

BEYOND THE "BOMBER":

The New Long-Range Sensor-Shooter Aircraft
AND United States National Security



Lieutenant General David A. Deptula, USAF (Ret.)

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The Mitchell Institute for Aerospace Studies

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About the Mitchell Institute for Aerospace Studies

The Mitchell Institute for Aerospace Studies is an independent, nonpartisan policy research institute established to promote understanding of the national security strategy advantages of exploiting the domains of air, space, and cyberspace. The Mitchell Institute's goals are 1) educating the public about the advantages of aerospace power in achieving America's global interests; 2) informing key decision-makers about the policy options created by exploiting the domains of air, space, and cyberspace, and the importance of necessary investment to keep America as the world's premier aerospace nation; and 3) cultivating policy leaders to understand the advantages of operating in air, space, and cyberspace.

About the Author

David A. Deptula is the Dean of the Mitchell Institute for Aerospace Studies. He is a highly decorated military leader who transitioned from the Air Force as a lieutenant general in 2010. General Deptula has significant experience in combat and leadership in several major joint contingency operations where he planned, flew, and commanded air operations in humanitarian relief, small-scale contingencies, and major theater war. He was the principal attack planner for the Desert Storm air campaign; commander of no-fly zone operations over Iraq in the late 1990s; directed the air campaign over Afghanistan in 2001 during the period of decisive combat; has twice been a joint task force commander; was the air commander for the 2005 South Asia tsunami relief; and also served on two congressional commissions charged with outlining America's future defense posture.

He has flown every current operational bomber in the US Air Force inventory—the B-1, the B-2, and the B-52, and has conducted airborne refueling of each. He has piloted more than 3,000 flying hours—400 in combat—to include multiple command assignments in the F-15. In his last assignment as the Air Force's first deputy chief of staff for intelligence, surveillance, and reconnaissance (ISR), he transformed America's military ISR and remotely piloted aircraft (drone) enterprises.

General Deptula holds a B.A. in astronomy; M.S. in systems engineering—both from the University of Virginia; and a M.S. in national security strategy from the National War College. In addition to his military awards, he is a recipient of the *Aviation Week & Space Technology* Laureate Award for extraordinary accomplishment in national defense; the General Arnold Award—the Air Force Association's highest honor to a military member in the field of national security; and he received a special award for his significant contributions in the field of airpower at the 2015 International Conference for Air and Space Power.

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Executive Summary

Power projection—the ability to deploy, sustain, and use military force overseas in support of United States national security goals—is a central mission of the US armed forces. It ideally requires unfettered access to international waterways, airspace, and regional ports and air bases. US adversaries, however, have observed the dependence of the American military on such access and have developed asymmetric technologies and capabilities to exploit the weaknesses in this method of power projection. Adversaries are deploying advanced air defenses—interceptors, surface-to-air missiles (SAMs), and radar networks—to defend their airspace and push US forces out of reach; ballistic and cruise missiles along with strike aircraft to attack US regional bases and naval forces; hardened facilities to limit damage from strikes; mobile systems to make the US targeting problem more difficult; attack submarines to interdict sea lines of communication; and cyber attacks to disrupt planning and operations. The combination of these capabilities creates what is known as the anti-access, area-denial (A2/AD) environment.

The President's 2015 National Security Strategy and 2012 Defense Strategic Guidance emphasized the need to rebalance toward the Asia-Pacific region and maintain security and stability in Europe and the Middle East. The changing geographic focus places a new premium on range. Distances in these regions dwarf the short ranges US forces confronted when deterring Soviet aggression in Europe during the Cold War. In addition, the US basing infrastructure in both areas is much less robust. Aircraft with longer range can operate from a much broader set of bases than short-range systems.

With this as background, the Defense Strategic Guidance emphasized the importance of projecting power in the face of growing A2/AD threats, and mandated the development of a new, stealthy bomber as part of a family of systems. The new stealth bomber—more accurately described as a long-range sensor-shooter, or LRSS—was specifically identified to support a range of critical missions outlined in the guidance because it has an unmatched ability to deliver rapid, sustained firepower and other effects against distant targets directly from the United States. Buttressing the strategic guidance is the Pentagon's Joint Operational Access Concept (JOAC), also from 2012, that describes broad approaches for operating in an A2/AD environment. No other single system appears to fulfill the concept's precepts as effectively as a stealth bomber.

The 2014 Quadrennial Defense Review (QDR) reiterated the need to project power in an A2/AD environment and identified the new bomber as one of the Air Force's top three priorities. The 2015 National Security Strategy reiterated that US forces must remain ready to project power globally. Air Force planning for its five core missions, notably global strike, accordingly places a premium on the need to develop and field a new stealth bomber.

As we move further into the 21st century, we are experiencing a transition of not just time but also capability—capability that will allow for a paradigm shift in the role aircraft will play in meeting US security needs for the remainder of the century. Since the last B-2A bomber was produced in 1993 we have undergone approximately 15 Moore's Law cycles (i.e., computer processing power doubling about every

18 months), resulting in an exponential *increase* in electronic *capability* with a phenomenal *decrease in cost* to achieve equal capability. This means that today we can incorporate sensors, processing capacity, and avionics in a single aircraft at an affordable cost to an unprecedented degree.

Accordingly, what we previously labeled as “bombers” can play dramatically broader roles than they ever did in the past. To capture this potential, however, requires innovative thought and shedding anachronistic concepts that aircraft can only perform singular functions and missions. The era of specialized aircraft is over, as technology has moved on and resource constraints have grown. The information age allows new aircraft to become much more than just “bombers” or “fighters” but actually sensor-shooter aircraft. When integrated with other system “nodes” in every domain—air, space, land, and sea—they will have the capability to create a “combat cloud,” a manifestation of a self-forming, self-healing intelligence, surveillance, and reconnaissance (ISR)-strike-maneuver-sustainment complex. The cloud has the potential to usher in an entirely new era in defense and to play a crucial role in the “third offset strategy” discussed later in this paper.

While the importance of the new bomber, or LRSS, in supporting US national security grows, the current US bomber fleet continues to age. It now averages 39 years of age. The B-52Hs and B-1Bs, with service lives extending to the 2040 time frame, can continue to offer important contributions, but their survivability when operating in contested airspace grows more questionable each year. The nation’s 20 B-2As have a projected service life out to 2058 and provide important capabilities for decades to come, but the small fleet size limits their potential contribution. To maintain the nation’s long-range power projection capabilities, the Pentagon has concluded it needs to begin now on developing and fielding a new bomber.

The new LRSS aircraft was determined to be a central element in the emerging combat cloud family of systems proposed by Pentagon planners. The critical attributes of the new long-range sensor-shooter are its combination of long-range, large payload, high survivability, and versatility to adapt to new developments. These capabilities makes the system uniquely suited to dealing with the challenges posed by the evolving security environment:

- **Long Range** provides the ability to respond rapidly, flexibly, and globally; to strike from bases outside the enemy threat envelope; to reach deep into enemy territory and hold any target at risk; to use tanker assets efficiently; to provide persistent attack; and to find and attack both fixed and mobile targets.
- **Large Payload** provides a “deep magazine” for persistence at long range in an A2/AD environment; increases the capacity of the Air Force to deliver a mix of weapons (including heavy munitions), especially at long range; enables operations at long range with a relatively small, efficient number of aircraft; and permits the destruction of hardened and deeply buried targets.

- **High Survivability** (involving stealth, tactics, and electronic warfare) enables bombers to enter heavily defended airspace and attack the enemy's most highly valued targets without suffering prohibitive losses; greatly reduces the requirement for supporting aircraft and tankers; facilitates the operations of other aircraft by destroying enemy air defenses so that friendly, nonstealthy aircraft can operate; enables the use of direct-attack munitions, far more cost-effective than standoff weapons; and places a far greater burden on the enemy defense than nonstealthy aircraft.
- **Versatility** allows for adaption to new developments, including new threats; for incorporating new technology, such as directed energy weapons, application of effects in the cyber domain, advances in electronic warfare, and kinetic weapons; and for accommodating expanding computer processing power and the new sensor and shooter capabilities associated with that expansion.

The new LRSS's unique combination of capabilities will enable the system to make decisive contributions to crisis management. These aircraft can operate from distant bases that are essentially invulnerable to surprise attack or deploy to regional bases if the United States wishes to increase the potential threat to an adversary. Their powerful power-projection capabilities also provide a means to deter enemy aggression.

LRSS aircraft will also play an important role in maintaining the nuclear triad, consisting of bombers, intercontinental ballistic missiles (ICBMs), and submarines armed with submarine-launched ballistic missiles (SLBMs). The bomber is the only element of the triad that can contribute to both conventional and nuclear operations. The 2010 Nuclear Posture Review stated that the United States should retain the triad to maintain strategic stability while hedging against potential technical problems or future vulnerabilities. Bombers are particularly valued for providing a means to signal to allies and potential adversaries, alike, in a crisis and for supporting strategic stability, because they do not present a first-strike threat to either side. Today, the United States must not only deter two modern powers (Russia and China), but also a number of "lesser" nuclear states. The US thus faces a spectrum of scenarios and potential opponents. American nuclear forces must deter and preserve strategic stability and engage in crisis management and, if necessary, employment. Bombers provide important contributions to all these elements, and production of a new stealth LRSS is essential to preserving the continued viability of the triad.

LRSS plays a central role in the developing long-range family of systems and is essential to the building of a combat cloud. This allows the successful implementation of the new strategy and operational concepts devised to enable the US military to project power in the face of A2/AD challenges. LRSS is the foundation of a credible and effective capability to hold any target on the planet at risk and, if necessary, to destroy targets promptly, even from bases in the continental United States. This global strike capability is indispensable for both conventional and nuclear deterrence and crisis management, is a fundamental underpinning of US military power, and is one of the US asymmetric advantages that allow us to maintain our position as the world's sole superpower. LRSS aircraft are highly flexible weapon systems whose long range, large payload, high survivability, and versatility make them useful across the entire conflict spectrum.

Introduction

The US Air Force is committed to the development and production of a new bomber. The bomber's exact capabilities remain highly classified, but we know the Air Force wants it to be a long-range, air refuelable, highly survivable (“stealthy”), optionally manned aircraft with a significant nuclear and conventional standoff and direct-attack weapons payload.¹ The aircraft is more appropriately characterized as a long-range sensor-shooter, or LRSS, as it will possess a sensor suite with room for expansion and the growth potential to carry and employ weapons beyond the “iron bombs” that were the defining characteristic of “bombers” from the last century. LRSS is based on mature technology to enable the Air Force to purchase sufficient numbers of aircraft to meet the nation's security requirements at an average unit procurement cost of \$550 million in base year 2010 dollars, with an initial capability in the mid-2020s.²

The decision to build a new LRSS is the product of many factors. The President and the Defense Department have determined that changes in the national security environment require a new strategy and new operational concepts to overcome emerging challenges to power projection. These changes compel a new investment in survivable LRSS capabilities; the new aircraft is arguably the single most important element in this portfolio. The existing bomber fleet, mostly consisting of older, nonstealthy aircraft, is not capable enough to support the new strategy in the face of new and evolving threats.

LRSS is vital to national security because it is the foundation of a credible and effective global strike capability. Global strike—the ability to hold any target on the planet at risk and, if necessary, to destroy targets promptly, even from bases in the continental United States—is one of the five core missions of the Air Force. Credible global strike capabilities are indispensable for deterrence and crisis management and remain the fundamental underpinning of US military power.

The critical attributes of the new bomber are long range, large payload, high survivability, and versatility to adapt:

- **Long Range** provides the ability to respond rapidly, flexibly, and globally; to strike from bases outside the enemy threat envelope; to reach deep into enemy territory and hold any target at risk; to use tanker assets efficiently; to provide persistent attack; and to find and attack both fixed and mobile targets.
- **Large Payload** provides a “deep magazine” for persistence at long range in an A2/AD environment; increases the capacity of the Air Force to deliver a mix of weapons (including heavy munitions), especially at long range; enables operations at long range with a relatively small, efficient number of aircraft; and permits the destruction of hardened and deeply buried targets.

1 Brian Everstine, “Air Force sends next-gen bomber requirements to industry, few details made public,” *Air Force Times*, July 10, 2014.

2 Ibid.

- **High Survivability** (involving stealth, tactics, and electronic warfare) enables LRSS to enter heavily defended airspace and attack the enemy's most highly valued targets without suffering prohibitive losses; greatly reduces the requirement for supporting aircraft and tankers; facilitates the operations of other aircraft by destroying enemy air defenses so that friendly, nonstealthy aircraft can operate; enables the use of direct attack munitions, far more cost-effective than standoff weapons; and places a far greater burden on the enemy defense than nonstealthy aircraft.
- **Versatility** allows for adaption to new developments, including new threats; for incorporating new technology, such as directed energy weapons, application of effects in the cyber domain, advances in electronic warfare, and kinetic weapons; and for accommodating expanding computer processing power and the sensor and shooter capabilities associated with that expansion.

This paper will describe the new security environment and the challenges to American power-projection forces. It will then explain the strategy and operational concepts US national security leaders have created to overcome these challenges. The paper will show that the new LRSS aircraft is essential to support the new strategy and operational concepts, and thus will be critical to American national security in future decades—perhaps to the end of the century.

Moving From the Industrial Age of Warfare Into the Information Age

As we move further into the 21st century, we are experiencing a transition of not just time but also capability—capability that will allow for a paradigm shift in the role aircraft will play in meeting US security needs for the remainder of the century. Since the last B-2A bomber was produced in 1993, we have undergone approximately 15 Moore’s Law cycles, resulting in an exponential *increase* in electronic processing *capability* with a phenomenal *decrease* in *cost* to achieve equal capability. There was no such thing as a smartphone in 1993—the term was first used publicly in 1995.³ Relatively few people even had a smartphone in 2000, and the iPhone didn’t appear on the market until 2007. The number of smartphones is expected to exceed two billion by 2016.⁴ Consider that in 1990 the cost to store a gigabyte was about \$10,000; today it is approaching one cent.⁵ Weather was still a factor in delivering munitions precisely in the early 1990s. Today we can deliver a precision guided weapon to anywhere on the Earth in all weather, day or night, rapidly and accurately to less than 10 feet of aimpoint error. The significance of these facts is that today we can incorporate sensors, processing capacity, and avionics in a single aircraft at an affordable cost to a degree never before possible using open modular mission architectures that leverage the breathtaking advances in commercial information systems. What will the exponential increase in processing technology and advances in cyber, directed energy, and electronic warfare enable in the next 20 years?

