgrades in sensors and electronic systems. The F-15E/EXs could support continental air defense operations and combat operations against less sophisticated powers. The proposed force also retains the current force of F-22s and continues development of a new long-range air superiority aircraft to maintain sixth-generation fighter options for the future. Given historical experience, the new fighter would not become available until the late 2030s or early 2040s. The potential of the B-21 to support air superiority missions thus could become more valuable. The proposed force structure also continues development of unmanned systems as they mature.

In terms of bombers, the proposed force structure retains re-engined B-52s, which can deliver a heavy stand-off punch, and sufficient quantities of stand-off weapons. It also envisions retiring B-2s as B-21s enter service in numbers into the early 2030s. Currently, the B-2 is the only long-range survivable aircraft in the U.S. inventory and should be kept viable until the new bomber is ready for operations. The B-1B fleet reportedly has structural problems that may be very difficult and costly to repair.[22] That said, if the structural problems are solvable at a reasonable cost, retaining the B-1s fitted with stand-off weapons would add to the USAF's long-range punch. This analysis assumes retirement of the B-1Bs, but if retention at an affordable cost is possible, the Air Force should explore maintaining this force element.

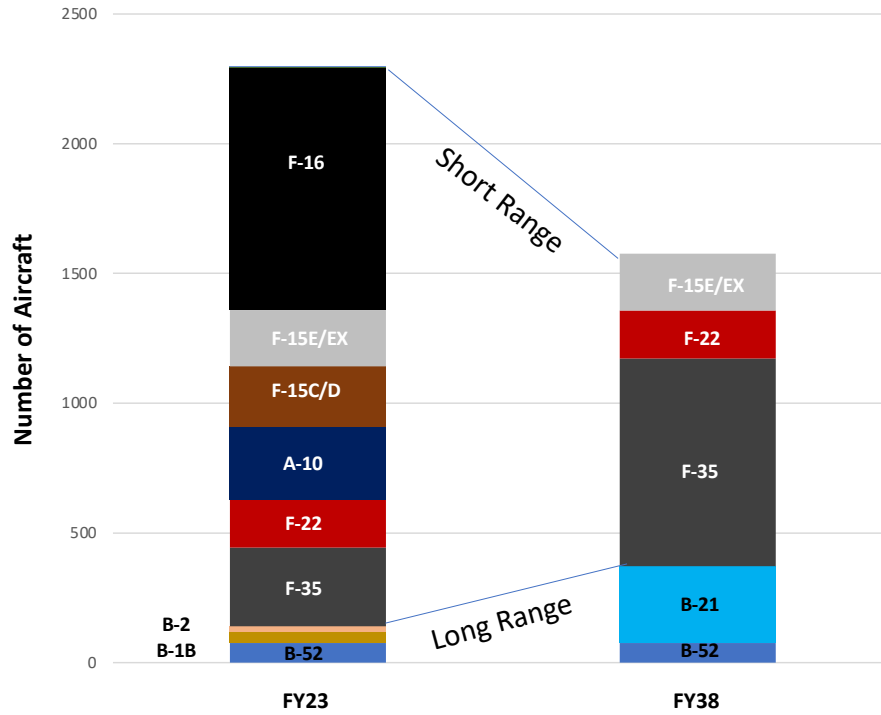
For the B-21, the proposed force structure doubles the B-21 procurement rate to 30 per year by 2030 and adds subsystems to increase its capability to conduct a wider range of missions. By 2038, the United States would have a force of 295 B-21s.

In sum, this plan postulates that the Air Force retire most of its non-stealth legacy fighters, build up the stealth fighter force, continue development of a new air superiority fighter and unmanned systems, retain the B-52s, and double B-21 production rates while planning for a much larger B-21 force. The resulting changes in USAF force structure are illustrated in the following chart.

Figure 5 below provides a summary overview of today's combat force structure compared to the proposed future force structure (see Appendix A for more details):

22 John A. Tirpak, "B-1s Can Make it to Finish Line, But Big Repairs Will Be Common Along the Way," *Air and Space Forces Magazine*, January 3, 2021, https://www.airforcemag.com/b-1s-can-make-it-to-finish-line-but-big-repairs-will-be-common-along-the-way/.

FIGURE 5: POTENTIAL USAF FORCE STRUCTURE SHIFTS: 2023–2038



Source: Data for the current inventory was provided by the "Air Force and Space Force Almanac 2022," *Air and Space Forces Magazine*, July 1, 2022. See Appendix A for an overview of the proposed changes in force structure.

