LONG-RANGE STRIKE: IMPERATIVES, URGENCY AND OPTIONS

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Thinking Smarter About Defense

Center for Strategic and Budgetary Assessments

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by

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April 2005

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This report is one in a series of CSBA analyses on future U.S. military strategy, force structure, operations, and budgets. These assessments are integrally linked to CSBA's research on the emerging military revolution. Previous reports in this series include *The Military-Technical Revolution: A Preliminary Assessment* (2002), *Meeting the Anti-Access and Area-Denial Challenge* (2003), *The Revolution in War* (2004), and *Winning the Race: A Naval Architecture for Enduring Maritime Supremacy* (forthcoming, 2005).

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CONTENTS

Glossary

AAA	Anti-aircraft artillery
AB	Air base
ACC	Air Combat Command
AEF	Air and Space Expeditionary Force
AESA	Active electronically scanned array
AFB	Air Force Base
AMRAAM	Advanced medium-range air-to-air missile
AT&L	Acquisition, Technology and Logistics
ATO	Air tasking order
AWACS	Airborne Warning and Control System
BAA	Broad agency announcement
C^2	Command and control
CALCM	Convention Air Launched Cruise Missile
CAV	Common Aero Vehicle
CAS	Close air support
CBO	Combined Bomber Offensive
CEP	Circular error probable
CIA	Central Intelligence Agency
CMUP	Conventional Mission Upgrade Program
CONUS	Continental United States
CoRM	Commission on Roles and Missions
CSBA	Center for Strategic and Budgetary Assessments
DARPA	Defense Advanced Projects Research Agency
DoAF	Department of the Air Force

DoD	Department of Defense
DSB	Defense Science Board
FALCON	Force Application and Launch from CONUS
FOFA	Follow-On Forces Attack
FY	Fiscal year
GBU	Guided bomb unit
GMTI	Ground moving target indicator
GPS	Global Positioning System
HCV	Hypersonic cruise vehicle
HDBT	Hard and deeply buried target
ICBM	Intercontinental ballistic missile
ID	Infantry division
IED	Improvised explosive device
INS	inertial navigation system
IOC	Initial operational capability
IR	Infrared
JASSM	Joint Air-to-Surface Standoff Missile
JDAM	Joint Direct Attack Munition
JSTARS	Joint Surveillance Target Attack Radar System
JORN	Jindalee Operational Radar Network
JSF	Joint Strike Fighter
J-UCAS	Joint Unmanned Combat Attack Systems
LGB	Laser-guided bomb
LRAP	Long-Range Air Power
LRRDPP	Long Term Research and Development Planning Program
LRS	Long-range strike
LRSA	Long-range strike aircraft
NATO	North Atlantic Treaty Organization
NASA	National Aeronautics and Space Administration
ODS	Operation Desert Storm
OEF	Operation Enduring Freedom
OIF	Operation Iraqi Freedom
OSD	Office of the Secretary of Defense
PGM	Precision-guided munition
PLA	People's Liberation Army
PRC	People's of China
QDR	Quadrennial Defense Review
RCS	Radar cross section
RDT&E	Research, development, testing and evaluation

RFI	Request for information
SAC	Strategic Air Command
SAM	Surface-to-air missile
SAR	Synthetic aperture radar (also Selected Acquisition Report)
SBR	Space-based radar
SDB	Small diameter bomb
SLBM	Submarine-launched ballistic missile
SLV	Small launch vehicle
SOF	Special operations forces
SSBN	Ballistic missile submarine, nuclear
SSGN	Guided-missile submarine, nuclear
TEL	Transporter erector launcher
TLAM	Tomahawk Land Attack Cruise Missile
TST	Time-sensitive target
USAF	US Air Force
USSR	Union of Soviet Socialist Republics
VLS	Vertical launch system
WP	Warsaw Pact

Executive Summary

This report has two main thrusts: first, to articulate the prospective role of long-range strike (LRS) in future US military strategy; and, second, to explore American LRS needs in the mid- to long-term. With regard to the first aim, the report argues that long-range strike is a core area of US strategic advantage in the current era. The growing ability of accurate, non-nuclear (or "conventional") munitions to achieve military effects comparable to nuclear weapons, *without* the collateral damage of nuclear employment, means that conventional LRS can be used for more than deterrence, which was the overriding goal of American and Soviet long-range, offensive forces during the Cold War.

Currently, however, American LRS capabilities are largely in the hands of a single military service, the US Air Force, and the evidence argues that the institutional Air Force is neither taking—nor planning to take—the near-term steps to ensure that the United States will have the long-range strike capabilities the country will need in the mid- to long-term. Hence, the principal implication of this report is that decisions and actions to move ahead in LRS—to maintain a position of substantial American military advantage—should be undertaken sooner rather than later, meaning within the next 5-10 years.

The heart of the argument for this conclusion lies in the strategic opportunities likely to be foregone, and challenges unmet, if greater priority and urgency are not accorded to LRS. The most important opportunity likely to be foregone is failing to maintain America's early lead in precision strike by building a robust capability to hold enemy targets at risk with accurate, conventional munitions at global distances. A crucial challenge likely to be unmet is neglecting to hedge against the rise of Asian powers and the spread of nuclear weapons. Other lost opportunities and unmet challenges include: reducing American reliance on nuclear weapons, denying prospective enemies sanctuaries, shaping their investments by forcing them to spend more on defending against American LRS capabilities, and closing capability gaps—preeminently the ability to prosecute emergent and time-sensitive targets deep inside defended airspace. These issues provide the strategic rationale for moving ahead promptly in LRS and are the focus of the second chapter of this report.

To be as clear as possible, the conclusion that it is urgent to begin developing a future LRS system in the near-term should not be construed as a call to neglect or jettison short-range strike. The issue is one of regaining more balance between long-range and short-range strike rather than betting everything—or nearly everything—on one or the other. The spending imbalance discussed at the end of the first chapter documents just how heavily Defense Department investments in precision strike are weighted in favor of short-range.

If the need to begin moving forward in the near-term to develop future long-range strike capabilities is truly urgent and compelling, then what sorts of new systems or platforms should the Defense Department consider? The LRS options that the Air Force has considered in recent years cover a bewildering range of prospective solutions. At the more familiar end of the spectrum are improved versions of the B-1B and B-2A, an "arsenal" plane based on equipping a commercial transport such as a 747 with large numbers of missiles that would be employed from a standoff position outside the reach of enemy air defenses, a strike variant of the F/A-22, and long-range unmanned aerial vehicles able to deliver air-to-ground munitions. At the more exotic end of the spectrum lie possibilities such as a Mach 8 hypersonic cruise vehicle able to reach any point on the globe in two hours from bases in the United States, and a space maneuver vehicle able to deliver conventional munitions worldwide from either a sub-orbital trajectory or low-earth orbit.

Narrowing the range of options is the focus of the third chapter in this report. Keeping prospective investment costs under control and constraining the technological risk provide at least part of the basis for eliminating various options. However, the heart of the matter is the trend among prospective American adversaries to exploit mobility, periodic relocation, concealment and camouflage, hardening, underground facilities, and geographic depth to deny US forces the targeting information required by non-nuclear guided weapons.

This central matter of being able to cope with the growing challenge of emergent, time-sensitive, fleeting and moving targets is raised in the second chapter of this report. It furnishes the key to sorting through the wide array of possible LRS options that is the task of the final chapter. When applied in conjunction with attention to affordability and technical risk, it leads to the following judgments about options for moving forward on LRS:

- For those rare occasions when it really is imperative to be able to strike anywhere on the globe from the United States as quickly as possible, a long-range ballistic-missile solution is the most sensible near-term option in light of cost and technological risk. The existing Peacekeeper and Minuteman inventory can provide the required launch vehicles. The key to positioning the Department of Defense to be able to field such a capability quickly is the Common Aero Vehicle (CAV)—a maneuverable, hypersonic glide vehicle that will be able to dispense around 1,000 pounds of conventional guided munitions. It is conceivable that the future security environment will evolve in a direction that will not require the United States to be able to strike any target on the globe in 35 minutes or less. Nevertheless, moving ahead to bring CAV to maturity will provide the essential hedge should this capability be needed down the road.