What this means is that the roles that used to be played by what we labeled “bombers” can be dramatically expanded. To capture this potential requires innovative thought and shedding anachronistic concepts that aircraft can only perform singular functions and missions. It is “old think” to assert that placing modern intelligence, surveillance, and reconnaissance (ISR) sensors and processors on the new “bomber” will require “gold-plating” the aircraft. The information age allows new aircraft to become much more than just “bombers” or “fighters” and actually perform as sensor-shooter aircraft. When integrated with other system “nodes” in every domain—air, space, land, and sea—these aircraft will have the capability to create a “combat cloud,” a manifestation of a self-forming, self-healing ISR-strike-maneuver-sustainment complex. The cloud has the potential to usher in an entirely new era in defense and to play a crucial role in the Defense Department’s “third offset strategy.”

This is the Mitchell Institute’s premise: The aerospace vehicle that is currently referred to as the long-range strike bomber, or LRS-B, will become much more than simply an evolution of a type of aircraft traditionally called a “bomber.” If properly designed to exploit information age products and concepts of operation, the new aircraft is better labeled a long-range ISR/strike aircraft—or long-range sensor-shooter, the LRSS. Words matter in terms of creating an understanding of what an aircraft is capable of accomplishing. The new aircraft will be able to perform in those roles and accordingly ought to be labeled as such. That is why we will refer to it in this paper as LRSS.

3 Pamela Savage, “Designing a GUI for Business Telephone Users,” *Interactions* (January 1995), pp. 32-41.

4 “Two Billion Consumers Worldwide to Get Smart(phones) by 2016,” *emarketer*, Dec. 11, 2014.

5 See the graph, “A History of Storage Cost,” at Matt Komorowski’s website: <http://www.mkomo.com/cost-per-gigabyte-update>.

The Anti-Access, Area-Denial Challenge

Power projection is the ability to deploy, sustain, and use military force overseas.⁶ It is a central mission of the US armed forces, which have a unique capability to do so. The ability to project significant combat power across thousands of miles of ocean is what makes America a global superpower and enables America to protect the political and economic relationships essential to world-wide peace and prosperity. Power projection was essential to victory in World War II and the successful conduct of the Cold War.⁷ After the Cold War, America projected power to defeat Saddam Hussein, fight the War on Terror, and conduct numerous military, counterterrorist, peacekeeping, and humanitarian operations. The Air Force has continuously adapted over the decades in order to project power in accordance with the nature of the threat, the missions that must be performed, and the technology available. Airpower projects power much more rapidly and with far less vulnerability and exposure than surface forces. This singular capability provides our national leadership with security options simply not available with other means.⁸

Projecting power beyond our shores ideally requires unfettered access to international waterways and airspace as well as to regional ports and air bases to allow American forces to deploy and operate effectively. The buildup of forces and logistics in a theater can require a significant period of time. For example, six months elapsed between the decision to deploy American forces to Saudi Arabia after Saddam Hussein invaded Kuwait in August 1990 and the start of Operation Desert Storm in early 1991.⁹ If the United States does not enjoy access to the necessary waters, airspace, ports, and air bases, then power projection becomes much more difficult, or impossible, and takes much longer. In the future, sheer geographic distance and the lack of nearby facilities available for American use may constrain access. Such constraints affected the number and type of forces used in the opening phases of Operation Enduring Freedom in late 2001.¹⁰ In other cases, the adversary may employ A2/AD technologies and operational concepts to deny access to American forces. Systems with long range and high survivability are critical to overcoming both types of constraint on access and to facilitate access for other elements of the joint force.

Military-technical challenges to power projection are the most commonly discussed A2/AD threats.¹¹ Potential adversaries have noted the dependence of the American military on unconstrained access to ports, airfields, international airspace, and global sea-lanes. They have developed asymmetric technologies

6 Some publications distinguish between “power projection” and “force projection,” with the former referring broadly to military and nonmilitary elements of national power, and the latter to the military elements only.

7 Good historical overviews of power projection include Colin S. Gray, *The Leverage of Sea Power* (New York: The Free Press, 1992), and Norman Friedman, *Seapower as Strategy* (Annapolis: Naval Institute Press, 2001).

8 Daniel Byman and Matthew Waxman, *The Dynamics of Coercion* (Cambridge, UK: Cambridge University Press, 2002), pp. 88-102. Charles J. Dunlap Jr., “America’s Asymmetric Advantage,” *Armed Forces Journal International* (September 2006).

9 Joseph P. Englehardt, *Desert Shield and Desert Storm: A Chronology and Troop List for the 1990-1991 Persian Gulf Crisis* (Carlisle, PA: Army War College, 1991).

10 See chapter two of Benjamin S. Lambeth, *Air Power Against Terror* (Santa Monica, CA: RAND, 2005).

11 The literature on A2/AD threats is extensive. For example, Andrew Krepinevich, Barry Watts, and Robert Work, *Meeting the Anti-Access and Area-Denial Challenge* (Center for Strategic and Budgetary Assessments, 2003), and Sam Tangredi, *Anti-Access Warfare: Countering Anti-Access and Area-Denial Strategies* (Annapolis, MD: Naval Institute Press, 2013).

and capabilities to exploit the weaknesses in this method of power projection.¹² A key adversary objective is to force American airpower—either land- or sea-based—to operate from extremely long range and to hunt for mobile, hardened, and deeply buried targets.¹³ The new LRSS will counter A2/AD challenges and will maintain and expand operational access for the joint and/or combined task forces that may also be involved in conflict resolution.

Many potential adversaries can conduct **ballistic or cruise missile attacks**. China has invested heavily in thousands of these systems, along with their supporting sensor and command and control networks. Chinese ballistic missiles employ modern guidance technologies, such as satellite navigation and terminal guidance seekers, to achieve high precision. Initial salvos could target air and missile defense systems and blanket regional airfields with thousands of submunitions to destroy parked aircraft and prevent surviving aircraft from taxiing or taking off. Additional attacks with cruise missiles and precision guided bombs could target runways, aircraft shelters, fuel storage, and personnel. Less-capable adversaries could employ commando teams with guided rockets, missiles, or mortar rounds to attack parked aircraft and facilities.¹⁴

Weapons of mass destruction (WMD) are brutal but effective tools for denying access. Nuclear weapons can destroy ports and airfields outright. Chemical and biological weapons can disrupt the flow of forces through ports and degrade sortie rates at airfields. One of the most important effects of these attacks would be to force ground crews to operate in protective gear, reducing their work rate and increasing the risk of heat exhaustion.¹⁵

Some adversaries have the capability to attack American naval assets using **anti-ship ballistic missiles** cued by ocean-surveillance satellites and over-the-horizon radar systems.¹⁶ They can launch **anti-ship cruise missiles** from sites on land, long-range aircraft, surface vessels, and submarines.¹⁷ Large numbers of increasingly quiet and capable submarines threaten American naval forces at great distances from

12 Roger Cliff, et al, *Entering the Dragon's Lair: Chinese Antiaccess Strategies and Their Implications for the United States* (Arlington, VA: RAND Corporation, 2007), online at: http://www.rand.org/content/dam/rand/pubs/monographs/2007/RAND_MG524.pdf.

13 Christopher J. Bowie, *The Anti-Access Threat to Theater Air Bases* (Center for Strategic and Budgetary Assessments, 2002), online at: <http://www.csbaonline.org/wp-content/uploads/2011/03/2002.09.24-Anti-Access-Threat-Theater-Air-Bases.pdf>.

14 John Stillion and David R. Orletsky, *Airbase Vulnerability to Conventional Cruise-Missile and Ballistic-Missile Attacks: Technology, Scenarios, and US Air Force Responses* (Arlington, VA: RAND, 1999), online at: http://www.rand.org/content/dam/rand/pubs/monograph_reports/1999/MR1028.pdf.

15 Greg Weaver and J. David Glaes, *Inviting Disaster: How Weapons of Mass Destruction Undermine US Strategy For Projecting Military Power* (McLean, VA: AMCODA Press, 1997).

16 Andrew S. Erickson, *Chinese Anti-Ship Ballistic Missile (ASBM) Development* (Washington, DC: Jamestown Foundation, 2013). Mark Stokes, *China's Evolving Conventional Strategic Strike Capability*, Project 2049, September 2009, online at: http://project2049.net/documents/chinese_anti_ship_ballistic_missile_asbm.pdf.

17 Dennis M. Gormley, Andrew S. Erickson, and Jingdong Yuan, *A Low-Visibility Force Multiplier: Assessing China's Cruise Missile Ambitions* (Washington, DC: National Defense University Press, 2014).

enemy coasts.¹⁸ Advanced mine warfare and small, fast missile boats can seek to deny our naval forces access to territorial waters.¹⁹

American aircraft that reach enemy airspace despite the above challenges face **increasingly capable surface-to-air missiles**. These missiles are extremely fast, maneuverable, high-flying, and long range, and typically incorporate counter-countermeasure capabilities. Mobile launchers and radars complicate the suppression of enemy air defenses. High-velocity, short-range missiles and automatic cannons provide point defense against American precision munitions for high-value targets.²⁰

Some adversaries have **advanced fighter forces** that can fire large salvos of long-range air-to-air missiles with mixed seekers to defeat countermeasures. Enemy fighters may have specialized missiles to attack “high-value” American aircraft such as AWACS and refueling tankers.²¹ Advanced “fourth generation” fighter aircraft such as the Su-27 have proliferated in large numbers.²² Some adversaries are developing “fifth generation” fighters with stealth and supercruise capability.²³

American aircraft that penetrate to the target area increasingly confront **mobile and relocatable targets** that are extremely difficult to find and track.²⁴ Targets that cannot move have **significant hardening or are deeply buried**; only a very specialized subset of large, heavy munitions can destroy such targets.²⁵ Adversaries also employ camouflage, concealment, and deception.²⁶ Geographically large adversaries can locate important targets deep inland where they are hard to reach with tactical aircraft.

Cyber attacks against American military and civilian infrastructures introduce further friction into the control systems, misroute supplies and spare parts, and disable or deceive sensors and communications systems. Very capable adversaries can even attack American satellites directly.²⁷

18 Peter Howarth, *China's Rising Sea Power: The PLA Navy's Submarine Challenge* (New York: Routledge, 2006). Andrew S. Erickson and Lyle J. Goldstein, “China's Future Nuclear Submarine Force,” *Naval War College Review* (Winter 2007), pp. 54-79.

19 Andrew S. Erickson Lyle J. Goldstein, and William S. Murray, *Chinese Mine Warfare* (Newport, RI: Naval War College, 2009), online at: https://www.usnwc.edu/Research---Gaming/China-Maritime-Studies-Institute/Publications/documents/CMS3_Mine-Warfare.aspx. John Patch, “A Thoroughbred Ship Killer,” *Naval Institute Proceedings* (April 2010), pp. 48-53.

20 Carlo Kopp provides excellent analysis of modern surface-to-air missiles at his Air Power Australia website: <http://www.ausairpower.net/sams-iads.html>. See also Department of Defense, “Annual Report To Congress: Military and Security Developments Involving the People's Republic of China” 2014, pp. 33-34, online at: http://www.defense.gov/pubs/2014_DoD_China_Report.pdf

21 Carlo Kopp, “The Russian Philosophy of Beyond Visual Range Air Combat,” Air Power Australia, 2008, online at: <http://www.ausairpower.net/APA-Rus-BVR-AAM.html>.

22 Carlo Kopp, “Russian Weapons Proliferation in Asia,” Air Power Australia, 2012, online at: <http://www.ausairpower.net/PDF-A/APA-Proliferation-Brief-Sept-2012-A.pdf>.

23 Department of Defense, *Annual Report To Congress: Military and Security Developments Involving the People's Republic of China 2014*, pp. 66-67.

24 Christopher J. Bowie, *Destroying Mobile Ground Targets in an Anti-Access Environment* (Northrop Grumman Analysis Center, December 2001).

25 Lt Col Craig Baker, *The Strategic Importance of Defeating Underground Facilities* (Carlisle, PA: Army War College, 2012). Col Russell J. Hart, Jr., *Defeating Hard and Deeply Buried Targets in 2035* (Maxwell AFB, AL: Air War College, 2012).

26 Senior Defense Official, “Background Briefing on Enemy Denial and Deception,” Oct. 24, 2001, online at: <http://www.defense.gov/transcripts/transcript.aspx?transcriptid=2162> (see also the briefing slides online at: <http://www.defense.gov/dodcmshare/briefingslide/195/011024-D-6570C-009.pdf>).

27 See Roger Cliff, et al, *Entering the Dragon's Lair*, pp. 51-62.

A2/AD technologies and capabilities attempt to push American airpower out to a range from which it cannot operate effectively. Properly designed LRSS aircraft can defeat anti-access challenges because they have enough range to hold the full depth of enemy territory at risk from distant bases outside the enemy threat envelope; sufficient stealth to penetrate enemy air defenses; and high-enough payload and persistence with the appropriate sensor capability to find and attack mobile and/or hardened targets.

Basing Infrastructure and Distance

During the Cold War, the United States prepared to fight in areas with well-developed infrastructure, such as Western Europe and South Korea, where our allies permitted us to station American forces on their territory in peacetime in order to defend them from potential aggression. Bombers based in the United States backstopped the forward deployed forces. The President’s decision in 2012 that the US military would rebalance to the Asia-Pacific region while remaining engaged in the Middle East/Southwest Asia highlights the problems of time and distance associated with power projection. In future decades, we may have to project power in regions without a well-developed port or air base infrastructure, or where the bases that exist are not advantageously located.²⁸ We cannot assume that host nations will allow us to use their bases or airspace for any possible contingency. Even nations with which we have formal defense alliances and excellent military-to-military relationships have at times refused us access when we wished to conduct operations they believed did not serve their interests.²⁹ The number of permanent, major operational USAF bases overseas has steadily declined from a peak of 98 in 1956, to 38 in 1990, to 13 today. About half the current major Air Force overseas installations are in Europe.