TABLE 1: FORCE STRUCTURE COMPARISON

Aircraft	FY23	FY38
B-52	76	76
B-1B	45	0
B-21	0	295
B-2	20	0
F-35	302	802
F-22	185	185
A-10	281	0
F-15C/D	232	0
F-15E/EX	218	218
F-16	935	0
Total	**2,294**	**1,576**

The proposed force offers the following attributes:

- The fighter/bomber ratio would shrink from 15:1 to 3:1—a ratio more in line with Air Force experience in the 1950s. A significantly larger proportion of the force could conduct long-range operations.
- Over 80% of the proposed fighter and bomber force would be stealthy compared to the 22% level today. The general warfighter consensus is that the lethality of modern defenses makes stealth "table stakes" for conducting offensive air operations.
- O&S costs for the proposed force would be approximately 25% lower ($16.7B per year compared to the current force, which consumes $21.8B per year). The savings could be applied to procurement accounts.[23] Logistical efficiencies may also be gained as the force goes from nine different types of aircraft to five.
- Although the new combat force of fighters and bombers is about 30% smaller, its overall range-payload capability (a rough measure of combat capability) will depend heavily on the unknown characteristics of the B-21. Assuming modest B-21 capabilities, the overall range-payload would be slightly lower than the current force, but significantly greater if the new aircraft features capabilities similar to current bombers.[24]
- The cost of the additional B-21s would be partially offset by the savings provided by retiring the non-stealth legacy fighters and reducing the Air Force F-35 buy. Each B-21, as currently planned, costs $660M in $FY23—though increased production rates should generate a reduction in costs.[25] The non-stealthy legacy force currently requires about $10B per year for O&S, which could support the procurement of roughly 15 additional B-21s per year. A B-21 costs about the same as six F-35s.[26] Accordingly, the savings from 961 F-35s could procure approximately 160 additional B-21s.[27]

23 See Appendix B for details on rough estimates on O&S costs. Although the proposed force features more modern sophisticated aircraft, Air Force data shows that O&S costs for all types of aircraft is a function of fleet size, not the type of aircraft. This is due to the high fixed costs associated with a particular fleet. The Air Force would be able to calculate much more accurate estimates.

24 See Appendix C for details on the payload-range calculations.

25 Assumes procurement unit cost of $511M in $FY10 per aircraft inflated to $FY23. See Tirpak, "The Raider Takes Shape."

26 The F-35 FY20 SAR states the unit cost at $83.1M in $FY12. Inflating to $FY23 results in a unit cost of $105M. Department of Defense, *F-35 Lightning II Joint Strike Fighter (JSF) Program (F-35)* (Washington, DC: DOD, 2019), https://www.esd.whs.mil/Portals/54/Documents/FOID/Reading%20Room/Selected_Acquisition_Reports/FY_2019_SARS/20-F-0568_DOC_32_F-35_SAR_Dec_2019_Full.pdf.

27 Under current plans, the USAF plans to buy 1,763 F-35s. Subtracting 802 from this total yields 961.

CHAPTER 5

Concluding Thoughts

Such a transformation will not happen overnight. Even if production rates are doubled, the B-21 will not enter service in large numbers for almost another decade (though sooner than the next generation fighter). The USAF could explore developing the multi-role potential of the aircraft over the next several years as F-35 production is accelerated in the near term and development of the next generation fighter and new unmanned systems take shape. These timelines provide an opportunity for Air Force planners to conduct the detailed operations analysis and live flying exercises needed to determine the potential of the new concepts.

Such a force, comprised primarily of stealthy aircraft, would significantly increase U.S. power projection and deterrent capabilities. It poses a difficult defensive challenge for an adversary, which would need to deal with multiple potential axes of attack as well as enhanced air-to-air and maritime strike capabilities—thus enhancing deterrence. A smaller fraction of our force would be forward-based and subject to heavy attack. The proposed force also offers significant logistical advantages, going from nine different types of aircraft to five, and could reduce annual O&S costs by around 25%.

That said, this plan is not without risk. The proposed force, though more capable, draws down the legacy fighter forces and overall fighter force levels, resulting in a combat force roughly two-thirds the size of today's force. The United States could maintain its deterrent posture in the Pacific theater by replacing legacy fighters in the Pacific theater with F-35s, F-22s, and bombers, but the shift would need to be managed carefully. US allies around the world would need to assume greater military responsibilities. Increased Air Force budgets could slow the drawdown of the legacy fighter force and extend F-35 production, but this would require increased defense spending and/or a change in the Air Force's share of the budget. Given the decline in Russian power and the importance of air and naval power in the Western Pacific, there are strong arguments for adjusting Service budget shares, but uncertainty surrounds prospects for success.