- For the vast majority of situations and targets—especially those that are only briefly vulnerable to attack—the principal requirement is the capability to dwell or loiter close enough to be able to acquire and strike emergent targets within minutes of the moment they reveal themselves. Future adversaries have powerful incentives to locate the targets they most want to protect—as well as the one US leaders are likely to deem most urgent to strike—deep in defended airspace and to make every effort to deny American forces the targeting information needed to strike effectively with non-nuclear precision munitions. To retain a dominant US capability to find and strike such targets despite mounting efforts on the other side to hide and conceal them, long-range and survivability will clearly be needed. The question underlying the bewildering array of LRS options the Air Force has been examining since 1999 is how much speed will be needed, whether in long-range platforms or their expendable munitions. The key answer suggested in the final chapter of this report is that, in light of affordability constraints and technical risk, the top-end cruise speed for a next-generation LRS platform, whether manned or unmanned, should probably be no higher than Mach 2.5.

I. Framing the Problem

This report seeks, first, to delineate the importance of long-range strike (LRS) in American military strategy in the early decades of the 21st century and, second, to explore US needs for LRS improvements in the mid- to long-term, meaning from around 2015 to roughly 2030. The first order of business is to consider how to think about the problem of long-range strike over a timeframe that extends to out to 2030, which is the focus of this chapter. The second chapter sets out the strategic case for moving forward on long-range strike, and the third tries to sort through the various options for near-term action.

BACKGROUND

In September 2004, CSBA published a backgrounder suggesting steps the Department of Defense (DoD) could take in the near-term to enhance American capabilities for long-range, non-nuclear (or "conventional") strike.[1] The three steps recommended in 2004 were to:

1. modernize the avionics in the existing fleet of 21 B-2s to give these bombers a robust capability against relocatable, time-sensitive, emergent and moving targets, as well as to free them from being rigidly tied to a pre-planned route or "blue line" inside defended airspace;

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[1] Barry Watts, "Moving Forward on Long-Range Strike," is available online at http://www.csbaonline.org.

2. equip some existing Peacekeeper or Minuteman intercontinental ballistic missiles (ICBMs) with conventional warheads to provide the United States with a prompt (under 35 minutes from launch to ordnance on target) global-response capability (as a Defense Science Board task force recommended in February 2004[2]); and

3. reorient the older B-52s and B-1s to the direct support of land forces in low-threat or benign air-defense environments.[3]

While some LRS options for the mid- to long-term were surveyed in CSBA's 2004 backgrounder, detailed analysis was deferred. This report endeavors to supply that analysis.

THE AIMS OF THIS REPORT

What *mix* of capabilities, systems, and platforms will meet US needs for long-range strike with non-nuclear, precision-guided munitions (PGMs) in the mid- to long-term at acceptable costs in terms of both resource investment and technological risk? And how important is it to take action in the near-term to improve America's LRS capabilities? These questions constitute both the focus of this report and the fundamental issues it addresses.

Future capabilities for long-range strike could, of course, also be adapted to deliver nuclear weapons. As the 2004 Defense Science Board (DSB) on strategic strike forces noted, during the Cold War America's "strategic" forces were designed to achieve the central goal of deterring a Soviet nuclear attack on the continental United States.[4] Toward this end, the DoD fielded a "nuclear triad" of long-range, offensive, nuclear forces consisting of manned bombers, ICBMs, and submarine-launched ballistic missiles (SLBMs).

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[2] Admiral Dennis Blair, General Michael Carns, and Vincent Vitto, *Report of the Defense Science Board Task Force on Future Strategic Strike Forces* (Washington, DC: Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics, February 2004), pp. 1-8.

[3] Barry D. Watts, "Moving Forward on Long-Range Strike," CSBA backgrounder, September 27, 2004, pp. 2, 15-18.

[4] Blair, Carns, and Vitto, *Report of the Defense Science Board Task Force on Future Strategic Strike Forces*, p. 2-2.

Nevertheless, B-52 heavy bombers, which comprised the bulk of the manned "leg" of the nuclear triad from the mid-1960s through the early 1990s, were utilized for conventional operations in Southeast Asia during 1965-72 and, again, in the Persian Gulf during January-February 1991 just before the Soviet Union's collapse.[5] Conversely, short-range fighter-bombers were equipped with nuclear weapons and sat nuclear alert in Western Europe and South Korea. So even during the Cold War, "nuclear" bombers were used in conventional operations and "conventional" fighter-bombers played a role (albeit a limited one) in nuclear deterrence.

In light of the post-Cold War security environment, the Pentagon's December 2001 *Nuclear Posture Review* advanced a new "strategic" triad of (1) long-range strike systems broadened to include both nuclear and non-nuclear systems, (2) active and passive defenses, and (3) a responsive industrial base.[6] One aim of this new triad was "to reduce" American "dependency on nuclear forces" by substituting accurate conventional munitions for nuclear warheads.[7] Given this history, it should suffice for purposes of this report to concentrate on the capabilities of long-range strike systems to deliver accurate conventional munitions.[8]

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[5] The last of the B-47s were retired by 1966. The B-58s that followed and, later, the FB-111As were never more than a quarter of Strategic Air Command's bomber force. Not only were the B-52s employed, but in December 1972 fifteen were lost to North Vietnamese SA-2 surface-to-air missiles.

[6] The Cold War triad of manned bombers, ICBMs, and SLBMs was to be reduced in size but retained as part of the offensive component of the new strategic triad (J. D. Crouch, "Special Briefing on the Nuclear Posture Review," January 9, 2002 (updated January 14, 2002), available online at http://www.defenselink.mil/transcripts/2002/t01092002_t0109npr.html).

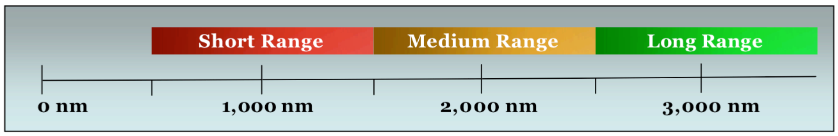
[7] Crouch, "Special Briefing on the Nuclear Posture Review."

[8] The one exception may be hard and deeply buried targets. Whether increased accuracy (single-digit miss distances) and better high-explosive, penetrating munitions can overcome the ability of "hiders" to place high-value assets deeper and deeper remains to be seen, although the 2004 DSB report on future strike was optimistic: "In the years ahead, we anticipate continued technological options to emerge that, when combined with operational experience, will open up new opportunities for non-nuclear payloads for strategic strike missions" (Blair, Carns, and Vitto, *Report of the Defense Science Board Task Force on Future Strategic Strike Forces*, p. 6-5).

LONG-, MEDIUM- AND SHORT-RANGE

As in CSBA's 2004 backgrounder, *long-range* is understood to mean combat aircraft with an unrefueled combat radius around 3,000 nautical miles (nm), or missiles with a one-way range around 3,000 nm. *Short-range*, by comparison, denotes combat aircraft with an unrefueled combat radius out to roughly 1,000 nm (or missiles with a one-way range around 1,000 nm). *Medium-range* will refers to aircraft and missiles with around 2,000 nm of reach, the medium-range envelope being 1,500-2,500 nm (Figure 1).