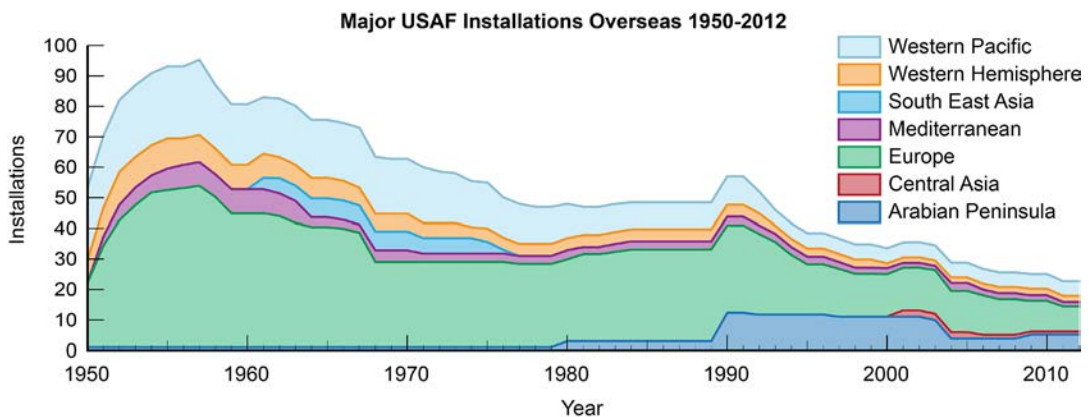


Figure 1: Major US Air Force Installations Overseas³⁰

28 Bowie, *The Anti-Access Threat to Theater Air Bases*, pp. 19-30.

29 Ibid., pp. 31-36.

30 Derived from the “Air Force Statistical Digest” published annually and available online at <http://www.afhs.af.mil/usafstatistics/>

During the Cold War, in the best case, it might take a week for reinforcements to cross the Atlantic Ocean from East Coast ports to European ports, while combat aircraft could deploy in a matter of hours. The potential theater of operations in Europe was not large; the distance to the Warsaw Pact border was perhaps 100 to 200 nautical miles from air bases in the Rhineland and about 400 NM from air bases in Britain. The relatively short distances from base areas to the likely battle zone meant that short-ranged fighter and attack aircraft could provide air cover and deliver air strikes very quickly. Accordingly, these types of aircraft were acquired in large numbers.

The following illustrations compare the distances in Europe to those in Asia by superimposing maps of Europe over the Western Pacific and Southwest Asia. Guam is more than 1,600 NM from the coast of East Asia, and Diego Garcia is more than 2,000 NM from the coast of Southwest Asia. In both cases, important potential targets are located hundreds of miles inland. The type of high-tempo operations that planners envisioned with fighter aircraft for NATO's central front are simply not possible in theaters of operations this large.

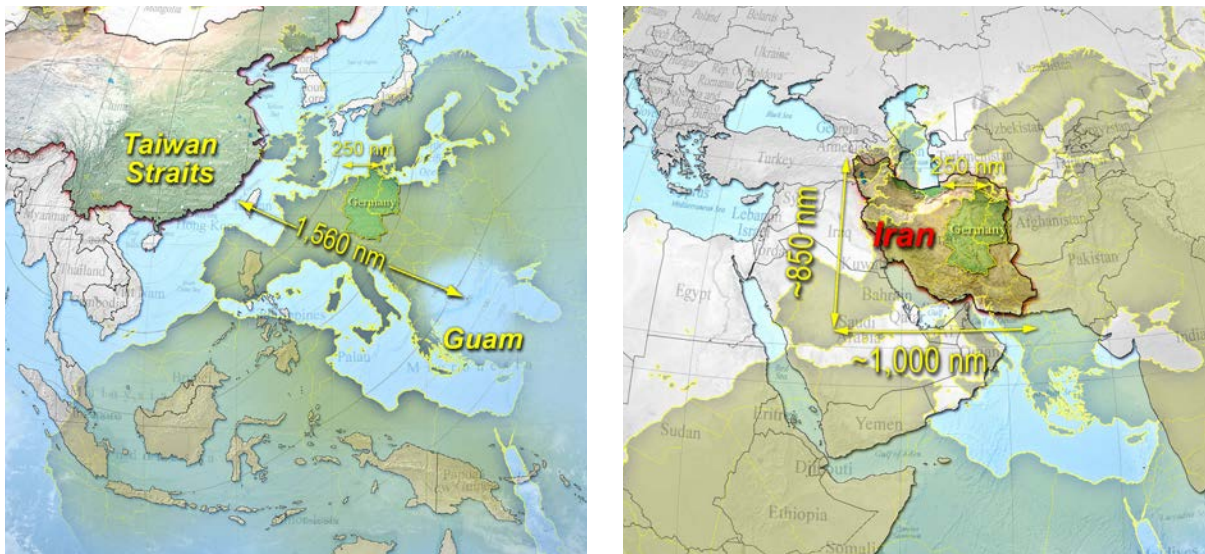


Figure 2: Comparative Distances in Europe and Asia

In the Western Pacific, real estate is sparse and the density of airfields is extremely low compared to Western Europe. Airfields in the region with long enough runways to support military jets must also have enough fuel and munitions storage, ramp space, hardened shelters, and hangars to conduct sustained operations. Most of the hardened airfields and aircraft shelters in the region are in Japan, South Korea, and Taiwan.³¹ The United States cannot take for granted that it would have access to these airfields for contingencies other than the direct defense of these nations. Moreover, they are so close to China that they would be exposed to large-scale air and missile attacks if China decided to launch them.

31 Bowie, *The Anti-Access Threat to Theater Air Bases*, p. 26.

The Air Force would certainly face significant basing challenges in any Taiwan or South China Sea contingency. If the 21 bases on Taiwan and three on Okinawa were denied through enemy action, the Air Force would have to operate from four bases in the Marianas, 1,500 NM from Taiwan, or even farther away. Meanwhile, the People's Liberation Army Air Force could operate from 56 hardened air bases within 500 NM of Taiwan, and from 82 additional air bases 500 NM to 1,000 NM from Taiwan.³²

Long-range operations with fighters are possible and the United States is now conducting them in the Middle East. However, experience indicates that such operations significantly reduce the fighter's attack potential. Sortie rates diminish dramatically at long range, and tanker support requirements greatly increase.³³ Bomber aircraft, of course, can operate effectively over much longer ranges. B-1, B-2, and B-52 bombers demonstrated this when they flew missions from the United States and Diego Garcia to Afghanistan. The high payload delivered on each strike compensated for the low sortie rate. For example, one B-1 sortie over Syria or in northern Iraq today can deliver the same ordnance as more than 40 F/A-18s launched from an aircraft carrier in the Persian Gulf. The decision to rebalance to the Asia-Pacific region clearly presages a much greater demand for bombers in order to operate over the long distances there.

Strategic Guidance and Operational Concepts

It is within this strategic context that the President issued a new Defense Strategic Guidance in 2012 to articulate priorities and guide military spending for the next decade.³⁴ The guidance noted that the global security environment presents an increasingly complex set of challenges and opportunities:

- Violent extremists continue to threaten US interests, allies, partners, and the homeland. They primarily operate in South Asia and the Middle East. The United States will continue to counter these threats by monitoring the activities of non-state threats worldwide, working with allies and partners to establish control over ungoverned territories, and directly striking the most dangerous groups and individuals when necessary.
- US economic and security interests are inextricably linked to the Asia-Pacific region, and therefore, “while the US military will continue to contribute to security globally, we will of necessity rebalance toward the Asia-Pacific region.” The maintenance of peace, stability, free flow of commerce, and of US influence in this region depends on the underlying balance of military capability and presence. Therefore, we will “make the necessary investments to ensure that we maintain regional access and the ability to operate freely in keeping with our treaty obligations and with international law.”

32 For the location of Chinese airbases, see: <http://www.ausairpower.net/APA-PLA-AFBs.html>.

33 Bowie, *The Anti-Access Threat to Theater Air Bases*, pp. 13-14.

34 The guidance is online at: http://www.defense.gov/news/Defense_Strategic_Guidance.pdf.

- In the Middle East, we will counter violent extremists and destabilizing threats, as well as uphold our commitment to allies and partner states.
- In Europe, we will support peace and prosperity and bolster the strength and vitality of NATO.
- We will protect freedom of access to the global commons and counter the proliferation of weapons of mass destruction.

The guidance particularly emphasized the importance of projecting power in the face of A2/AD threats and mandated the development of a new, stealth LRSS aircraft. Taken together, the need to rebalance toward the Asia-Pacific region, maintain security and stability in Europe and the Middle East, and counter emerging A2/AD threats will create additional demand for LRSS aircraft in the future.

The guidance identified 10 primary missions for US armed forces. Few of them were truly new, and in fact, bombers have performed nine of these missions since 1945:

Missions	Examples of Bombers Conducting These Missions
Counter Terrorism and Irregular Warfare	Laos 1965-72, Afghanistan, Iraq, Syria
Deter and Defeat Aggression	Cold War, Vietnam 1972, Desert Storm, Allied Force
Project Power Despite A2/AD Challenges	Afghanistan
Counter Weapons of Mass Destruction	Desert Storm, Desert Fox
Nuclear Deterrence	Cold War, Cuban Missile Crisis, Korean Peninsula
Defend the Homeland	Cuban Missile Crisis, maritime tracking
Provide a Stabilizing Presence	Cold War, Continuous Bomber Presence
Conduct Stability and COIN Operations	Vietnam, Afghanistan, Iraq
Operate Effectively in Cyberspace and Space	None
Conduct Humanitarian, Disaster Relief, and Other Operations	Few

Figure 3: Bombers and Their Missions

One of those mission descriptions directly stated that the Air Force will develop a new stealthy LRSS and it provided a powerful rationale for doing so. Therefore, it is worth quoting in full:

“Project Power Despite Anti-Access, Area-Denial Challenges: In order to credibly deter potential adversaries and to prevent them from achieving their objectives, the United States must maintain its ability to project power in areas in which our access and freedom to operate are challenged. In these areas, sophisticated adversaries will use asymmetric capabilities, to include electronic and cyber warfare, ballistic and cruise missiles, advanced air defenses, mining, and other methods, to complicate our operational calculus. States such as China and Iran will continue

to pursue asymmetric means to counter our power projection capabilities, while the proliferation of sophisticated weapons and technology will extend to non-state actors as well. *Accordingly, the US military will invest as required to ensure its ability to operate effectively in anti-access and area-denial (A2/AD) environments* [emphasis added]. This will include implementing the Joint Operational Access Concept, sustaining our undersea capabilities, *developing a new stealth bomber* [emphasis added], improving missile defenses, and continuing efforts to enhance the resiliency and effectiveness of critical space-based capabilities.”

The stealth bomber was specifically identified because it has an unmatched ability to deliver rapid, sustained firepower directly from the United States against distant targets in A2/AD environments. Stealth LRSS aircraft are centrally important to the Joint Operational Access Concept that addresses such operations.

With regard to the **deter and defeat aggression** mission, deterrence results from the ability to inflict military defeat on the enemy and impose unacceptable costs on the enemy. The stealth LRSS aircraft is the most compelling instrument of conventional deterrence. The guidance states that the military, if engaged in a major campaign against an aggressor, must still be able to deter and defeat an opportunistic second aggressor in a distant region. The stealth LRSS aircraft is ideally suited to meet this challenging requirement. It can bring enormous firepower to bear anywhere on the globe within hours of the decision to do so and shift rapidly between widely separated theaters of operation.

The guidance notes that the United States must **maintain a safe, secure, and effective nuclear deterrent** that “can under any circumstances confront an adversary with the prospect of unacceptable damage.” Nuclear deterrence was the central mission of the bomber force from 1945 to 1991. A new, nuclear-capable stealth LRSS will be a key element of the future nuclear deterrent—and, unlike the other elements of the US deterrent force, it is useful across the conflict spectrum. Such an aircraft can counter the proliferation of weapons of mass destruction by attacking these systems and their production facilities and by responding appropriately to WMD use.

LRSS will contribute importantly to the **provide a stabilizing presence** mission, especially in the Asia-Pacific region. Since 2004, bombers have maintained a continuous presence on Guam, from which they can reach anywhere in the Western Pacific. They play a particularly important role in stabilizing the Korean Peninsula. They periodically fly training missions over South Korea and participate in exercises there.³⁵ They also reassure friends and allies such as Australia, Japan, the Philippines, Singapore, and Thailand.³⁶ The B-2 bomber periodically rotates among the combatant commands worldwide for training deployments in order to provide a stabilizing presence.³⁷ This contributes strongly to “extended deterrence”—the ability of the United States to deter attacks on friends and allies—and provides assurance to those friends and allies that the United States will protect them from intimidation, coercion, or attack.

35 Tom Bowman and Robert Siegel, “US Flies B-2 Stealth Bombers Over South Korea Amid Escalating Tensions With The North,” *National Public Radio*, March 28, 2013.

36 “B-52 lands at RAAF Base Darwin,” Air Force Global Strike Command news, Dec. 10, 2014.

37 Arie Church, “Spirit World Tour, Coming to a Theater Near You.” *Air Force Magazine.com*, Nov. 9, 2012.

Buttressing the new strategic guidance is the Defense Department's Joint Operational Access Concept that describes broad approaches for operating in the A2/AD environment.³⁸ The JOAC does not advocate specific materiel solutions as such, but a careful reading of it clearly indicates the vital role the new stealth LRSS will play. No other single system appears to fulfill the JOAC's precepts as effectively as a stealth LRSS. For example:

- **Maneuver directly against key operational objectives from strategic distance.** The JOAC succinctly describes what stealth LRSS can do: "Some elements of the joint force will operate directly against key objectives from points of origin or other points outside the theater without the need for forward staging." The advantages of this capability are clear: "Not being tied to fixed forward bases will increase operational flexibility while complicating enemy defensive preparations. The greater the proportion of such elements in the joint force, the less will be the overall burden on such bases and the less vulnerable the joint force will be to a successful attack against those bases."
- **Attack enemy A2/AD capabilities in depth rather than rolling back those defenses from the perimeter.** Stealth LRSS aircraft have the range, payload, and survivability needed to attack critical enemy systems and facilities across the full depth of the enemy's territory.
- **Exploit advantages in one or more domains to disrupt enemy A2/AD capabilities in others.** The stealth LRSS can locate and attack enemy missile forces and surface ships, thus enabling friendly naval and land forces to operate. As the JOAC notes, "Low-signature forces," such as stealth aircraft, "are especially key for early penetration of an enemy's A2/AD defenses before they have been degraded."

The JOAC has evolved since January 2012 and may eventually be superseded. However, a capable, access-insensitive LRSS will necessarily play a central role in any operational concept for gaining and exploiting access.

The 2014 Quadrennial Defense Review (QDR) amplified on the 2012 Defense Strategic Guidance.³⁹ The QDR reiterated the need to project power in the A2/AD environment and to "defeat a regional adversary in a large-scale multiphased campaign, and deny the objectives of—or impose unacceptable costs on—another aggressor in another region." For the Air Force, the QDR identified three priorities: the F-35 fighter, the KC-46A tanker, and "a new, stealthy, long-range strike aircraft, to maintain the ability to operate from long ranges, carry substantial payloads, and operate in and around contested airspace."