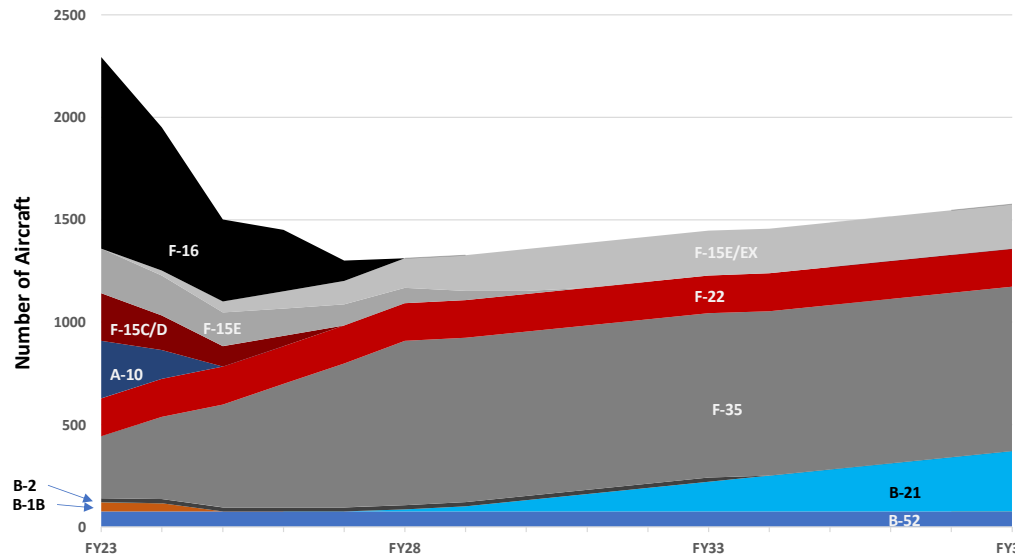
If the United States continues on its current course, it could end up with a force ill-suited to the challenges posed by China. Air Force planners in the 1950s faced a similar dilemma and took bold and decisive action. China has responded effectively after observing our concepts of operations over the past three decades. The United States should be able to do the same starting now. At the very least, a debate over current plans and the future of the combat force is warranted.

APPENDIX A

Potential Force Structure Evolution

The stacked area chart above shows the proposed force structure evolution over this period. The legacy fighter force would be drawn down over the next five years as the F-35 force increases in size. The typical rule when planning retirements is to draw down as fast as possible in order to reap the savings and get the pain over with quickly. The fighter force reduction could be spread out over more years, but this would reduce the potential savings in O&S spending.

FIGURE 6: FORCE EVOLUTION: FY23–FY38



Source: Data for the current inventory was provided by the "Air Force and Space Force Almanac 2022," *Air and Space Forces Magazine*, July 1, 2022. See Appendix A for an overview of the proposed changes in force structure.

The table below provides the assumed inputs into the area chart (types of aircraft procured per year and overall force levels). In this proposed plan, F-35 production ends as B-21 production ramps up. Increased USAF budgets could allow extended F-35 production. The Air Force could, of course, conduct much more sophisticated planning on force evolution options.

TABLE 2: FORCE STRUCTURE PROCUREMENT AND EVOLUTION

Proposed Procurement Plan																
	FY23					**FY28**					**FY33**					**FY38**
B-52	76															
B-1B	45															
B-21	0					10	15	30	30	30	30	30	30	30	30	30
B-2	20															
F-35	302	100	100	100	100	100										
F-22	185															
A-10	281															
F-15C/D	232															
F-15E	218															
F-15X	0	24	30	30	30	30	30	30	14							
F-16	935															
Proposed Force Structure Evolution																
	FY23					**FY28**					**FY33**					**FY38**
B-52	76	76	76	76	76	76	76	76	76	76	76	76	76	76	76	76
B-1B	45	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B-21	0	0	0	0	0	10	25	55	85	115	145	175	205	235	265	295
B-2	20	20	20	20	20	20	20	20	20	20	20	0	0	0	0	0
F-35	302	402	502	602	702	802	802	802	802	802	802	802	802	802	802	802
F-22	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185
A-10	281	140	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F-15C/D	232	170	100	50	0	0	0	0	0	0	0	0	0	0	0	0
F-15E	218	194	164	134	104	74	44	14	0	0	0	0	0	0	0	0
F-15X	0	24	54	84	114	144	174	204	218	218	218	218	218	218	218	218
F-16	935	700	400	300	100	0	0	0	0	0	0	0	0	0	0	0
	2294															1576

APPENDIX B

O&S Cost Estimates

Data from Todd Harrison of the Center for Strategic and International Studies (CSIS) was used to calculate the total O&S cost of the current and proposed combat air force.[28] Harrison's methodology, based on Air Force data, calculates the cost to sustain a single aircraft in a fleet, which is a much better metric than the traditional metric of cost per flying hour.[29] Harrison's data shows that Air Force O&S costs (which includes fuel, spares, personnel, and upgrades) for a type of aircraft are a function of fleet size due to the high proportion of fixed costs for any particular fleet. The data illustrates that regardless of aircraft type (bomber, fighter, tanker, stealth, or non-stealth), fleet size dominates what it costs to sustain an aircraft fleet. Small fleets cost more per aircraft annually than large fleets. And surprisingly, stealth aircraft cost no more to sustain than non-stealth aircraft. Importantly, these rough estimates of O&S costs do not factor in mission-capable rates. Higher mission-capable rates can drive up O&S spending.