Figure 1: Unrefueled Strike Radius/Range Bands



Also as before, a short-range missile, such as the AGM-86C Conventional Air Launched Cruise Missile (CALCM), if launched from a long-range bomber, will be taken to constitute part of a long-range strike system because the bomber itself is not tied to the sea as are ships and submarines. The B-52Gs, for instance, that fired 35 CALCMs at targets in Iraq on the opening day of Operation Desert Storm (ODS) launched from, and recovered at, Barksdale Air Force Base (AFB) in Louisiana.[9] Following this same logic, a submarine or a surface combatant that launches short-range UGM/RGM-109 Tomahawk Land Attack Missiles (TLAMs) against targets ashore will be understood to be a short-range system on the grounds that these launch platforms are tied to the sea, thereby limiting their reach against inland targets.[10]

STRATEGIC AND TECHNOLOGICAL UNCERTAINTIES

While articulating the main issues about American LRS options in the mid- to long-term is relatively easy and straightforward, resolving

[9] John Tirpak, "The Secret Squirrels," *AIR FORCE Magazine*, April 1994.

[10] To underscore the importance of being clear about terminology, the US Navy refers to the TLAM and its successor, Tactical Tomahawk, as munitions used for the "precision destruction of targets at *long range* [italics added]."

them with any degree of precision is not for at least two reasons. First, there are a number of considerations bearing on US needs for conventional LRS in the mid- to long-term that cannot be known today with any degree of confidence. The more obvious of these uncertainties include, but are not limited to, the following questions, most of which involve the future international security environment and American foreign policy in that environment. Who or what will be the nation's principal military competitors in this period, and what sorts of operations and conflicts will US military forces either conduct or seek to deter? What strategic objectives will the United States pursue during the years 2015-2030? Will the current "uni-polar moment" in which the United States is the world's sole superpower give way to a Cold-War type rivalry with another peer competitor or, alternatively, to the kind of balance-of-power competition among a number of "great powers" that preceded World War II? Regarding the infrequent, but fundamental changes in how wars are fought for which the Pentagon's Andrew W. Marshall introduced the term "revolution in military affairs," how much will war's conduct be transformed over the next two or three decades?[11] And, last but not least, how costly will the more attractive or militarily desirable LRS options be to acquire and operate, and what risks might they entail?

Second, the notion embedded in the question of what might constitute a prudent or preferred mix of LRS capabilities, systems, and platforms for the long haul points to at least two levels of prospective metrics: (1) broad, force-level characteristics such as the adequacy of a given force mix in some set of scenarios to strike various targets or target systems within some timeframe; and (2) the performance characteristics of individual systems and platforms within the LRS force mix—combat radius, persistence in defended airspace, speed (cruise and dash), payload, etc. Force-level characteristics such as being able to hold at risk or cover specific target sets with some degree of assurance, however, ultimately depend not only on system/platform charac-

[11] Marshall has been the Director of Net Assessment in the Office of the Secretary of Defense (OSD/NA) since 1973. He introduced the term *revolution in military affairs* (*RMA*) in 1993 (A. W. Marshall, "Some Thoughts on Military Revolutions," OSD/NA memorandum for the record, July 27, 1993, p. 1). His aim at the time was to emphasize that even in technology-enabled RMAs such as the creation of *Blitzkrieg*, new operational concepts and organizational arrangements often played a greater role in the maturation and success of the new way of fighting than possession of the new military hardware.

teristics, but also on the details of the opponent and the contingency at issue. Yet these specifics are precisely the kinds of things about the mid- to long-term future that cannot be known with much certainty at all. Indeed, it was the much greater uncertainty about the *who?* and *where?* of America's future wars in the post-Cold War era that prompted the Pentagon in 2001 to try to move away from threat-based planning and embrace what was termed a "capabilities-based approach," meaning one that would concentrate more on the *how?*[12] Thus, capabilities-based planning arose from recognizing that in the early 21st century, key elements of America's future security environment will most likely be far less predictable than they had been during the US-Soviet Cold War.

The combined uncertainties affecting decisions about what combination of range, persistence, payload, sensors, speed, and survivability a given LRS system or platform might need in 2015 or 2030 are, if anything, even more daunting. Besides those pertaining to the future security environment and strategy on both sides, there are also significant technological uncertainties. Take, for example, the low observability (particularly to radar) that, when combined with sound tactics, have given F-117s and B-2s the stealth to strike targets within the reach of enemy air defenses since the late 1980s. The emphasis on low radar cross section (RCS) in the F/A-22 and F-35 Joint Strike Fighter (JSF) programs indicates that the US Air Force, Navy, and Marine Corps are betting heavily that stealth will continue to stay ahead of air defenses for at least 2-3 more decades. In other words, America's ability to hide its strike platforms using low observability and tactics will continue to be more successful than the ability of enemy air defenses to find them.

While current technological trends do suggest that "information-denial capabilities will generally keep pace with the development of

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[12] Department of Defense, *Quadrennial Defense Review Report*, September 30, 2001, p. 15. As Secretary Donald Rumsfeld observed in early 2002, "with the disappearance of the relatively predictable and potentially existential Soviet threat," US strategy should focus "less on who might threaten us or where we might be threatened, and more on how we might be threatened and what we need to do to deter and defend against such threats" (transcript of speech on transformation, National Defense University, Washington DC, January 31, 2002; available at http://www.defenselink.mil/speeches/2002/s20020131-secdef.html).

new sensor and information acquisition technologies"—implying that "stealth, broadly conceived, will remain practicable and no dimension of the battlespace will become completely transparent by 2025"—one cannot be certain when trying to peer as far into the future as 2030.[13] There is, after all, ongoing competition between "hiders" striving to reduce signatures (including platform RCS) and "finders" developing improved means of gaining tactical information (including ever more advanced and capable sensors). The competition between aircraft and radar (radio detection and ranging) dates back to the 1940 Battle of Britain, when the Chain Home Radar System robbed the German air force of tactical surprise and helped the Royal Air Force "compensate for inferiority in numbers."[14] Stealth, of course, is the latest move in this ongoing competition by aircraft "hiders." The "finders," though, have not been idle. The Australians, for example, claim that their Jindalee Operational Radar Network (JORN)—an active, over-the-horizon system—has some capability against stealth aircraft.[15] Similar claims have been advanced for the Czech VERA-E passive surveillance system.[16] One cannot, therefore, assert with certainty that the balance between hiders and finders in the narrow sense of stealthy strike air vehicles versus integrated air defenses will be as favorable to hiders in 2025 or 2030 as it is today.[17]

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[13] Michael G. Vickers and Robert C. Martinage, *The Revolution in War* (Washington, DC: Center for Strategic and Budgetary Assessments, December 2004), p. 114.

[14] Rebecca Grant, *The Radar Game: Understanding Stealth and Aircraft Survivability* (Arlington, VA: IRIS Independent Research, 1998), p. 8.

[15] Michael Sinclair-Jones, "JORN Assures Early Warning for Australia," *Defence Systems Daily*, February 29, 2000, available online at http://defence-data.com/features/fpage37.htm.

[16] Tomas Kellner, "Radar Detected," *Forbes*, November 15, 2004, p. 64.

[17] The hider-finder competition encompasses more than stealthy air vehicles versus radar-based air defenses. US stealthy strike platforms also seek to find enemy forces and targets to attack them, any competent adversary will strive to hide forces and targets from American air attack using concealment, dispersion, camouflage, placing high-value facilities deep underground, active countermeasures against American sensors, and any other means that might prove effective. Historically weather and darkness greatly aided hiders, but technological advances have severely undercut their effectiveness in recent decades.

Again, the basic questions underlying this report are easily stated. Answering them, though, is far more difficult task. Merely trying to choose metrics for deciding what *mix* of capabilities, systems and platforms might best satisfy American needs for LRS over the mid- to long-term at reasonable costs immediately runs into major uncertainties about both the future security environment and future technology.