In late 2014, then-Defense Secretary Chuck Hagel and his deputy, Robert O. Work, made important speeches on defense innovation.⁴⁰ They observed that during the Cold War, the Defense Department made

38 The JOAC is online at: http://www.defense.gov/pubs/pdfs/JOAC_Jan%202012_Signed.pdf.

39 The 2014 QDR is online at: http://www.defense.gov/pubs/2014_Quadrennial_Defense_Review.pdf.

40 Defense Secretary Chuck Hagel, Defense Innovation Days Opening Keynote, Sept. 3, 2014, and Reagan National Defense Forum Keynote, Nov. 15, 2014. Deputy Defense Secretary Bob Work, National Defense University Convocation, Aug. 5, 2014. Online at: <http://www.defense.gov/Speeches/Speech.aspx?SpeechID=1873>, <http://www.defense.gov/Speeches/Speech.aspx?SpeechID=1877>, and <http://www.defense.gov/Speeches/Speech.aspx?SpeechID=1903>.

two efforts to offset Soviet quantitative superiority through American technological superiority. In the 1950s, the Eisenhower Administration built a robust nuclear deterrent force to offset Soviet conventional forces. In the 1970s, the Carter Administration initiated the revolution in stealth, information, and guided munitions. Matured during the 1980s, this revolution remains the foundation for American military superiority to this day. Unfortunately, the fruits of that revolution are proliferating widely, and the US military will face advanced disruptive technologies in the future. Therefore, the Defense Department is preparing a “third offset” strategy to maintain America’s military-technological advantage. The third offset effort will include “the development of new operational concepts, new ways of organizing, and long-term strategies,” said Work.

Informed observers of defense strategy development such as Robert Martinage at the Center for Strategic and Budgetary Assessments in Washington, DC, believe that the third offset strategy will likely involve exploiting enduring sources of American military advantage, including stealth and long-range strike.⁴¹ (Other areas of advantage include unmanned warfare and undersea warfare.) The new stealth bomber reflects decades of hard-won experience in stealth and long-range air operations and thus will prove critically important to the fulfillment of the third offset.

As mentioned earlier, information technology allows new aircraft to be much more than just bombers or fighters, becoming sensor-shooter aircraft that will have the capability to create a combat cloud when integrated with other system “nodes” in every domain: air, space, land, and sea. The combat cloud is a manifestation of a self-forming, self-healing ISR-strike-maneuver-sustainment complex that has the potential to usher in an entirely new era in defense and facilitate the third offset strategy.⁴² However, sustained investment over many years will certainly be required to bring this new construct into being, to bring the new stealth LRSS to operational status, and thus preserve America’s edge in stealthy, long-range strike and reconnaissance.

The 2015 National Security Strategy re-emphasizes the themes of the 2012 Defense Strategic Guidance.⁴³ The United States will advance the rebalance to the Asia-Pacific region, strengthen its alliance with Europe, especially given Russian aggression in Ukraine, and seek stability and peace in the Middle East and Africa. Recent bomber operations over Iraq and Syria to combat ISIS terrorists highlight the continued importance of long-range strike capabilities in the Middle East.⁴⁴

41 Robert Martinage, *Toward A New Offset Strategy* (Center for Strategic and Budgetary Assessments, Washington, DC, 2014), online at: <http://csbaonline.org/wp-content/uploads/2014/10/Offset-Strategy-Web.pdf>.

42 For further discussion of the “combat cloud” concept, see “‘Combat Cloud’ is ‘new face of long-range strike,’” *Armed Forces Journal International*, Sept. 18, 2013. Mark Gunzinger and David A. Deptula, *Toward a Balanced Combat Air Force* (Center for Strategic and Budgetary Assessments, 2014). David A. Deptula, “A New Era for Command and Control of Aerospace Operations,” *Air and Space Power Journal* (July-August 2014). These works are online at: <http://www.armedforcesjournal.com/deptula-combat-cloud-is-new-face-of-long-range-strike>, <http://csbaonline.org/publications/2014/04/toward-a-balanced-combat-air-force>, and <http://www.au.af.mil/au/afri/aspj/digital/pdf/articles/2014-Jul-Aug/SLP-Deptula.pdf>.

43 Online at: https://www.whitehouse.gov/sites/default/files/docs/2015_national_security_strategy.pdf

44 Julian E. Barnes, “B-1 Pilots Describe Bombing Campaign Against ISIS in Kobani,” *Wall Street Journal*, Feb. 17 2015.

Airpower has always projected power and ensured access so that friendly land and maritime forces can operate. As amplified by Gen Mark A. Welsh III, Air Force Chief of Staff, the five core missions of the Air Force have been constant since 1947: (1) air and space superiority; (2) intelligence, surveillance, and reconnaissance; (3) rapid global mobility; (4) global strike; and (5) command and control.⁴⁵ How Airmen have performed these missions has changed over time, and the Air Force has routinely adjusted its forces based on the technology available and the nature of the conflicts the nation is involved in or anticipates involvement. The Air Force will certainly perform all five core missions to support the new strategy and project power despite A2/AD challenges. The new LRSS is, of course, a principal contributor to the global strike mission. How it will support this mission and the Defense Strategic Guidance is described in the 2013 Air Force Posture Statement:

“Air Force global strike provides the nation the ability to project military power more rapidly, more flexibly, and with a lighter footprint than other military options. The Air Force’s nuclear deterrent and conventional precision strike forces can credibly deny adversary objectives or impose unacceptable costs by effectively holding any target on the planet at risk and, if necessary, disabling or destroying targets promptly, even from bases in the continental United States. Global strike may entail close support to troops at risk, interdicting enemy fielded forces, or striking an adversary’s vital centers from great distances. Credible long-range strike capabilities are indispensable for deterrence and provide fundamental military capabilities to underpin US military power. Air Force global strike capability relies on a wide range of systems including bombers, missiles, tankers, special operations platforms, fighters, and other Air Force systems. ...

Against a backdrop of increasingly contested air, space, and cyber environments, the Air Force must maintain its ability to hold any target at risk and provide the nation a credible strategic deterrent force. This capability, unmatched by any other nation’s air force, will only grow in importance as America rebalances its force structure and faces potential adversaries that are modernizing their militaries to deny access to our forces. Therefore, the Air Force will modernize global strike capabilities to ensure that American forces are free to act when, where, and how they are needed.

Consistent with the Defense Strategic Guidance, in [Fiscal 2014], the Air Force is investing in the development of the long-range strike family of systems. The Long-Range Strike Bomber (LRS-B)—another of the Air Force’s three top acquisition programs—is a key piece of that effort.”⁴⁶

Together, the new Defense Strategic Guidance, JOAC, QDR, and the third offset effort provide a sound, logical response to the emerging political, military-technical, and budgetary challenges to power

45 Gen Mark A. Welsh III, *Global Vigilance, Global Reach, Global Power for America*, online at: http://www.af.mil/Portals/1/images/airpower/GV_GR_GP_300DPI.pdf.

46 Department of the Air Force, “USAF Posture Statement 2013,” p. 13, online at: <http://www.posturestatement.af.mil/shared/media/document/AFD-130619-104.pdf>.

projection. Implementing the strategic guidance and the supporting operational concepts requires very different forces from the current or planned systems. To counter military A2/AD challenges and the tyranny of time and distance requires a responsive, persistent, survivable, and precise global strike force of significant size and capacity.

Recapitalizing the Bomber Force

The American bomber force is aging. The B-52 was designed in the late 1940s based on World War II experience. Hundreds were built in the 1950s. The B-52H model in use was built in 1961 and 1962. The B-1 was designed in the 1960s and 1970s and began flying in the 1980s. The B-2 was designed in the late 1970s and early 1980s and was produced in the 1990s. Consequently, the average age of the bomber force is roughly 39 years.⁴⁷

	Current Inventory	First Flight	Last Delivery	Average Age
B-52H	76	1961	1962	53
B-1B	63	1984	1988	28
B-2A	20	1988	1997	20

Figure 4: Current Bomber Inventory (2015)

With proper maintenance and modernization, the Air Force can operate the B-52 and B-1 until 2044, when they will be 60 to 80 years old. This accounts only for their structural ability to fly, not their ability to carry out their missions. Very few aircraft this old can still fly today, and they are in museums, not operational military forces. The B-2 is a newer aircraft that can operate until 2058, when it will be more than 60 years old. We should note, however, that when the LRSS enters service in the 2020s, the B-2 will be more than 30 years old. This is about the same age that the B-52H was when the B-2 entered service in the 1990s. Our sons and daughters deserve better tools to fight the nation's wars. To put aircraft age into perspective, the use of B-52s today is like using B-17s in the fight against Iraq during Desert Storm in 1991.

Sustainment and modification of the legacy bomber force is necessary, but will be increasingly expensive as the aircraft age.⁴⁸ With aircraft this old, the risk on unanticipated structural failures increases (as we saw in the case of the C-141 airlifter and more recently the F-15 fighter).⁴⁹ Moreover, their overall readiness will inevitably decline with age, and the risk of noncombat accidents will increase. In the past 10 years, we have lost four bombers to accidents, and fires seriously damaged two others.

47 Jeremiah Gertler, *US Air Force Bomber Sustainment and Modernization: Background and Issues for Congress* (June 4, 2014), 16. Gertler's claim that the average age of the bomber force is 33 years does not take into account the fact that there are 76 older B-52s and only 20 newer B-2s.

48 United States Air Force Scientific Advisory Board, "Report on Sustaining Air Force Aging Aircraft into the 21st Century," Aug. 1, 2011.

49 Richard Sisk, "F-15 Crash Raises Concerns on Aging Fleet," Sept. 11, 2014, online at: <http://www.dodbuzz.com/2014/09/11/f-15-crash-raises-concerns-on-aging-fleet/>.

But the most serious strategic issue is that of capability. The B-52 can no longer survive in contested air space and must employ expensive standoff munitions in order to bring firepower to bear (see Figure 14 for a view of the standoff versus penetrating cost-effectiveness issue). B-1s can operate in some areas, but cannot survive against modern defenses. In the face of advanced air defenses, today only the B-2 possesses the ability to penetrate and hold the full range of adversary targets at risk. However, the small fleet of 20 B-2s is insufficient to provide the kind of long-range firepower needed to deter adversaries. The Air Force is therefore committed to the production of a new LRSS, so that it can enter service in the 2020s and begin taking over for the legacy force in the following decades and maintain US global power projection capabilities in the long term.

The Value of the New Long-Range Sensor Shooter

The critical attributes of the new LRSS are its combination of long range, large payload, high survivability, and versatility. This combination of capabilities makes the system uniquely suited to dealing with the challenges posed by the new security environment.

Long Range

Bombers are large aircraft with much longer organic unrefueled range than fighter aircraft. Long range provides great strategic responsiveness; bombers can rapidly strike targets on the other side of the globe and “swing” combat power between widely separated theaters of operation. They can base outside the range of most enemy strike systems and attack targets deep inside enemy territory. Long range permits bombers to loiter for extended periods over the battlespace. They can thus act in conjunction with friendly ground troops to provide persistent direct attack of the enemy or find and attack mobile or “time-sensitive” targets in enemy territory.

Aerial refueling can extend the range of any aircraft capable of receiving fuel. However, there are definite limits as to how far tankers can extend the operational radius of fighters. Beyond about 750 NM, fighter crews are typically limited to one sortie per day due to fatigue, and beyond about 1,400 NM, the number of tankers required to support each fighter sortie becomes excessive.⁵⁰ On the other hand, aerial refueling permits bombers to strike targets literally on the other side of the Earth, if required. In the 1950s, Strategic Air Command bombers would periodically circumnavigate the globe nonstop to demonstrate exactly this point to the Soviets.⁵¹ Unlike fighter pilots, bomber crews can conduct long-range missions without prohibitive fatigue because they can get out of their seats and take breaks or sleep. A relatively small number of tankers are required to support bomber operations. For example, a single refueling extends the range of the B-2 from 6,000 miles to 10,000 miles. The long range of LRSS aircraft means their supporting tankers

50 At long range, one tanker sortie can be required to support each fighter. Bowie, *The Anti-Access Threat to Theater Air Bases*, p. 13.

51 “52s Shrink A World,” *Life* (Jan. 28, 1957), pp. 21-27.



Figure 5: Unrefueled Reach of a 2,500-NM Range LRSS From Guam, Diego Garcia, and RAF Fairford

can operate safely out of reach of enemy fighters, but the LRSS aircraft can still reach deep into hostile airspace from the tanker orbit.

History abounds with examples of extremely long-range, long-duration bomber operations. During Operation Linebacker II in 1972, B-52s flew 18-hour missions from Guam to Vietnam and back, an 8,200 mile round trip.⁵² During the 1982 Falklands War, RAF Vulcan bombers flew 16-hour, 7,900-mile round-trip missions between Ascension Island and the Falklands.⁵³ Bombers have repeatedly struck targets on the other side of the world, flying directly from bases in the United States, using en route tanker support as required. In Desert Storm, B-52s launched from Barksdale AFB, LA, struck targets in Iraq, and returned, a 35-hour, 14,000-mile round-trip.⁵⁴ Other B-52s struck Iraq from the United States and then landed in Saudi Arabia. During Operation Allied Force in 1999, B-2s flew 30-hour round-trip sorties between Whiteman AFB, MO, and Serbia.⁵⁵

In October 2001, a B-2 flew from Missouri nonstop to Afghanistan, then attacked Taliban targets and landed on Diego Garcia 44 hours after takeoff. After a 15-minute “hot refueling,” a fresh crew flew the aircraft on the 30-hour return trip to Missouri.⁵⁶ In early 2003, B-2s flew nonstop, 36-hour missions to Iraq from the United States.⁵⁷ Operation Odyssey Dawn in 2011 featured B-2 strikes on Libya from Missouri.⁵⁸ And, for the first time, B-1 bombers struck targets overseas directly from Ellsworth AFB, SD. The B-1s recovered at a forward location, refueled and rearmed, and then struck Libyan targets again on their way back to the United States.⁵⁹

Bombers have thus repeatedly demonstrated their capability to deliver high volumes of precision firepower rapidly at intercontinental distances. If the United States were engaged in conflict in one region, and a second, geographically distant nation contemplated or initiated aggression, a large and sufficiently capable LRSS force would represent the principal means to deter or defeat the second aggressor. Ground forces

52 James R. McCarthy, *Linebacker II: A View from the Rock* (Washington, DC: Office of Air Force History, 1985), p. 5.

53 Rowland White, *Vulcan 607* (New York: Bantam, 2012) is a compelling account.

54 Bill Yenne, *B-52 Stratofortress* (Minneapolis: Zenith Press, 2012), p. 123.

55 Thomas Withington, *B-2A Spirit Units in Combat* (New York: Osprey, 2006), pp. 39-40.

56 *Ibid.*, p. 48.