Using an equation based on Harrison's curve, O&S costs were calculated in $FY20 for each aircraft based on fleet size. The derived equation is:

TABLE 3: TOTAL ANNUAL COST PER AIRCRAFT EQUATION

Total Annual Cost Per Aircraft =	m * TAI ^ b
m =	155848817.4
b =	-0.493733514

The annual cost per aircraft in $FY20 was then multiplied by the fleet size to estimate the total O&S cost per fleet. The costs were then inflated to FY23 using DoD Green Book Data.

28 Todd Harrison, *The Air Force of the Future: Comparison of Alternative Force Structures*, (Washington DC: Center for Strategic and International Studies, October 2019), pp 9-10.

29 Cost per flying hour is a poor metric because the costs can change radically depending on how much the aircraft is flown.

Using the 92.14 deflator for Operations and Maintenance (Budget Authority) from the Green Book results in total annual costs for the current fleet at $21.82B ($FY23) and $16.7B ($FY23) for the proposed fleet. O&S costs for the proposed fleet would thus be approximately $5B per year less—the savings could be used to support acquisition of other systems. Obviously, the USAF could provide much more refined analysis on what future O&S costs would be for alternative force postures.

TABLE 4: ESTIMATED ANNUAL O&S COSTS

Inventory			O&S Cost ($FY20)	
Aircraft	**FY23**	**FY38**	**FY23**	**FY36**
B-52	76	76	1.39	1.39
B-1B	45	0	1.07	0
B-21	0	295	0	2.77
B-2	20	0	0.7	0
F-35	302	802	2.8	4.6
F-22	185	185	2.19	2.19
A-10	281	0	2.1	2.1
F-15C/D	232	0	2.45	0
F-15E/EX	218	218	2.38	2.38
F-16	935	0	4.97	0
Totals	2,294	1,576	$20.05	$15.43
Inflated to $FY23			**$21.8**	**$16.7**

APPENDIX C

Range-Payload Calculations

The following table provides the assumptions on aircraft combat radii and payloads to calculate the range/payload capability of the fleet—a very rough measure of combat capability. The calculations multiply radius, payload, and estimated sortie rate together for each major aircraft type to get a ton-mile total. Bombers are assumed to fly 0.5 sorties per day and fighters fly 1 sortie per day, since all aircraft will be flying long distance missions. Radius for all the aircraft except B-21 comes from the Air Force Fact Sheets. Payload numbers are the author's estimate if data is not available from the Air Force Fact Sheets.

The Air Force has not released any data regarding B-21 capabilities. This analysis uses a parametric approach to provide a perspective on overall force capabilities: 10 tons of payload and 2,000 nm radius for the low end; 20 tons of payload and 3,000 nm for the high end.

TABLE 5: RANGE-PAYLOAD CALCULATIONS

	FY21	FY36	Payload (Tons)	Sortie	Radius (nm)	FY23 Ton-Miles	FY38 Ton Miles
B-52	76	76	24.5	0.5	4176	3,887,856	3,887,856
B-1B	45	0	21	0.5	2837	1,340,483	
B-21	0	295	10 to 20	0.5	2000-3000		2,950,000-8,850000
B-2	20	0	20	0.5	3000	600,000	
F-35	302	802	2	1	590	356,360	946,360
F-22	185	185	1	1	671	124,135	124,135
A-10	281	0	4	1	300	337,200	
F-15C/D	232	0	2	1	685	317,840	
F-15E/EX	218	218	4	1	685	597,320	597,320
F-16	934	0	2	1	676	1,262,768	
Totals						**8.8M**	**8.5M to 14.8M**

LIST OF ACRONYMS

AMRAAM	Advanced Medium Range Air to Air Missile
CONUS	Continental United States
EW	Electronic Warfare
FYDP	Future Years Defense Plan
JDAM	Joint Direct Attack Munition
ICBM	Inter-Continental Ballistic Missile
IRST	Infra-Red Search and Track
ISR	Intelligence/Surveillance/Reconnaissance
O&S	Operations and Sustainment
PLA	People's Liberation Army
SAM	Surface-to-Air Missile
SLBM	Submarine-Launched Ballistic Missile
SIGINT	Signal Intelligence
USAF	United States Air Force

CSBA

Center for Strategic and Budgetary Assessments

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