Nevertheless, some basis for making reasoned choices about LRS has to be embraced despite the uncertainties. The fact is that making no decisions at all in this mission area over the next decade is itself a strategic choice: namely, a decision to do nothing when something probably ought to be done—at least as a hedge against the prospect of the reemergence of one or more near-peer competitors. Since no amount of analytic legerdemain will greatly reduce, much less eliminate, the uncertainties of the mid- to long-term future, it will be necessary to suggest a way forward. Toward this end, a combination of intuition, common sense, understanding of the principal operational challenges facing LRS and, where possible, the underlying physics and aerodynamics probably offer as good a path through the thicket of unknowns as any.

LRS DEVELOPMENTS SINCE 1991

Beyond the need for a sensible approach to evaluating LRS options, there is the antecedent issue of deciding just how urgent it may be to take steps in the near-term to improve existing capabilities in the mid- to long-term. Because US ICBMs and SLBMs remain nuclear-only systems, the only LRS platforms currently operated by the United States are the Air Force's heavy bombers. It seems appropriate, therefore, to broach the urgency issue by asking: What has the US Air Force been doing over the last decade or so to move ahead in long-range strike? On the evidence, the short answer is: very little beyond some exploration of advanced technologies.

The fall of the Berlin wall in late 1989 and the collapse of the Soviet Union itself two years later ended the US-Soviet Cold War. One obvious military implication of the Cold War's end was a reduction in US needs for intercontinental nuclear forces. Decisions reflecting this new reality quickly followed. In January 1992 President George H. W. Bush terminated B-2 production at 20 aircraft. And, by mid-1992, Strategic Air Command (SAC) was disestablished and its bombers transferred to the new Air Combat Command (ACC), the successor to Tactical Air Command.[18]

Looking back, these decisions, while triggered by the Cold War's abrupt end, should probably also be viewed as reflecting a broader shift within the Air Force. As Phil Meilinger observed in 2003, in the aftermath of the Vietnam War USAF fighter pilots, who had borne the brunt of their service's share of that conflict, began taking over the top leadership positions in the Air Force.[19] During this same period, there were force-structure changes that increasingly emphasized fighters and fighter-bombers, thereby putting more fighter pilots into the rated pipeline for senior rank.[20] "The backbone of the air fleet, which had been the heavy bombers and ICBMs of SAC, . . . decreased dramatically in numbers and importance," and by 2003 the Air Force had over 2,500 fighters and fighter-bombers compared with around 200 bombers.[21]

Given both the demise of the Soviet threat and this cultural shift within the USAF, from 1992 to early 1998 there was considerable debate within the Air Force about the future of the American heavy bomber fleet. During these years that debate largely focused on whether to buy additional B-2s. Those who advocated doing so stressed the B-2's potential for long-range strike with guided, non-nuclear weapons. The stealthy F-117's success delivering laser-guided bombs (LGBs) during the opening days of the 1991 Persian Gulf War, before Iraq's integrated air defense system had been rolled back, went far to bolster the B-2's potential for "conventional" strike operations against targets deep in defended airspace. LGBs, though, required clear air, and could not be employed through weather or other atmospheric obscurations.

Understandably, those who favored buying additional B-2s began, even before the Cold War had ended, pointing to the promise of

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[18] Only in the event of a nuclear conflict would any of the long-range bombers revert to the control of the new Strategic Command, the successor to SAC.

[19] Philip S. Meilinger, "A History of Effects-based Air Operations," *The Royal Air Force Air Power Review*, Autumn 2003, p. 20.

[20] Rebecca Grant, "In Defense of Fighters," *AIR FORCE Magazine*, July 2002, p. 41.

[21] Meilinger, "A History of Effects-based Air Operations," p. 20.

add-on kits employing inertial navigation system (INS) guidance to provide through-weather accuracy for ordinary "dumb" bombs.[22] Some advocates of these munitions also began to realize that INS guidance could be improved substantially if augmented with location and timing information from Global Positioning System (GPS) satellites. INS/GPS-aided guidance was first implemented on expensive cruise missiles by SAC.[23] Not until the late 1990s was this type of guidance also fielded in kits that could be strapped onto ordinary unguided bombs such as the 2,000-pound (lb) Mark-84 and BLU-109/B.[24] These guidance kits opened the door to a class of vastly cheaper, all-weather guided munitions.[25]

During the North Atlantic Treaty Organization's 1999 air war against Serbia, the B-2 and this new class of INS/GPS-aided bombs more than fulfilled their promise for accurate, long-range, all-weather strike. B-2s operating from their home station at Whiteman Air Force Base (AFB), Missouri, delivered a total of 652 2,000-lb Joint Direct Attack Munitions (JDAM) against Serbian targets.[26] In this initial combat trial, JDAM reliability from the B-2 was 97 percent and accuracy was better than either the 13-meter goal of the development program or the 10.3-meter circular error probable (CEP) achieved during the initial 22 test drops in 1996.[27] In fact, during late 2001 and early

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[22] Industry proposals for inertially aided munitions date back to the mid-1980s.

[23] The first combat employment of INS/GPS-aided weapons occurred in 1991 when B-52Gs launched AGM-86C CALCMs against Iraqi targets on the opening night of Operation Desert Storm.

[24] The BLU-109/B was designed to penetrate hardened targets such as bunkers, aircraft shelters, and reinforced concrete structures.

[25] The cost differential between JDAM and land-attack cruise missiles such as TLAM or CALCM is in the vicinity of two orders of magnitude (roughly factors of 60-100) when both development and production costs are taken into account.

[26] During Operation Allied Force, B-2s also delivered four 5,000-pound GPS-Aided Munitions (GBU-37s) during 45 effective combat sorties, which used an earlier version of the INS/GPS-aided guidance in JDAM.

[27] Rebecca Grant, *The B-2 Goes to War* (Arlington, VA: IRIS Publications, 2001), p. 95; McDonnell Douglas, "JDAM Gets Go-ahead for Low-Rate Initial Production," press release 97-102, May 6, 1997, available at http://www.boeing.com/news/releases/mdc/97-102.html. CEP is usually ex-

2002 in Afghanistan—where JDAM was first heavily used by Air Force and Navy strike aircraft—the munition's CEP was in the vicinity of 6-7 meters.[28]

Yet, despite the promise of the B-2/JDAM combination, the B-2 production line was not reopened during the late 1990s.[29] In 1994, B-2 supporters mounted an effort to keep the production line in Palmdale, California, intact long enough for the report of the Commission on Roles and Missions (CoRM) to be completed the following year. Congress had tasked the commission to address whether there was a need for additional B-2s. The CoRM, however, chose to sidestep the issue, recommending instead a DoD-wide study to "determine the best mix" of deep-strike capabilities while delaying "a final decision on the B-2 bomber."[30] Congress then added $483 billion to the B-2 program for Fiscal Year (FY) 1996 to convert a flight-test B-2 (Air Vehicle 1) into an operational aircraft. After some wrangling between Congress and the White House, President Bill Clinton acceded to using this money as Congress intended, thus bringing the total B-2 inventory to 21 aircraft.[31]

The Air Force's initial position on the B-2 during these years was, at best, ambivalent. In 1994, General Merrill McPeak, then USAF chief of staff, stated that while the Air Force would like more B-2s, it

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pressed as the radius of a circle, centered on the aim-point, within which 50 percent of the munitions are expected fall.

[28] Interview with Pat "Doc" Pentland, October 24, 2002. Pentland is a retired Air Force colonel and former professor at the School of Advanced Airpower Studies, Maxwell AFB, Alabama. At the time of this interview, he was with the Science Applications International Corporation (SAIC) working under contract to the Air Force on Task Force Enduring Look, which was analyzing Coalition air operations in Afghanistan. Prior to joining SAIC, Pentland was the study-group coordinator for the US Commission on National Security—21st Century.

[29] Major subassemblies on the last production B-2 were completed in 1994. Dismantlement of the assembly line and break-up of the subcontractor team, which included Boeing and Vought, began soon thereafter.