57 *Ibid.*, pp. 72-73.

58 “Air Force Global Strike Command Supports Operation Odyssey Dawn,” Air Force Global Strike Command Public Affairs, 20 March 2011.

59 Hrair H. Palyan, “Lessons Learned, Operation Odyssey Dawn,” 28th Bomb Wing Public Affairs, 21 March 2012.

and fighter aircraft would face severe challenges in responding with the speed and numbers required to fight two wars nearly simultaneously. LRSS aircraft, given adequate tanker support, are more able to swing combat power rapidly from one theater to another distant theater than any other type of conventional weapon in the US arsenal.

The Air Force has often enjoyed access to a large number of well-developed forward bases to operate short-range aircraft from. This may not be the case in the future. In some situations, such bases simply may not exist at all, as they did not during the opening stages of Operation Enduring Freedom. Alternatively, access to useful bases may be denied politically or through enemy action. A longer range bomber increases the number of useful bases that are potentially available, decreases US dependence on bases in any particular country, and reduces vulnerability to enemy threats. If operations from forward bases are militarily undesirable or politically impossible, bombers can operate effectively from secure regional hubs such as RAF Fairford in Britain, Diego Garcia, and Guam.

The ability to reach into enemy territory depends on the aircraft's range from the tanker orbit. Due to the suppression (or lack) of enemy air defenses, tanker orbits have historically been close to enemy territory. For example, during the Vietnam War, tankers orbited over Laos or just off the North Vietnamese coast.⁶⁰ In Desert Storm, tankers could operate close to the Saudi-Iraqi border.⁶¹ In Allied Force, tanker tracks were over the Adriatic Sea, Bosnia, Hungary, and Macedonia.⁶² In Enduring Freedom, tankers orbited at first near the Pakistani-Afghan border and eventually over Afghanistan itself.⁶³

The United States may not have this advantage in future conflicts. An adversary with advanced surface-to-air missiles could force the tankers to operate 200 miles or 300 miles from his coast. An enemy with Su-27 interceptors armed with long-range air-to-air missiles could force American tankers to stand off 1,000 miles. If American fighter aircraft could reach the enemy coast at all from these distances, their ability to penetrate inland would be severely limited. LRSS aircraft, on the other hand, could penetrate deep into enemy territory even from a tanker orbit far from the enemy coast to hold key targets at risk, as illustrated in the next figure. This, in turn, would deny the enemy the option to place valuable assets in sanctuaries far beyond the reach of American fighter aircraft. It would also force the enemy to defend his entire territory rather than just a shallow coastal strip.

60 See the map at: <http://www.nationalmuseum.af.mil/shared/media/photodb/photos/110330-F-DW547-029.jpg>.

61 Thomas A. Keaney and Elliot A. Cohen, *Gulf War Air Power Survey Summary Report* (Washington, DC: Government Printing Office, 1993), p. 191.

62 Tim Ripley, *Conflict in the Balkans, 1991-2000* (New York: Osprey, 2001), p. 64.

63 Steve Vogel, "Gas Stations in the Sky Extend Fighters' Reach," *Washington Post*, Nov. 1, 2001.

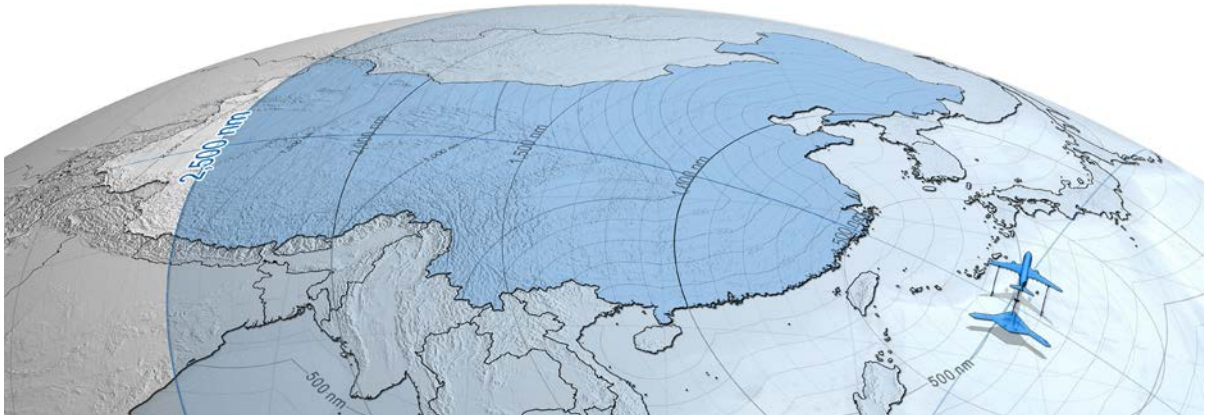


Figure 6: Reach of a 2,500 NM-Range LRSS Refueled 500 NM from the Asian Coast

Loitering for an extended period, also known as persistence, is critical to finding and attacking mobile or time-sensitive targets and to providing timely operations with American ground troops. Aircraft must be able to respond within 10 or 15 minutes to strike before the target moves or completes its attack on friendly troops. This means that they must already be flying in or near enemy territory, because subsonic aircraft can only travel 108 miles in 10 minutes. Roughly six such “quick-response orbits” would be needed to cover an area the size of Afghanistan as Figure 7 shows.

Long-range aircraft generate quick-response orbits more efficiently than short-range aircraft, especially if the orbits are located very far from the aircraft’s base. Bombers operating from Diego Garcia, 2,500 miles from Afghanistan, were able to loiter over the battlefield for hours during Operation Enduring Freedom.⁶⁴ The number of notional bombers required to sustain six quick-response orbits at ranges of 500 NM to 2,500 NM from their base is not large. If air defense threats force the refueling tankers to orbit farther from the operational area, the number of bombers required would increase, but not to an unsustainable level as Figure 8 illustrates.

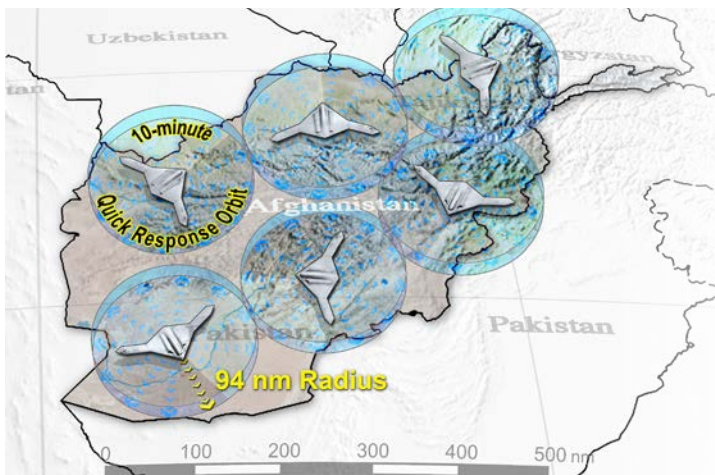


Figure 7: Six “Quick Response Orbits” Are Required to Cover Afghanistan

64 Lt Col Eric E. Theisen, *Ground-Aided Precision Strike: Heavy Bomber Activity in Operation Enduring Freedom* (Maxwell AFB: Air University Press, 2003), p. 11. Online at: <http://www.au.af.mil/au/awc/awcgate/maxwell/mp31.pdf>.

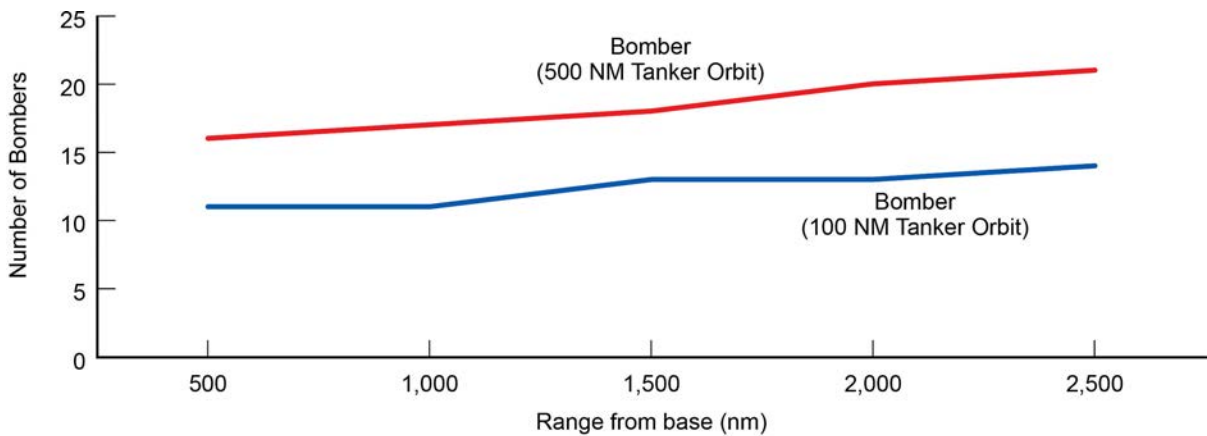


Figure 8: Number of Bombers Required to Sustain Six “Quick Response Orbits” As a Function of Range from Base and Tanker Standoff^[1]

^[1] This is a notional bomber with a 2,500 NM organic range capable of generating 0.85 sorties per day. It refuels from a tanker conservatively positioned 500 NM from the orbit.

In summary, the advantages of long range include:

- Responsiveness *anywhere* around the world in a matter of hours;
- Ability to strike from bases enjoying the sanctuary beyond the range of an enemy;
- Ability to reach deep inland and hold any target at risk;
- Efficient use of tanker assets; and
- Ability to provide persistent close air support and conduct time-sensitive targeting.

Large Payload

The core mission of the bomber has historically been to drop bombs. Therefore, bombers are designed to carry a much larger payload than fighters. Bombers have always assumed a major role in ordnance delivery. In every conflict from December 1941 onward, bombers constituted a relatively small fraction of the overall complement of the operational combat airpower and flew a relatively small fraction of the total sorties. However, they dropped a disproportionately large proportion of the total bomb tonnage. For example, in the first three months of Operation Enduring Freedom, when the United States had only limited access to land bases within range, a force of 24 bombers flew *11 percent of the total sorties, but dropped 75 percent of the munitions*.⁶⁵

65 Lambeth, *Air Power Against Terror*, pp. 248-253.

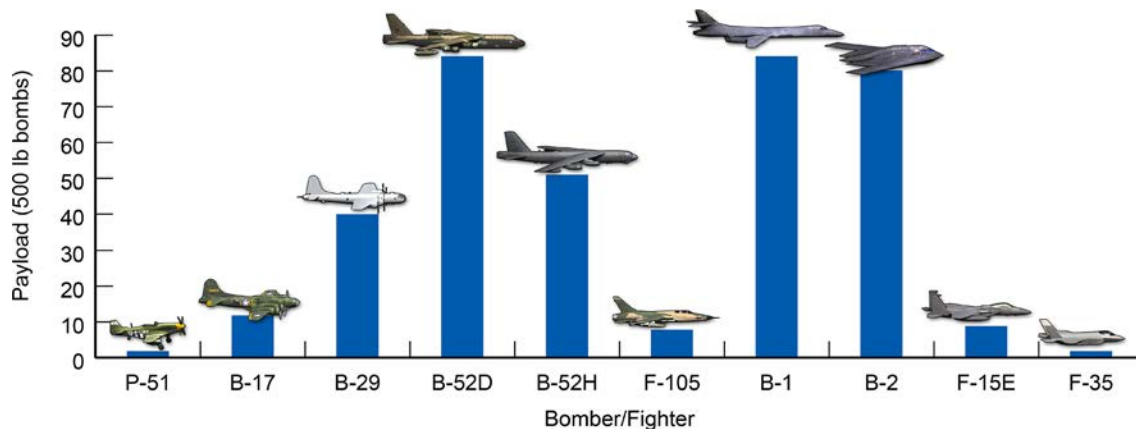


Figure 9: Comparative Fighter and Bomber

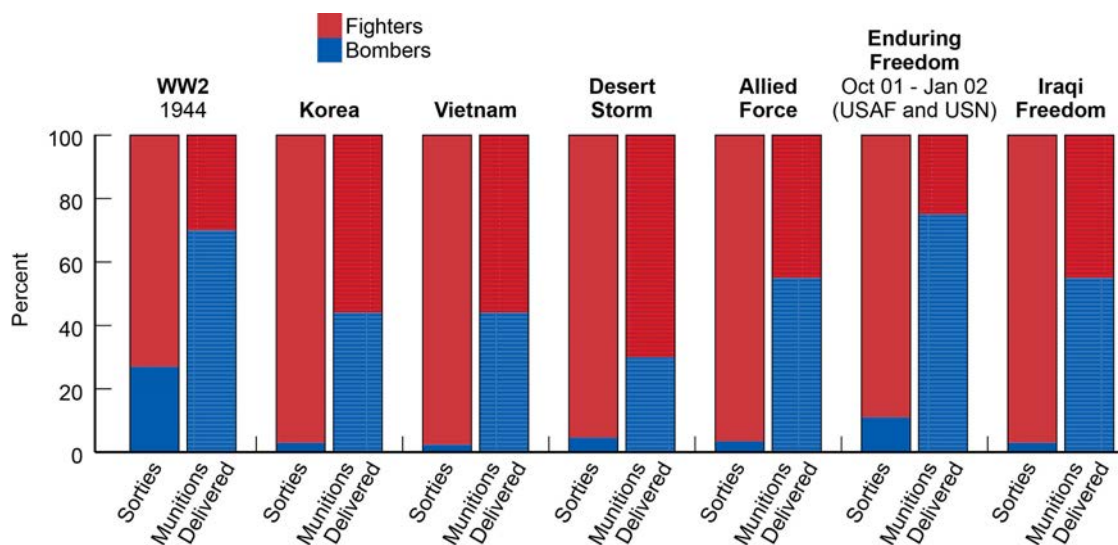


Figure 10: Relative Sorties Flown and Tonnage Delivered by Bombers and Fighters⁶⁶

Before the 1990s, bombers delivered unguided payloads, with the large number of bombs dropped compensating for poor accuracy. Bombers began employing precision guided munitions (PGMs) in the 1990s and contributed significantly to recent precision strike campaigns. For example, in the first eight

⁶⁶ Figures are Air Force-only, except for Operation Enduring Freedom. **World War II:** Office of Statistical Control, *Army Air Forces Statistical Digest (World War II)*, December 1945, pp. 221-227, and pp. 243-248. **Korea:** *United States Air Force Statistical Digest, Fiscal Year 1953* (Washington, DC: HQ USAF, 1953), p. 26. **Vietnam:** "USAF Management Summary," *Southeast Asia Review*, 28 February 1974. **Desert Storm:** *Gulf War Air Power Survey*, Volume V, p. 316, and p. 418. **Allied Force:** HQ USAFE, *Air War Over Serbia (AWOS) Fact Sheet*, Jan. 21, 2000, p. 6. **OEF:** William Arkin, "Old-Timers Prove Invaluable in Afghanistan Air Campaign," *Los Angeles Times*, Feb. 10, 2002. 917th Wing Office of Public Affairs, 93rd Bomb Squadron Fact Sheet, September 2010. **OIF:** Lt Gen T. Michael Moseley, "Operation Iraqi Freedom – By The Numbers," 30 April 2003.

weeks of Operation Allied Force in 1999, the B-2 flew three percent of the sorties but hit 33 percent of the total targets.⁶⁷ In the first six months of Operation Enduring Freedom, B-1B bombers dropped 67 percent of all the 2,000-pound Joint Direct Attack Munitions (JDAMs).⁶⁸ In Operation Iraqi Freedom, the B-1 alone flew one percent of the sorties but dropped 43 percent of the JDAMs and 22 percent of the guided munitions used in the campaign.⁶⁹

In the past, bombers dropping unguided bombs generally attacked a single target per sortie. With PGMs, bombers can attack a large number of targets in a single sortie. For example, over Serbia in 1999, each B-2 struck up to 16 different targets in a single mission. On the opening night of the air campaign against Libya in 2011, three B-2s destroyed 45 separate hardened aircraft shelters with a single PGM each.⁷⁰ A typical airfield contains a large number of potential targets, including runways, taxiways, parking areas, aircraft shelters, hangars, fuel storage, fuel distribution, munitions storage, and operations buildings. It is far more efficient to attack these targets with a small number of bomber sorties rather than a larger number of fighter sorties. Destruction of enemy airfields and aircraft on the ground in this way contributes to achieving air superiority and reduces the burden on friendly fighter aircraft.



Figure 11: Aircraft Shelters at Ghardabiya Airfield, Libya, after a B-2 Strike, March 20, 2011⁷¹

67 Committee on Armed Services, Military Procurement Subcommittee, House of Representatives, "Performance of the B-2 Bomber in the Kosovo Air Campaign" (June 30, 1999). See Gen Richard Hawley's statement on p. 33.

68 US Air Force Fact Sheet, B-1B Lancer, online at: http://www.dyess.af.mil/library/factsheets/factsheet_print.asp?fsID=17905&page=1.

69 Gertler, p. 44.

70 DOD News Briefing with Vice Adm. Bill Gortney from the Pentagon on Libya Operation Odyssey Dawn, March 20, 2011, online at: <http://www.defense.gov/transcripts/transcript.aspx?transcriptid=4787>.

71 Ibid.

PGMs, along with improved Intelligence and communications, have greatly increased bomber versatility. From World War II through Desert Storm, mission planners selected bomber targets long before takeoff. The ability to change targets while en route was limited; in many cases, the only options were to abort the mission or divert to a secondary preplanned target if visibility over the primary target was poor. Starting with Operation Enduring Freedom in 2001, bombers could launch from their distant base without any preplanned targets. Bomber crews received their instructions and updates while in flight. Orbiting over the combat zone, they engaged time-sensitive targets called in by terminal attack controllers on the ground, responding within minutes of the request.⁷² In Operation Iraqi Freedom, B-1 bombers loaded with JDAMs acted as “roving linebackers” that provided on-call fire to destroy enemy forces with ground units acting as ISR sensors. Perhaps the best-known example of this time-sensitive targeting in Iraq was the effort to kill Saddam Hussein. Within 15 minutes of the order to do so, a B-1 dropped four JDAMs on his suspected location. The intelligence was not accurate, but the event illustrated the bomber’s responsiveness.⁷³

Bombers not only can destroy a large number of targets on a single sortie, but can also carry a mix of weapons to attack different types of targets. The Generic Weapons Interface System on the B-2 is a software package that allows the aircraft to carry different mixes of standoff weapons and direct-attack munitions. The B-2 can thus attack with precision weapons on a single mission up to four different types of targets, such as armored vehicles, air defenses, command-and-control bunkers, airfields, and a variety of other individual targets.⁷⁴ Bombers can carry enough weapons to attack “pop-up” air defense threats while en route to the target, and have a significant electronic attack capability. Therefore, they can operate relatively independently in enemy airspace, with a reduced requirement for supporting escorts.

Since World War II, heavy bombers have rarely been used as they were in that conflict, to destroy the enemy’s cities and war industries. Instead, bombers have focused on interdicting enemy logistics and troop movements and on smashing enemy troop formations in contact with American forces. German, North Korean, North Vietnamese, Iraqi, and Serbian troops have experienced the shattering military and psychological effects of American bomber attacks. Since the advent of PGMs, bombers have provided highly efficient and effective close air support. Range, payload, and accuracy make the bomber a persistent source of precision firepower. During operations in Afghanistan and Iraq, the large payload of the bombers employed meant that they could stay on station for long periods with critical weapon loads.

High payload and large internal capacity permit LRSS aircraft to carry the munitions needed to destroy hardened and deeply buried targets. These targets may include command bunkers or facilities for the production or storage of weapons of mass destruction. An F-15E can carry only a single 5,000-pound GBU-28 bunker-buster bomb, but the B-2 can carry eight of them. Only the B-2 is certified to operationally carry the 30,000-pound GBU-57 Massive Ordnance Penetrator that can penetrate 200 feet underground before detonating.

72 Theisen, p. 12.

73 Thomas Withington, *B-1B Lancer Units in Combat* (New York: Osprey, 2006), pp. 69-80.

74 Withington, *B-2A Spirit Units in Combat*, p. 24.

All signs indicate that the Air Force will need to increase its capacity to deliver munitions at long range in future conflicts. This capacity necessarily resides in the bomber force today, as the capacity of fighter aircraft to deliver munitions drops off sharply as ranges increase. If strong enemy air defenses require the use of stealth aircraft, then the present capacity of the Air Force to deliver munitions at long range resides entirely in the B-2 bomber force, having a *maximum* of 16 ready for combat at any given time. This is simply insufficient to fight a modern air campaign, which can be extremely intense and last for many weeks:

Campaign	Duration (Days)	Intensity (Strikes)	Intensity (Strikes Per Day)	Weapons Dropped	Weapons Per Day
Desert Storm	43	53,362	1,241	227,166	5,283
Desert Storm (USAF only)	43	31,947	743	153,645	3,573
Iraqi Freedom	30	20,733	691	29,199	973

Figure 12: Duration and Intensity of Historical Air Campaigns⁷⁵

Let us assume a joint force air component commander needed to conduct a Desert Storm-like air campaign in an anti-access environment against targets more than 1,500 NM from bases. This would require dropping approximately 3,500 bombs per day. For the purposes of this example, assume each aircraft carries 20 bombs. To carry the total required bombs per day would require 175 LRSS aircraft if they were the only aircraft with the capacity to operate in the demanding threat environment, and over the long ranges. If the bombers had a sortie rate of 0.7 per day, then the Air Force would need 250 aircraft to launch 175 sorties per day. Likely, it would require more aircraft because it could not always use a perfectly efficient number of aircraft. An aircraft carrying multiple bombs can still only be in one place at a time. A campaign might require simultaneous attacks on geographically widely separated fixed targets, or distributing the aircraft around the country to permit them to search for mobile threats or respond rapidly to pop-up targets. Additional aircraft would be in maintenance depots and withheld for training, nuclear deterrence, and conventional deterrence of aggression elsewhere. Finally, the bomber fleet would have to be large enough to tolerate some level of attrition from accidents and enemy action. A program of a minimum of 100 aircraft would provide sufficient reserves to permit the commitment of 70 LRSS aircraft to combat in one contingency at the given availability rate. The air component would be unable

75 "Sources: Gulf War Air Power Survey, Volume V (Washington: Government Printing Office, 1993), p. 232, 550, 553-4, 619. (<http://www.afhso.af.mil/shared/media/document/AFD-100927-065.pdf>). Lt Gen T. Michael Moseley, US Central Command Air Forces publication, "Operation Iraqi Freedom By The Numbers," April 30, 2003. (<http://www.afhso.af.mil/shared/media/document/AFD-1306613-025.pdf>)"

to conduct a campaign on the order of a Desert Storm operation at longer distances and in a higher threat environment relying on LRSS alone. Furthermore, our National Military Strategy calls for the need to be able to operate in multiple contingencies simultaneously. These might not necessarily be at the same intensity as depicted in the example above. Nonetheless, when one considers the additional demands of maintaining the presence around the world during peacetime, then one must also consider the numbers to assure a sufficient rotational base to sustain that requirement. This example illustrated the demands of conducting a major regional contingency at a long distance and against advanced threats. A forthcoming Mitchell Institute monograph will address the issue of the appropriate numbers of LRSS aircraft to meet the needs of the current National Security Strategy.

In summary, a large payload is needed:

- To provide a deep magazine for persistence at long range in an A2/AD environment;
- To increase the capacity of the Air Force to deliver a mix of munitions (including heavy munitions) at long range, especially in the A2/AD environment;
- To fight at long range with a cost-effective number of aircraft; and
- To permit the destruction of hardened and deeply buried targets.

High Survivability

Survivability is the product of an aircraft's signature (to radars and other sensors), tactics (such as penetration routes and deception), and electronic countermeasures. The Air Force has determined that stealth is a critical element in survivability. The purpose of stealth (or "low-observable") technology is to increase an aircraft's survivability by reducing the enemy's ability to detect, track, and attack it. Stealth is the combination of aircraft shape, design features—such as hidden engine inlets and exhausts—and the use of special radar-absorbent materials and techniques. Stealth seeks to reduce not just the radar cross section of the aircraft, but also the aircraft's signature in the infrared, acoustic, and visual spectrums. Stealth decreases the need for large packages of support aircraft and enables the aircraft to operate relatively autonomously in highly defended airspace. Stealth, used in combination with intelligent tactics and electronic countermeasures, increases an aircraft's survivability and offensive potential. Stealth is not a stand-alone "solution," but rather one element of a variety of tactics and technologies that increases air vehicle survivability.⁷⁶

Air defenses must perform several functions effectively to destroy enemy aircraft. In the surveillance stage, low-frequency radars search the surrounding airspace to detect and classify aircraft. If an enemy intruder is detected, then high-frequency fire control radars guide a weapon to the vicinity of the target. Then the

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Rebecca Grant, *The Radar Game* (Arlington, VA: IRIS Research, 1998) is a good overview of stealth.

weapon's seeker acquires the target, and the weapon homes in. When the weapon's fuse detects the target, the weapon explodes. If the progression through this "kill chain" is broken at any point, the target survives. Stealth reduces the effectiveness of all these air defense functions:

- Search radars have great difficulty detecting stealthy intruders and determining their position, direction, speed, and altitude.
- Fire control radars have great difficulty tracking stealthy aircraft.
- Locking onto stealthy aircraft and achieving a kill is extremely challenging for radar guided missile seekers and fuses.⁷⁷

To improve survivability, stealth is used in conjunction with other methods, including route planning, terrain masking, chaff, decoys, electronic warfare, and attacks on enemy radars and missile launchers. Stealth does not confer invisibility or invincibility. Many countries are investigating counters to it, but no convincing, operationally useful counter-stealth approaches have emerged. Even if the ability to detect and track stealth aircraft increases, they would remain orders of magnitude less detectable than nonstealthy aircraft. For this reason, nonstealthy aircraft will always suffer vastly higher attrition rates than stealthy aircraft and have far greater difficulty carrying out their missions when confronted with modern air defenses.

The justification for the original development of stealth aircraft in the 1970s and 1980s was the Soviet air defense system. This consisted of a dense network of radars, SAMs, and airborne interceptors. Advanced air defense systems still exist and have been modernized since the end of the Cold War. Moreover, they are increasingly available worldwide, especially in Asia:

- The Russian S-300 series, known to NATO as the SA-10, SA-12, and SA-20, comprises advanced surface-to-air missile systems. They can detect targets at very long range and all altitudes and engage multiple targets with high-speed missiles up to several hundred kilometers from the launcher. Their components—the missile launcher, radar, and command vehicles—are mobile and thus more difficult to attack than fixed air defense systems. Both Russia and China operate large numbers of these types of systems.⁷⁸
- "Goalkeeper" mobile air defense systems like the SA-15, SA-19, and SA-22 are designed to counter American precision guided munitions with high-velocity missiles and automatic cannons. They are often used to provide point defense for the larger S-300 systems and other high-value targets. They can frustrate US attacks and drive up their cost. Over time, these systems will render nonstealthy, subsonic PGMs like cruise missiles increasingly less relevant. Russia and China use the most modern versions of these systems, but older types are widely employed in the Middle East and Africa.⁷⁹

77 Ibid., 34-36.

78 See at the Air Power Australia website: SA-10/20: <http://www.ausairpower.net/APA-Grumble-Gargoyle.html>; SA-12: <http://www.ausairpower.net/APA-Giant-Gladiator.html>; and SA-2: <http://www.ausairpower.net/APA-S-400-Triumf.html>.