[30] John P. White, *Directions for Defense: Report of the Commission on Roles and Missions of the Armed Forces* (Washington, DC: US Government Printing Office, 1995), p. ES—5.

[31] This aircraft, the 21st B-2, was delivered to the Air Force in 1997.

could not afford them given other, higher-priority requirements.[32] As time went on, this position hardened. By 2001, with low-rate production of the F-22 in the offing, Air Force leaders had grown firmly opposed to buying any additional B-2s. Not only, they insisted, was there no money for more of these airplanes, but neither was there any operational need since the B-2 was limited to attacking fixed targets at night.[33]

By 2001, then, the chances of restarting B-2 production were virtually nil. Looking back, they probably ended with recommendations of the congressionally mandated panel to review Long-Range Air Power (LRAP), which was chaired by retired USAF General Larry D. Welch.[34] The LRAP panel's most fundamental conclusion was that, even though its members believed long-range air power to be "an increasingly important element of US military capability," restarting B-2 production would be "ill-advised"; instead, the panel recommended that any additional funding for the B-2 program be used to improve the bomber's deployability, survivability and maintainability.[35] As Welch testified to a House National Security subcommittee on April 1, 1998, you could "more than double" the B-2's sortie rate by making appropriate investments to improve the aircraft, thereby giving combatant commanders the sortie equivalent of operating a larger B-2 force at a far lower cost.[36] Even more devastating, he informed the

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[32] James W. Canaan, "McPeak Sums It Up," *AIR FORCE Magazine*, August 1994, p. 30.

[33] John A. Tirpak, "Bomber Questions," *AIR FORCE Magazine*, September 2001, p. 41; Vago Muradian, "Roche: Air Force Needs New Stealthy, Fast, Long-range Bomber, Not More B-2s," *Defense Daily International*, October 19, 2001. By this time, Air Force Secretary James Roche was shunning any and all proposals to buy more B-2s, whether they came from Northrop Grumman, the Office of the Secretary of Defense, or Capitol Hill (ibid.).

[34] At the time Welch was head of the Institute for Defense Analyses. He was also a retired USAF chief of staff.

[35] "Report of the Panel To Review Long Range Air Power," March 1998, unclassified. The LRAP panel also produced a classified report. The other members of the panel were Samuel D. Adcock of Daimler-Benz Corp., former Sen. James J. Exon of Nebraska, John S. Foster Jr. of TRW, Inc., Frederick L. Frostic of Booz·Allen & Hamilton, Inc., former Air Force Chief of Staff Gen. Merrill A. McPeak, Walter E. Morrow Jr. of MIT Laboratory, former Secretary of the Air Force Donald B. Rice, and retired Air Force Gen. Robert L. Rutherford.

[36] John T. Correll, "The B-2 and Beyond," *AIR FORCE Magazine*, July 1998. In his testimony, Welch resisted stating unequivocally that doubling the B-2's

subcommittee that "no member" of the LRAP panel, not "even the most avid supporters of the B-2," thought the Air Force should accept Northrop Grumman's offer to reopen the line and build nine more stealthy bombers at a cost of $14 billion.[37]

With the B-2 effectively stopped at 21 aircraft, the next logical question was what, if anything, should be done to develop a next-generation LRS system. The LRAP panel recommended that "high priority" be given to a "continuing program" to demonstrate the advanced technologies for the B-2's successor, but added that there was "not yet an adequate basis" for choosing a next-generation system.

Congress largely endorsed these recommendations. Both the appropriations bill and the authorization act for the Pentagon's Fiscal Year (FY) 1999 budget directed the Defense Department and the Air Force "to prepare a comprehensive plan for the future of the long-range bomber force," including identifying bomber upgrades and a timeline for acquiring a follow-on platform.[38] In response, the Air Force produced a "bomber road map" in March 1999 (Figure 1). The projected bomber inventory in this document, which covered 2000-2050, did not depict a follow-on system as a pressing priority. Instead, the timeline deferred the mission-area assessment for a new LRS platform to 2013, anticipated the initiation of a new acquisition program in 2019, and indicated the initial operational capability (IOC) for a B-2 follow-on could wait until 2037.[39]

As Figure 2 makes clear, the Air Force's 1999 roadmap argued, in effect, that the existing mix of B-52Hs, B-1Bs, and B-2s would suffice to satisfy US needs for long-range strike into the late 2030s. If so,

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sortie rate would be equivalent to operating 42 of the stealth bombers as opposed to 21. However, he opined that no combatant commander would be happy with the sortie rate available from the unimproved force of 21 B-2s.

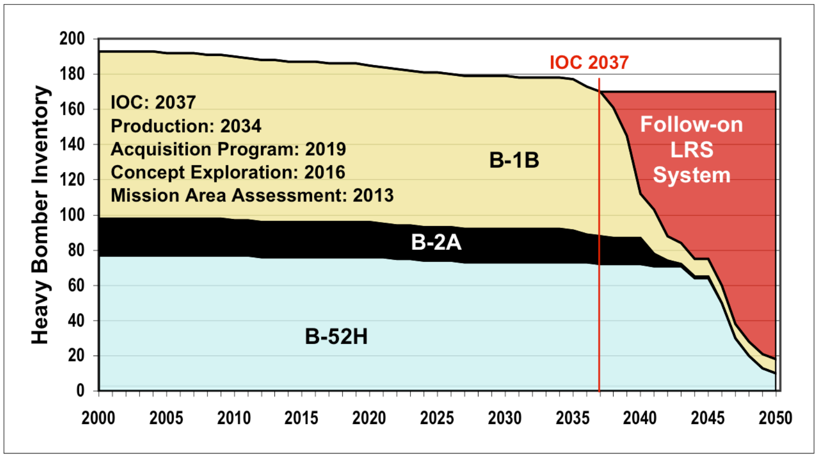
[37] "Hearings on National Defense Authorization Act for Fiscal Year 1999—H.R. 3636 and Oversight of Previously Authorized Programs Before the Committee on National Security," House of Representatives, April 1, 1998, p. 687, http://commdocs.house.gov/committees/security/has162200.000/has162200_of.htm.

[38] Department of the Air Force (DoAF), *U.S. Air Force White Paper on Long Range Bombers*, March 1, 1999, p. 21.

[39] DoAF, *U.S. Air Force White Paper on Long Range Bombers*, p. 22.

then there appeared to be ample time to study the options and decide what sort of follow-on system to choose. Even assuming a two-decade gestation period between the beginning of concept definition and the IOC of a next-generation system, the Air Force position was that the service had at least a decade, if not longer, to study options and develop technologies before any decision need be made.

Figure 2: The Air Force's 1999 Bomber Roadmap[40]



In late 2001, the Air Force issued an update to the 1999 bomber roadmap. This white paper on LRS aircraft sought to incorporate the results of the 2001 Quadrennial Defense Review (QDR), recent operational experience with bombers in Serbia and Afghanistan, and new defense planning guidance.[41] The 2001 document focused on modernization of the existing bomber fleet and did not revise the inventory roadmap in Figure 2. Indeed, it cautioned explicitly that this update "should not be used as a substitute for a detailed bomber roadmap."[42]

[40] DoAF, *U.S. Air Force Long-Range Strike Aircraft White Paper*, p. 22.

[41] DoAF, *U.S. Air Force Long-Range Strike Aircraft White Paper*, November 2001, p. 1.

[42] DoAF, *U.S. Air Force Long-Range Strike Aircraft White Paper*, p. 1.

No new detailed bomber roadmap has been released publicly since the 2001 white paper.[43] One can, however, update the March 1999 inventory projection based two developments. First, Air Force leaders decided that a total inventory of "150 bombers is the right number."[44] Toward this end, a decision was taken to retire 30 B-1Bs, although, after Congressional intervention, the number ended up being 23, which raised the inventory requirement back up to 157.[45] Second, in November 2001 Under Secretary of Defense for Acquisition, Technology and Logistics (AT&L) E. C. Aldridge directed the Air Force to "begin now" to position the DoD "potentially to start an acquisition program" for the Next-Generation Bomber (or Future Long-Range Strike Aircraft) "in the 2012-2015 time frame."[46] Aldridge felt that the department could not wait until 2019 to initiate an acquisition program for a next-generation LRS system, as suggested in the Air Force's 1999 bomber roadmap. Further, after Aldridge left, his successor, Michael Wynne, reiterated AT&L's commitment to the 2012-15 time frame for a new start. As a result, General T. Michael Moseley, the Air Force vice chief of staff, announced in 2004 that "the next generation system could be ready as early as 2025."[47]

The updated heavy-bomber inventory in Figure 3 uses these two developments to update the March 1999 projection. Figure 3 also assumes that the B-1B airframe will reach the end of its useful service life before the B-52H, and that even the venerable B-52s will be retired by 2045. In addition, Figure 3 does not reflect any attrition of the bomber force due to combat operations or accidents.

On the one hand, these changes to the 1999 bomber roadmap suggest some willingness on the part of Air Force officials to begin de-

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43 Reportedly a revised bomber roadmap was completed by Air Combat Command in August 2002, but it was never released (Adam J. Hebert, "The Long Reach of the Heavy Bombers," *AIR FORCE Magazine*, November 2003, p. 28).

44 Hebert, "The Long Reach of the Heavy Bombers," p. 27.

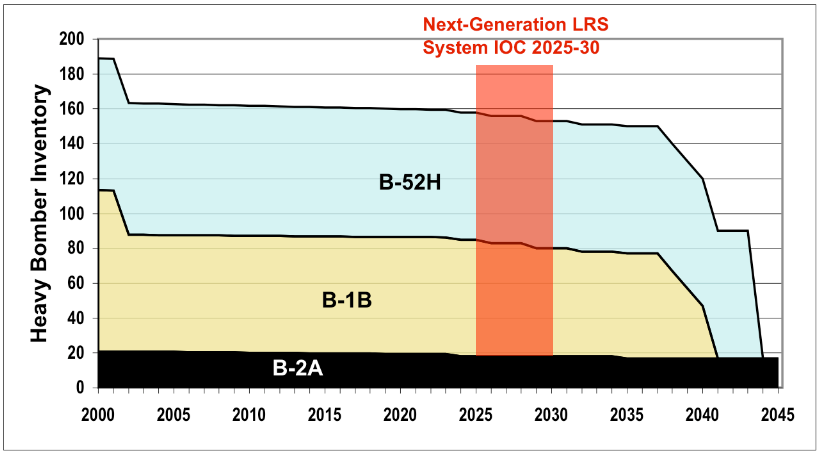
45 Adam J. Hebert, "Long-Range Strike in a Hurry," *AIR FORCE Magazine*, November 2004, p. 30. Most of the 23 B-1Bs retired in 2001 have been cannibalized for structural parts.

46 E. C. Aldridge, Jr., "Future Long-Range Strike Aircraft (LRSA-X)," memorandum for the Secretary of the Air Force, November 2, 2001.

47 Hebert, "Long-Range Strike in a Hurry," p. 27.

veloping a successor to the B-2 earlier than the timeline in Figure 2. On the other hand, there are several reasons for questioning just how serious the Air Force really is about LRS. To begin with, the DSB's February 2004 suggestion that a small number of ICBMs be converted to non-nuclear attack has not found any traction within OSD or the Air Force. The same can be said of CSBA's suggestion in September 2004 that the Pentagon should find the roughly $2 billion needed to modernize the B-2's avionics.[48] Thus, it is difficult to be sanguine about the commitment of Air Force leaders to making the most of existing LRS assets in the near term.

Figure 3: US Heavy-Bomber Inventory 2000-2045 (CSBA Estimate)



Next, there is the Air Force's ongoing ambiguity about a next-generation LRS system. Since the LRAP effectively ended the B-2 buy at 21 aircraft, the Air Force and its in-house think tanks have been ex-

[48] Again, the B-2's computer architecture uses 1984-vintage processors, which are already operating at 90-99 percent of their dynamic memory capacity (Watts, "Moving Forward on Long-Range Strike," pp. 16-17). Unless the computer architecture is upgraded, the new radar arrays the Air Force has funded will be not be able to provide the 1-foot synthetic aperture radar (SAR) resolution inherent in Active Electronically Scanned Array sensors; instead SAR resolution will remain around 10 feet, Ground Moving Target Indicator (GMTI) will not be implemented, the B-2 will remain tied to a preplanned "blue line," and the plane's capabilities for time-sensitive targets will be limited.

ploring every conceivable option for a next-generation platform. The first such study was conducted by USAF engineers at Wright-Patterson AFB, Ohio, in 1999. This effort explored the six different speed options for a "global mission vehicle": (1) subsonic (Mach 0.85), (2) Mach 2.4 (the maximum for aluminum structure), (3) Mach 4.0 (the maximum for uncooled titanium honeycomb), (4) Mach 7 (the maximum for endothermic hydrocarbon fuels), (5) Mach 11 (the maximum for hydrogen fuel), and (6) orbital ("Mach 26").[49] That same year, RAND Corporation analysts investigating the potential anti-access threat to in-theater airbases from enemy ballistic and cruise missiles recommended either an arsenal plane that could launch large numbers of cruise missiles from outside the reach of enemy air defenses, or a Mach 2 bomber with an unrefueled combat radius of 1,625 nm, their preference being for the latter.[50] In 2002, ACC conducted a Long-Range Global Precision Engagement Study, but did not advocate a specific choice for a future LRS system (although Major General David Deptula, then ACC's director of plans and programs, speculated that hypersonic research then being conducted at the Air Force Research Laboratory might "hold the key to breakthrough strike capabilities in the future").[51]

Despite all these studies and explorations of options, the Air Force seems little closer to reaching a firm decision on the next LRS system than it was in 1998 or 1999. In 2001 then chief of staff General Michael Ryan indicated that while the USAF wanted to "make a big leap in capability with its next strategic system," he felt that technology "to do that" had not yet arrived.[52] The implication was that more

[49] Gordon C. Tamplin, John W. Livingston, David L. Hammond, Donald P. Breidenbach, et al., "System and Operational Implications for Choosing the Best Speed for Global Missions," Aeronautical Systems Center, Wright-Patterson AFB, OH, December 1999, p. 2.

[50] John Stillion and David T. Orletsky, *Airbase Vulnerability to Conventional Cruise-Missile and Ballistic-Missile Attacks: Technology, Scenarios, and U.S. Air Force Responses* (Santa Monica, CA: RAND, 1999), MR-1028-AF, pp. 57, 85-93.

[51] Hebert, "The Long Reach of the Heavy Bombers," pp. 28-9. Hypersonic refers to speeds of Mach 5 (five times the speed of sound) or greater.

[52] John A. Tirpak, "Bomber Questions," *AIR FORCE Magazine*, September 2001, p. 43.

study, research, and perhaps some technology development were needed before any decision could be made.