79 See the Air Power Australia website: SA-15: <http://www.ausairpower.net/APA-9K331-Tor.html>; and SA-19/22: <http://www.ausairpower.net/APA->

- Fourth generation fighters like the Su-27, Su-30, and J-10 are able to carry numerous air-to-air missiles and PGMs externally. Their radars have seen significant improvements since the end of the Cold War. Their unrefueled combat radius and long-range missiles enable them to contest airspace more than a thousand miles from their bases. Russia, China, and other Asian countries operate hundreds of these aircraft.⁸⁰
- Fifth generation fighters like the PAK-FA, J-20, and J-31 are intended to match the F-22 and F-35. They incorporate stealth, supercruise, and thrust-vectoring technologies. They are presently only in the development and testing stage, but operational deployment in the 2020s will put all nonstealthy aircraft and surface assets at risk. Russia has agreed to permit India to produce a licensed version of the PAK-FA. It may then become available to other nations.⁸¹
- Advanced, long-range air-to-air missiles like the AA-10, AA-12, and PL-12 are comparable to the American AIM-120 AMRAAM. They are widely employed in Asia. Russia has also developed a series of long-range air-to-air missiles designed to kill American tanker and AWACS aircraft.⁸²

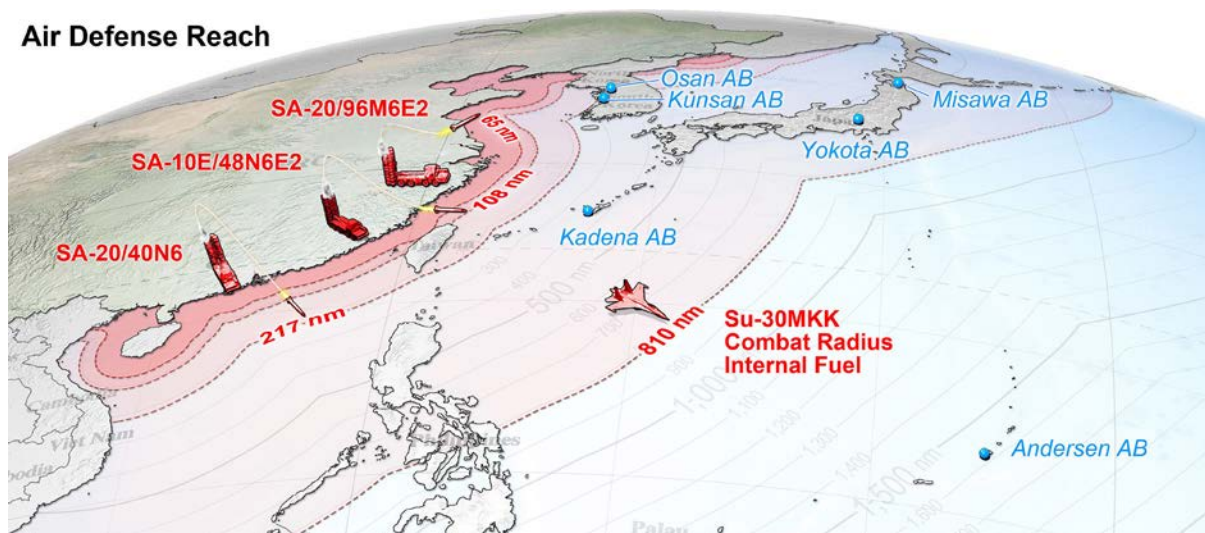


Figure 13: Fighter and Surface-to-Air Missile System Ranges in Asia

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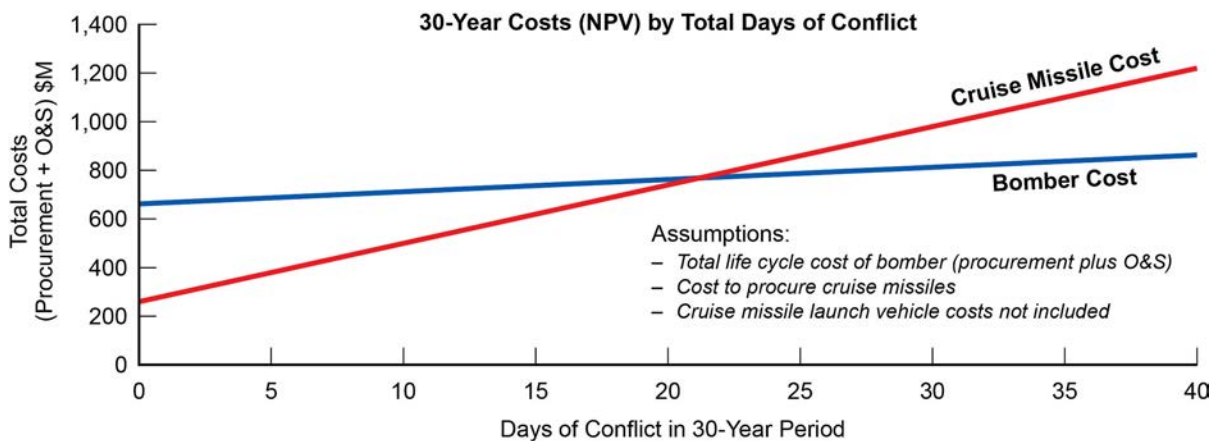
80 Good overviews are Yefim Gordon, *Flankers: The New Generation* (Hinckley, UK: Midland Publishing, 2002), *Sukhoi Su-27* (Hinckley, UK: Midland Publishing, 2007), and *Chinese Airpower* (Hinckley, UK: Midland Publishing, 2010).

81 Carlo Kopp, "Assessing the Sukoi PAK-FA," Feb. 15, 2010, online at: <http://www.ausairpower.net/APA-2010-01.html>, and Bill Sweetman, "J-20 Stealth Fighter Design Balances Speed and Agility," *Aviation Week*, Nov. 10, 2014. Recently, Russia announced cuts in the PAK-FA program for economic reasons. Reuben F. Johnson, "Moscow Slows PAK-FA Production Plans due to Economic Slump," *Jane's Defense Industry*, March 29, 2015.

82 See Kopp, "The Russian Philosophy of Beyond Visual Range Combat."

As a practical matter, advanced SAMs can deny nonstealthy aircraft access to airspace. A nonstealthy bomber can drop bombs in permissive environments, but against capable adversaries can only function as a cruise missile launcher. Cruise missiles are useful weapons, but reliance on them is cost-effective only for short air operations (i.e., punitive raids that last no more than a few days). As the cost of a single cruise missile is nearly 50 times the cost of a precision guided bomb, this is not surprising. Additionally, cruise missiles can only attack preplanned targets unless they can receive inflight-targeting updates. These updates would require off-board sensors on a penetrating platform such as a stealth LRSS.

RAND Corp. developed the cost-effectiveness analysis in the chart that follows.⁸³ The vertical axis is total cost in millions of dollars; the horizontal axis is days of conflict in a 30-year period. The blue line is the cost to procure a penetrating bomber, operate it for 30 years, and buy sufficient weapons to support one sortie per day in conflict. The red line represents the most optimistic case for the cruise missile: the cost of 12 cruise missiles fired per day, but not the procurement or operating cost of the launch platform (ship, submarine, or aircraft). The chart illustrates that within just 22 days of combat, the penetrating bomber is less costly than the cruise missile option. Protracted air campaigns, which the United States has repeatedly conducted over the past 70 years, require reusable platforms that can deliver inexpensive ordnance. Stealth bombers are cost-effective relative to cruise missiles for protracted campaigns.



Source: Thomas Hamilton, *Comparing the Cost of Penetrating Bombers to Expendable Missiles Over Thirty Years* (RAND Corporation), WR-778-AF, 2010

Figure 14: Affordability of Bombers Versus Cruise Missiles

83 Thomas Hamilton, "Comparing the Cost of Penetrating Bombers to Expendable Missiles Over 30 Years," RAND, August 2010, online at: http://www.rand.org/content/dam/rand/pubs/working_papers/2011/RAND_WR778.pdf. See also: http://www.rand.org/content/dam/rand/pubs/technical_reports/2012/RAND_TR1230.pdf.

Stealth LRSS aircraft are key enablers for other American aircraft. They penetrate enemy air defenses in the early stages of the conflict and degrade these defenses to permit nonstealthy aircraft to operate. For precisely this reason, B-2 bombers were employed on the first night of the last four major US air campaigns: Operation Allied Force in 1999, Operation Enduring Freedom in 2001, Operation Iraqi Freedom in 2003, and Operation Odyssey Dawn in 2011. During Allied Force, the air war over Serbia, six B-2s conducted 45 sorties (out of 9,211 Air Force fighter and bomber sorties in the entire war), but dropped a third of all the precision weapons used in the conflict. The opening night of Operation Enduring Freedom was notable for the record-breaking 44-hour B-2 mission launched against Afghanistan directly from Whiteman Air Force Base in Missouri. In the opening phases of Iraqi Freedom, B-2s struck air defense sites and hardened communications nodes. Over Libya in 2011, the B-2 dropped 45 2,000-pound GPS guided munitions that destroyed 45 hardened aircraft shelters, essentially eliminating the Libyan fighter force. All these opening strikes facilitated the subsequent operations of nonstealthy aircraft. However, that is history. As technology evolves and proliferates, modern potential adversaries may acquire and grow inventories of A2/AD capabilities, such as advanced “double-digit” surface-to-air missiles, and sophisticated electronic warfare capabilities. When this occurs, the notion of “kicking down the door” to enable follow-on non-stealth forces to freely engage is no longer a viable option. Stealth is now a prerequisite for effectively operating in contested airspace.

Nonstealthy aircraft require extensive support to penetrate defended enemy airspace. Typically, some escorts are dedicated to defense against enemy fighters, while others employ chaff, electronic warfare, and anti-radiation missiles against enemy missile launchers and radars. Over North Vietnam in 1972, a typical Air Force strike package consisted of 48 support aircraft and only 12 strike aircraft.⁸⁴ Moreover, each aircraft in the package required tanker support before entering enemy airspace and after leaving it. The suppression of enemy air defenses again required major efforts during Desert Storm in 1991. Nonstealthy aircraft typically flew in strike packages of 24 to 36 aircraft, generally with four escorts per dedicated strike aircraft.⁸⁵ Meanwhile, the stealthy F-117 flew unescorted. On the first day of the war, F-117s flew 45 sorties against 76 targets. Meanwhile, nonstealthy aircraft flew 1,096 sorties against 109 targets.⁸⁶ Thus, in this case, each stealth sortie was worth 17 non-stealth sorties on a sortie per target basis. The offensive as well as the defensive value of stealth was clear.

84 Marshal L. Michel, *Clashes* (Annapolis, MD: Naval Institute Press, 1997), p. 219.

85 Keaney and Cohen, p. 168.

86 Brig Gen David A. Deptula, “Effects-Based Operations” (Arlington, VA: Aerospace Education Foundation, 2001), p. 18.



The Value of Stealth

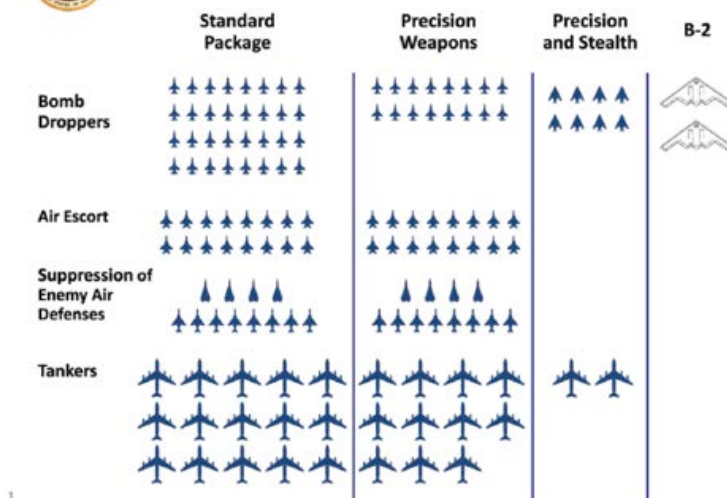


Figure 15: The Value of Stealth

The Air Force released the chart above in 1991 to illustrate the value of stealth.⁸⁷

- The standard package on the left was flown against 16 aimpoints on an Iraqi airfield on the opening day of Desert Storm. Two F-16s delivering unguided weapons were targeted against each aimpoint.
- As illustrated by the precision weapons column, if the F-16s had been armed with precision weapons, a single aircraft could have been targeted against each aimpoint. However, the F-16s still required fighter escort and defense suppression, while the whole package needed refueling support.
- F-117s combined stealth and precision weapons. However, their limited payload required planners to allocate eight aircraft, while their limited range required refueling support.
- In 1991, plans were to fit the B-2 with eight precision weapons; thus two aircraft were needed to strike all 16 aimpoints. However, it should be noted that the advent of GPS-guided, all-weather weapons has dramatically increased the precision payload of the B-2 (and future bombers). Currently, each B-2 can carry up to 80 independently targeted 500-pound weapons. Accordingly, the same job could be done in theory by “one-fifth” of a B-2.

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Online at: http://www.dod.mil/pubs/foi/Science_and_Technology/Other/263.pdf

A nonstealthy force must be much larger than a stealthy force not only due to the greater requirement for escorts and support, but also due to the effects of attrition. As nonstealthy aircraft suffer greater losses than stealthy aircraft, larger numbers of nonstealthy aircraft than stealthy aircraft must be procured and employed to maintain the same level of combat power over time. The fact that the United States has not suffered significant losses since losing more than 3,000 fixed wing aircraft in Vietnam has obscured the effects of such attrition. Against a capable opponent, we would experience far higher losses than have been the case for the past 40 years.

When combined with range, stealth permits the attacker to hold the full extent of the enemy's territory at risk from multiple potential avenues of approach. This is clearly preferable to attempting to roll back the enemy defenses from the periphery and from a single predictable direction. American stealth bombers force the enemy to defend in depth, and from all directions, rather than focusing its defensive efforts on a single avenue of approach. Stealth thus imposes significant costs on the enemy and forces it to invest in defensive rather than offensive systems.

Overall, stealth enables LRSS to enter heavily defended airspace and attack the enemy's most highly valued targets without suffering prohibitive losses. Stealth LRSS are more affordable than cruise missile launchers for protracted air campaigns. Stealth greatly reduces the requirement for supporting aircraft and tankers. Stealth aircraft facilitate the operations of other aircraft by destroying enemy air defenses so that friendly, nonstealthy aircraft can operate when that kind of environment allows it. In more demanding A2/AD environments, stealth throughout a campaign is an absolute requirement to assure reasonable survivability. Stealthy aircraft, especially stealthy LRSS airplanes, place a far greater burden on the enemy defense than nonstealthy aircraft.

Versatility to Adapt

When a single platform can blur the notions of roles and airpower categories and incorporate new technologies that regain and reestablish aerial pre-eminence, then something important has occurred. In the history of airpower, there are many examples of aircraft whose design enabled new capabilities, but there are far fewer genuine game-changing aircraft. In reality, most “new” aircraft are incremental improvements over what came before, but they always seem to fall prey to factors like design trade-offs of cost, configuration, performance, payload, and outer mold-line. It is not that the LRSS somehow makes those trade-off equations null and void; rather, the platform has the potential to redefine the interplay of trade-offs when best-of-breed technology, theory, and versatility to adapt to new technologies are merged within its design and performance.

We must put a high value on the design characteristic of adaptability to developments such as new threats; technological advances in directed energy, cyber warfare, electronic warfare, and kinetic weapons; and accommodation of expanding computer processing power and the new sensor and shooter capabilities associated with that expansion. By placing a high value on adaptability, the LRSS can alter the strategic competition to America’s advantage if we regard the aircraft as a venue to adapt and incorporate new technologies in novel ways. In this manner, seeing the LRSS as “just an airplane” overlooks all of its attributes that, while not externally visible, present potential adversaries and competitors with vexing challenges to overcome. One platform in any domain cannot rewrite the dynamics of strategic competition, but if designed and exploited with the idea of adaptability as a core attribute, the LRSS is not simply just another aircraft like those we have fielded in the past.