It was not until the end of 2002, though, that a decision was made in the Pentagon to establish a joint program office to begin exploring certain technologies, including a long-range hypersonic-cruise vehicle, that might one day provide the "big leap" forward in LRS Ryan had advocated. Moreover, the direction to establish FALCON (*F*orce *A*pplication and *L*aunch from *CON*US[53]) under the leadership of the Defense Advanced Projects Research Agency (DARPA) and the Air Force came from the deputy secretary of defense, not the Air Force.[54]

While some observers—particularly in industry—were inclined to the optimistic interpretation that FALCON signaled the commitment of the Air Force leadership to a definite path toward next-generation LRS, the situation was in fact both more complicated and more ambiguous. The better part of a year before the direction to stand up FALCON, Air Force leaders had begun discussing the possibility developing a strike variant of the F/A-22—initially called an FB-22 (now described as a medium-range "regional bomber")—to provide an interim capability to bridge the gap between the current bomber force and next-generation systems.[55] And, while no decision had been by early 2005 to proceed with an FB-22, Air Force secretary James Roche observed that "the idea has great appeal versus going to a new-start

53 CONUS is the military acronym for Continental United States.

54 In December 2002, deputy defense secretary Paul D. Wolfowitz directed DARPA and the Air Force to establish a joint program office to accelerate technologies to satisfy "the requirement for rapid conventional strike worldwide to counter the proliferation of weapons of mass destruction and provide a forward presence without forward deployment"—DoAF, *Fiscal Year (FY) 2006/2007 Budget Estimates: Research, Development, Test and Evaluation (RDT&E) Descriptive Summaries*, Vol. II, Budget Activities 4-6, February 2005, p. 801.

55 By October 2002, the Air Force secretary had an FB-22 model in his Pentagon office (John A. Tirpak, "Long Arm of the Air Force," *AIR FORCE Magazine*, October 2002, p. 33). In depth press coverage of the FB-22 option began in June 2002 (see Bill Sweetman, "Smarter Bomber," *Popular Science*, June 13, 2002), and details on the FB-22 were circulating in Pentagon emails as early as March of that year, indicating that Lockheed Martin had been asked to explore the possibility even earlier.

program costing as much as $40 billion."[56] By then, Lockheed Martin had offered six different FB-22 variants, and the most promising one had an estimated combat radius of nearly 1,600 nm on a profile that included a Mach 1.5 dash of 50 nm.[57]

The long-term concern about this regional bomber option is, of course, that if an FB-22 is eventually pursued, it could end up pushing the IOC of the next LRS system back to the 2030s, more or less in line with the Air Force's March 1999 bomber roadmap. It seems highly unlikely that the Air Force will have the resources to field both FB-22s and FALCON's hypersonic cruise vehicle by 2025.

In the meantime, the Air Force's position seems to be studied ambiguity as to what LRS path it will take. In April 2004, the Air Force issued a request for information (RFI) to Boeing, Lockheed Martin, and Northrop Grumman seeking their suggestions for an "interim strike capability" that could be on the ramp within a decade as well as for a much more advanced "next generation" system.[58] This RFI elicited responses that ranged from a subsonic "B-2C" and Mach 2.2 "B-1R" to an orbital (Mach 26) space plane dispensing Common Aero Vehicles (maneuverable glide vehicles containing conventional munitions). Unmanned as well as manned solutions were included in industry responses.

What has happened since industry responded to the RFI in mid-2004? As of this writing, the Air Force had not followed the industry submissions with requests for proposals, which might have foreshadowed an institutional consensus to select a definite path forward in long-range strike. To further muddy the waters, Congressional appropriators inserted language for the FY 2005 defense budget that led to the Common Aero Vehicle (CAV) being redesignated the Hypersonic Technology Vehicle and restricted use of the funds to "non-weapons related research."[59] The way ahead in LRS, then, is anything but clear

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56 John A. Tirpak, "The Raptor as Bomber," *AIR FORCE Magazine*, January 2005, p. 31.

57 Tirpak, "The Raptor as Bomber," p. 30. The comparable F/A-22 combat radius with 50 nm of Mach 1.5+ dash is 455 nm (ibid.).

58 Hebert, "Long-Range Strike in a Hurry," p. 27.

59 DoAF, *Fiscal Year (FY) 2006/2007 Budget Estimates: Research, Development, Test and Evaluation (RDT&E) Descriptive Summaries*, Vol. II, p. 802;

and, as will be discussed in the third chapter, there are elements of FALCON that appear not only to be a large leap but a bridge too far.

THE INVESTMENT IMBALANCE

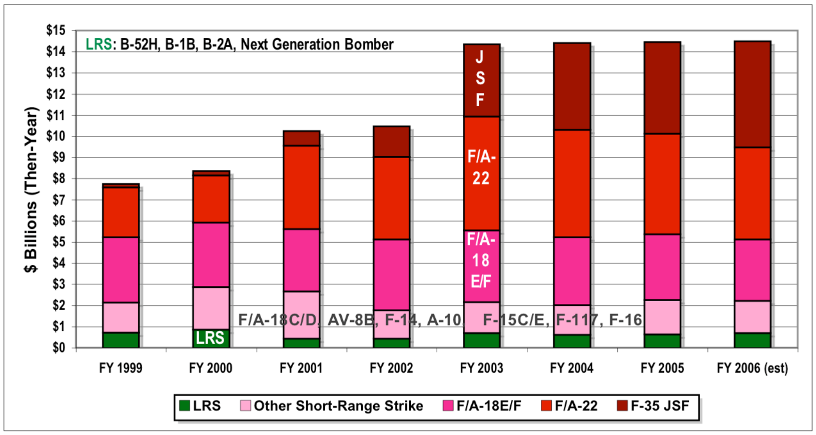
The preceding review of long-range strike developments since 1991 focused on roadmaps, plans, and visions of the future. An alternative way of thinking about LRS since 1991 is to look at actual investments. Figure 4 depicts Air Force, Navy and Marine Corps investments in short- and long-range strike from 1999 through the president's budget for FY 2006. Investment includes research, development, testing and evaluation (RDT&E) as well as procurement.

The DoD-wide investment total for the short-range systems is over $89 billion; the comparable total for long-range strike, including the Air Force's next-generation-bomber line, is just over $5 billion. If RDT&E on unmanned strike systems, including Predator, are added, the short-range investment total climbs to nearly $92 billion. The ratios of short- to long-range investment are, respectively, 17.6-to-1 and 18.1-to-1.

How much of these totals can be attributed to the Air Force alone? If the JSF and lethal unmanned aerial vehicle (UAV) programs are arbitrarily split down the middle between the Air Force and Navy departments, then the USAF's share of the nearly $92 billion in investment for short-range strike during FY 1999-2006 is almost $50 billion. Ignoring Navy and Marine investments on the grounds that LRS is not part of their portfolios, the Air Force alone spent nearly ten times as much in short-range strike as in long-range strike during FY 1999-2005 and the same preference is evident in the recently submitted Air Force budget for FY 2006. Further, even if the Air Force is the only service in the conventional LRS business, from the standpoint of both military strategy and management of the Defense Department, the investment imbalance between short- and long-range strike should probably be viewed as a DoD-wide issue.

Jeffrey Lewis, "Selected Space Programs in the 2005 Appropriations Process," Center for Defense Information, Issue Brief, August 2004, p. 7.

Figure 4: DoD Investment in Short-Range versus Long-Range Strike, 1999-2006[60]



Whether one embraces this perspective or not, the investment data have some telling implications. The most obvious is that, whatever Air Force officials may say about their intentions regarding LRS in the mid- to long-term, they have been putting the vast majority of their strike RDT&E and procurement dollars into short-range platforms and capabilities for the better part of a decade. Moreover, there is scant evidence in the Air Force's future-year budget projections that this imbalance is likely to be remedied anytime soon. Air Force budget-justification materials for FY 2006 do contain an RDT&E program element for a next-generation bomber that projects an investment of nearly $1.3 billion during fiscal years 2006-2011.[61] But, given the growing pressures on the Pentagon's budget, it is doubtful that this money will both materialize and be spent on a new LRS system. Recall that these budget pressures prompted OSD to issue Program Budget Decision (PBD) 753 two days before Christmas 2004, and that a major decision in PBD 753 was to terminate F/A-22 production after FY 2008, thereby eliminating the last 91 planes from the planned buy 279

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[60] Source: DoD budget documents at http://www.defenselink.mil/ comptroller. The main ones used were: National Defense Budget Estimates, RDT&E Programs (R-1), and Procurement Programs (P-1). Spending on unmanned strike systems has not been included in Figure 4.