The LRSS distinguishes itself from aircraft in the global marketplace by doing what other nations cannot do but would certainly like to do. It will not only move the goal posts of performance, but also add another new level to the airpower contribution to national security. The air domain is increasingly crowded with imitations and new executions of old ideas, but truly novel aircraft are hard to identify and even more difficult to imagine. A case in point is the first combat use of the F-22. While many believed its sole role was as a traditional air-to-air “fighter,” its great value is as a sensor-shooter “quarterback” that enhances the situational awareness of the entire armada of air forces engaged. It amplifies the capability of all the other aircraft by sensing and then sharing the information it collects, while retaining the capability to engage with air-to-air and air-to-surface lethal force. Imagine the additive potential of an LRSS with 10 times the payload capacity and four to eight times the unrefueled range of an F-22.

In the second century of airpower, we must untether airpower from the confining categories of “B” for bomber, “A” for attack, “F” for fighter, “MQ” for multirole platform, or any other label a doctrinaire designer or short-sighted leader would apply. Constrained thinking and restrictive classification schemes are antithetical to innovation.

The Contribution of Stealth LRSS to Crisis Stability and Crisis Management

Serious confrontations between powerful states—international crises—have occurred many times throughout history.⁸⁸ Cold War events such as the 1962 Cuban Missile Crisis are familiar to many, but crises often occurred before World War II and after the Cold War. Sometimes they resulted in war, and other times states defused tensions short of war. The goal of crisis management is to persuade an opponent to desist from an undesirable course of action, without resorting to overt force and without sacrificing important American national interests. Crisis stability is said to exist when none of the actors involved in a crisis believes that war is inevitable or that initiating hostilities confers a significant military advantage. Crisis instability results when an actor with aggressive intentions perceives a window of opportunity to attack, or when actors who wish to avoid war conclude that war is unavoidable and that striking first is preferable to waiting. During crises, even genuinely defensive military preparations can suggest aggressive intent to the other actors, potentially leading them to conclude that war is inevitable and that their opponent is about to strike.

Military power is an essential tool for crisis management. American leaders for the past 70 years regarded combat aircraft as their most useful instruments for deterrence, coercion, and crisis management. Aircraft are, by their very nature, flexible, responsive, useful for political signaling and able to generate a variety of effects in numerous different scenarios.⁸⁹ Bombers, in particular, have proved particularly useful for crisis management. They played critical roles in the 1948 Berlin Crisis, Cuban Missile Crisis, US-Soviet confrontation at the end of the 1973 Yom Kippur War, post-Cold War North Korean nuclear crises, and many others.⁹⁰

Military forces can promote crisis stability or instability, depending on their inherent attributes and how states use them during a crisis. Conventional forces must be powerful enough to persuade a potential aggressor that escalation to war involves a high risk of outright defeat or a prolonged war of attrition. Friendly forces must not be excessively vulnerable to surprise attack; this encourages the enemy to contemplate a pre-emptive attack. At the same time, friendly forces should not present a significant, immediate threat of surprise attack; this also creates an incentive for the enemy to launch a preemptive strike.⁹¹ The United States no longer has a single, relatively familiar opponent as during the Cold War. Therefore, American forces must be flexible enough to respond to crises involving unpredictable opponents and scenarios. As crises erupt suddenly in distant regions, American forces must be capable of rapid employment. To support diplomacy during a crisis, American forces must be capable of signaling the capability to prevail militarily and resolve or restraint as the situation dictates.

88 Forrest Morgan, *Crisis Stability and Long-Range Strike: A Comparative Analysis of Fighters, Bombers, and Missiles* (Santa Monica, CA: RAND, 2013).

89 *Ibid.*, pp. 54-55.

90 *Ibid.*, pp. 128-139.

91 *Ibid.*, pp. 27-34.

Too much reliance on short-range, forward-based forces is a potential source of crisis instability. In confrontations with opponents capable of striking regional land, sea, and air bases with ballistic and cruise missiles, these bases present a vulnerability of surprise attack and strongly tempt the opponent to launch a pre-emptive strike against them.⁹² Operating fighter aircraft from distant land bases and from sea bases outside the region may mitigate the threat of preemptive attack, but significantly reduces their combat effectiveness due to the reduction in payload and sortie rates. Thus, their deterrent or coercive power is reduced in this posture.⁹³

Nonstealthy bombers armed with cruise missiles also do not promote crisis stability. They can be based out of range of enemy surprise attack. However, they may cause an opponent to fear an American surprise attack, especially if they begin patrolling outside enemy airspace when a large number of American fighter aircraft are deployed nearby. (Many US air campaigns have commenced with massed cruise missile attacks that degrade enemy air defenses, allowing nonstealthy fighter aircraft to operate.)⁹⁴ Cruise missiles are too expensive to acquire in large enough numbers to fight an entire campaign using only them. As a point of reference, a nominal major regional campaign involves on the order of 40,000 to 50,000 aimpoints. Cruise missiles also have operational drawbacks such as their limited capability against mobile targets. Therefore, they do not by themselves have a large stabilizing deterrent effect, because they cannot credibly threaten to inflict military defeat on a major adversary.

LRSS aircraft contribute very effectively to crisis stability and are ideal tools for crisis management:

- They operate from distant bases that are essentially secure from surprise attack.
- They can strike from well outside enemy airspace, reducing the enemy's fear of surprise attack. Alternatively, they can stage to regional bases outside the enemy threat envelope if the United States wishes to increase the apparent threat to the enemy.
- They are useful in a range of scenarios from a punitive raid to sustained conventional warfare to nuclear warfare.
- They can be deployed rapidly to regional bases, or employed directly from the United States.
- They can be redirected or withdrawn while en route to the target if required.
- They can penetrate deep into enemy airspace, operate persistently, and deliver high volumes of precision ordnance against a broad spectrum of targets, credibly threatening military defeat or severe punishment on the enemy.

92 *Ibid.*, pp. 38-40.

93 *Ibid.*, pp. 42-43.

94 *Ibid.*, pp. 40-42.

LRSS and Nuclear Deterrence

We have focused so far on the conventional contributions that the stealth bomber provides due to its long range, heavy payload, and high survivability. At the same time, these attributes make the LRSS a highly effective instrument for political purposes: namely, for maintaining nuclear deterrence and for conducting either conventional or nuclear crisis management.

During the Cold War, the United States developed the so-called triad of bombers, ICBMs, and SLBMs to deter the Soviet Union. Every American bomber in service today—the B-1, B-2, and B-52—was designed for this purpose. Like the other legs of the triad, the bomber force is aging and needs replacement. Although the Cold War nuclear arms race is over, there is a clear need to modernize the triad, and especially the bomber force with the LRSS, to ensure that America’s deterrent remains safe, secure, and effective in the new security environment.

The 2010 Nuclear Posture Review Report stated that the United States should retain the triad in order to maintain strategic stability while hedging against potential technical problems or vulnerabilities.⁹⁵ Each leg of the triad complements the others and complicates the problems of the enemy. The report noted the advantages of bombers:

“Nuclear-capable bombers are important to extended deterrence of potential attacks on US allies and partners. Unlike ICBMs and SLBMs, heavy bombers can be visibly forward deployed, thereby signaling US resolve and commitment in crisis.”⁹⁶

The report observed that heavy bombers are strategically stabilizing, because they “do not pose a first-strike threat to either side” and “on a day-to-day basis, few or no bombers are loaded with nuclear weapons” and maintained on alert.⁹⁷

Russia and China are modernizing their nuclear arsenals. Russia has developed and deployed new ICBMs and SLBMs since the end of the Cold War and intends to replace all of its Soviet-era ICBMs and SLBMs within the next decade.⁹⁸ Russian President Vladimir Putin has announced that a new strategic bomber will enter service in the 2020s.⁹⁹ Russia has also deployed the SS-26, a new, highly accurate, nuclear-capable short-range ballistic missile system. From forward positions on Russian soil, this missile can reach deep into NATO territory.¹⁰⁰ In recent years, Russia has employed its nuclear-capable forces to send political signals. Russian bombers have been particularly active in this respect, participating in large-scale exercises, simulated attacks on foreign targets, incursions into foreign air defense identification zones, and overflights

95 2010 NPR is online at: <http://www.defense.gov/npr/docs/2010%20Nuclear%20Posture%20Review%20Report.pdf>.

96 *Ibid.*, p. 24.

97 *Ibid.*, p. 21.

98 National Air and Space Intelligence Center, “Ballistic and Cruise Missile Threat” (Wright-Patterson AFB, OH 2013), p. 18 and p. 22.

99 “Russia to develop new strategic bomber by 2017,” Sputnik News, Dec. 23, 2009.

100 “Russia Confirms Tactical Missile Deployment on NATO Borders,” Sputnik News, Dec. 16, 2013.

of foreign warships.¹⁰¹ China is modernizing and increasing the size of its ICBM force. The new DF-41 ICBM is a mobile, solid-fueled missile that can carry up to 10 warheads. China is deploying the new Jin-class ballistic missile submarine with the JL-2 SLBM to create a credible sea-based deterrent. The upgraded Chinese bomber fleet can carry long-range, nuclear-capable cruise missiles.¹⁰²

After the end of the Cold War, Pakistan and North Korea tested nuclear weapons. Other countries such as Iran aspire to possess nuclear capability, and non-state actors remain the subject of serious proliferation concern. The calculus of deterrence and defense in the “second nuclear age” is thus likely to be very different from during the Cold War, when the United States faced a single, relatively predictable, technologically sophisticated adversary.¹⁰³ Today, America must deter not only two modern nuclear powers, but also a number of “lesser” nuclear states. These states may not be able to ensure the security and reliability of their arsenals, may have weak command and control systems, and may have questionable or unknown doctrines for nuclear use. Worse yet, a terrorist group may acquire a nuclear weapon or nuclear materials from a patron state, either through deliberate transfer, theft, or purchase. Rogue states or non-state actors may not hesitate to employ nuclear weapons, and in such cases, American nuclear strikes to retaliate or eliminate the threat may be necessary.

The United States thus faces a spectrum of scenarios and potential opponents, including peer competitors with large, capable arsenals, lesser states with smaller arsenals, rogue states or aspirants with nascent nuclear capabilities, and non-state actors. In all these scenarios, American nuclear forces must deter and preserve nuclear stability. They must also be useful for crisis management and, if necessary, employment.

The case for preserving the traditional triad is strongest in scenarios involving Russia or China. Stealthy LRSS aircraft are a highly stabilizing system, because they provide neither side any incentive to strike first during a crisis. Their ability to generate rapidly and disperse on warning makes them unattractive targets for an enemy surprise attack. Their slow speed relative to ballistic missiles means they do not threaten the opponent with a disarming American nuclear attack. Due to their high survivability, they present a potent threat of retaliation in the event America is attacked. Unlike ballistic missiles, LRSS aircraft can be recalled after launch. They are better suited than ICBMs or SLBMs for sending signals of national resolve, as was repeatedly demonstrated during Cold War crises. They can deploy forward or fly airborne alerts if necessary to coerce the adversary into de-escalating during a crisis. The production of a new stealthy LRSS to recapitalize our aging bomber force hedges against further expansion and modernization of the Russian or Chinese nuclear arsenals, and against the possibility of a technological breakthrough that threatens the other legs of the triad.

For scenarios involving lesser nuclear powers or non-state actors, deterrence must rest on a credible threat of actual use. The threat of employment of ballistic missiles against such powers is much less credible than

101 “Russian Bombers Continue Probing US Defenses,” *Forbes*, Sept. 16, 2014.

102 NASIC, “Ballistic and Cruise Missile Threat,” pp. 18-19 and pp. 22-23.

103 Keith Payne, *Deterrence in the Second Nuclear Age* (Lexington, KY: University Press of Kentucky, 1996). Paul Bracken, *The Second Nuclear Age* (New York: St. Martin’s, 2013).

the threat of LRSS employment. ICBMs launched from North America against such powers would have to overfly Russia. Permission for this could easily be refused, or take too long to arrive, thus negating the military purpose of the attack. The launch of an ICBM or SLBM risks inadvertently precipitating a nuclear crisis with other nuclear powers that may misinterpret American intent. Ballistic missiles are not well-suited to attacks on mobile targets, due to time-of-flight issues, and of course, they cannot be recalled once launched.

Stealthy LRSS aircraft have none of the drawbacks of ballistic missiles. Their use against lesser nuclear powers or non-state actors does not require permission from, or risk confrontation with, other nuclear powers. Such bombers are highly capable of finding and attacking mobile targets because they can persist in defended airspace with a combined package of sensors and weapons. Their crews can check the validity of the target in the immediate moments before weapons delivery and can adjust the aimpoint if necessary based on data acquired from on-board sensors. The crews can conduct a battle damage assessment and then an immediate follow-on attack, if required. LRSS airplanes can effectively attack hardened and deeply buried targets like command centers, nuclear production facilities, and nuclear storage sites. Finally, LRSS aircraft can be recalled at any moment, and their weapons remain under strict human control until the moment of release near the target. This preserves the option to de-escalate for the longest possible time. Stealthy LRSS airplanes thus represent a highly credible deterrent against lesser nuclear powers. If such powers employed weapons of mass destruction against American forces or allies, and the United States had to retaliate in kind and eliminate the threat, the stealthy LRSS would be the delivery system of choice.¹⁰⁴

Production of the LRSS aircraft is essential to preserve the continued viability of America's nuclear deterrent in the post-Cold War era. They are highly survivable, reliable, responsive, and credible delivery systems. They are the system that best lends itself to political signaling during a crisis. They can deter adversaries of all sizes and technological sophistication. They are usable in every scenario across the spectrum of conflict. In the event that the United States needs to employ nuclear weapons against a rogue state or non-state actor, stealthy LRSS aircraft are the best system to do so.

Conclusion

The new long-range sensor-shooter is essential to the successful implementation of the new strategy and operational concepts devised to enable the US military to project power in the face of A2/AD challenges. LRSS is the foundation of a credible and effective capability to hold any target on the planet at risk and, if necessary, to destroy targets promptly, even from bases in the continental United States. This global strike capability is indispensable for deterrence and crisis management and is a fundamental underpinning of US military power. It is also a discriminator of the United States as the world's sole superpower. The new LRSS is a highly flexible weapon system whose long range, large payload, sensor potential, and high survivability make it useful across the conflict spectrum.



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