[61] DoAF, *Fiscal Year (FY) 2006/2007 Budget Estimates: Research, Development, Test and Evaluation (RDT&E) Descriptive Summaries*, Vol. II, p. 771.

Raptors.[62] While it remains to be seen whether this decision will stand, one cannot help but suspect that the next-generation bomber wedge in FY 2008-09 is more likely to be spent on a medium-range regional bomber, based on the F/A-22, than on a new long-range strike system.

The other implication of the investment imbalance is that it has been so lop-sided in favor of short-range systems as to undermine the Air Force's implicit claim that it has not had the money to do more to improve the existing bomber force. The fact that the Air Force has not been able to find $1-2 billion to upgrade the B-2's avionics reflects less a paucity of investment funds than a strong preference for fighters and short-range strike systems. As noted at the end of CSBA's September 2004 backgrounder, the avionics of the B-2 fleet could be probably be modernized for less than half of the $5.4 billion cost overrun in the production portion of the F/A-22 program that the Air Force managed to cover in 2001.[63] Avionics modernization would include upgrading the plane's computer architecture and recoding software into C+/C++ as well as adding 1-foot SAR image resolution, Ground Moving Target Indicator (GMTI), a fiber-optic bus, freeing the plane from a pre-planned blue-line with an auto-router, and providing a capability against moving targets. With regard to these sorts of near-term choices, the issue is not money but priorities—especially in view of the fact that comparable upgrades are underway for the other two bombers.[64]

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[62] The source of the 279 total for the F/A-22 buy is: OUSD(AT&L), *Selected Acquisition Report (SAR) Summary Tables*, September 30, 2004, p. 5. The USAF, of course, wants to procure at least 381 F/A-22s. 381 is the total Air Force officials estimate would have to be procured to sustain a combat-coded force of ten 24-aircraft Raptor squadrons, one for each of the Air Force's ten Air and Space Expeditionary Forces (AEFs), over the plane's service life (Robert S. Dudney, "The Fighter Force You Have," *AIR FORCE Magazine*, February 2005, p. 2). The 141 F/A-22s above the 240 in ten AEFs would cover such things as attrition, a "school-house" for pilots transitioning into the Raptor, the USAF weapons school, additional developmental testing, and a float for depot maintenance.

[63] Watts, "Moving Forward on Long-Range Strike," p. 23.

[64] In-progress B-52H and B-1B computer upgrades are described in the next chapter.

II. The Case for Near-Term Action

Having addressed how to think about LRS, the next order of business is to examine the opportunities and the challenges in the mid- to long-term that might justify committing resources in the near-term to fielding next-generation capabilities, systems, and platforms. The basic argument of this chapter is that there are a series of mutually reinforcing reasons for moving forward sooner rather than later. These arguments range from imposing costs on prospective adversaries and closing significant gaps in America's LRS capabilities, to hedging against the emergence of a near-peer or peer competitor with strategic depth and staying power. Before taking up these arguments, however, the likely longevity of the existing bombers needs to be considered.

THE INEVITABILITY OF A FORCE MIX

In light of the history reviewed in the previous chapter, it seems reasonable to anticipate that American LRS capabilities are likely to remain an untidy mixture of legacy and next-generation platforms and systems for the foreseeable future. In the first place, there is no reason to think that the Air Force will retire its entire heavy-bomber fleet anytime soon. ACC insisted in late 2003 that the existing bombers would be "viable through 2025," and there is no indication that the Air Force has retreated from this position.[65]

How reasonable are Air Force plans to retain current bombers into the 2030s or longer? In the B-2's case, improvements to the bomber's RCS signature and, more importantly, to the ease of maintaining that signature have been funded by the Air Force under the Alternative High Frequency Materials and related initiatives. The main outstanding issue regarding the B-2 is modernizing its avionics, especially the plane's early 1980s computers with their antiquated, overburdened, Intel-286 era microprocessors. Presuming the plane's computer architecture is eventually modernized and its software rewritten to take advantage of the new Active Electronically Scanned Array (AESA) radars, the B-2 is likely to retain some ability to operate in defended airspace—at least at night—for some time to come.[66] Indeed, it is the only long-range system with a significant capability to utilize stealth to hide from enemy air defenses.

The B52H is also likely to remain serviceable either as a standoff platform or in undefended airspace well into the 2030s. The last of the 102 B-52Hs produced was delivered to the Air Force in October 1962.[67] The B-52 was built in the era of slide-rule engineering and the airframe was "over-designed for its initial, high altitude bombing mission."[68] The result was a very strong, durable aircraft, which, combined with structural modifications made in the mid-1980s, is now estimated to be structurally serviceable through the late 2030s. As of 1999, the average B-52H had accumulated 14,700 flight hours, but the airframe service life was estimated to average 32,500-37,500 hours based on traditional mission profiles.[69]

[65] Hebert, "The Long Reach of the Heavy Bombers," p. 29.

[66] AESA radars are programmed to replace the B-2's original radars to shift their operating frequency out of a commercial-use band.

[67] Walter J. Boyne, *Boeing B-52: A Documentary History* (Washington, DC: Smithsonian Institution Press, 1981), pp. 146, 149.

[68] Gail Kulhavy, "B-52 Maps Its Way into New Century," Air Force News Service, November 19, 1999.

[69] General Michael P. C. Carns, *Defense Science Board Task Force on B-52H Re-Engining*, revised and updated June 2004, p. ES3.

Further, in contrast to the B-2's situation, the Air Force has funded a major avionics upgrade of the B-52H. This program, which is now underway, includes replacing Commodore-type processors with Pentium IIs and an open architecture that should facilitate future upgrades as computer technology advances.[70] The principal modernization issue outstanding on the B-52 is whether to re-engine the aircraft. While three earlier Air Force studies since 1996 had concluded that "re-engining was not economically justifiable," a DSB task force, commissioned in 2002, "concluded that taken together, the economic and operational benefits far outweigh the program cost," and the task force unanimously recommended that "the Air Force proceed with B-52H re-engining without delay."[71] If this recommendation is implemented, the B-52H should remain a viable element of US LRS capabilities into the late 2030s both for direct-attack inside airspace not defended by enemy fighters or radar-guided surface-to-air missiles (SAM), as well as for the standoff employment of cruise missiles from positions outside the reach of enemy air defenses.

The B-1B, too, has been upgraded over the last decade to improve its non-nuclear capabilities. These upgrades have been carried out under the Conventional Mission Upgrade Program (CMUP), which began in the mid-1990s.[72] The latest Block E improvements, which should begin entering service in 2005, include new mission computers using 300 MHz PowerPC microprocessors and updated avionics software (rewritten in Ada95).[73] Among other things, these changes permit the B-1B to employ three different munitions simultaneously.[74]

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[70] Kulhavy, "B-52 Maps Its Way into New Century"; also Captain Catie Hague, "B-52 Launches Avionics Midlife Improvement Program," January 22, 2003, available online at http://www.edwards.af.mil/archive/2003/2003-archive-b52_midlife.html.

[71] Carns, *Defense Science Board Task Force on B-52H Re-Engining*, p. ES1. The driver behind the DSB's position was a more realistic estimate of fuel prices. The three prior Air Force studies had all valued fuel at about one dollar per gallon, whereas a 2001 DSB calculated the cost of fuel delivered in-flight to be $17.50 per gallon, excluding the capital cost of tankers (ibid.).

[72] As of June 30, 2004, B-1B CMUP still appeared in OSD's latest Selected Acquisition Report as a $647.7 million program, but the number of planes involved had been reduced from 95 to 60.

[73] Charlotte Adams, "Building Blocks To Upgrade the B-1B," *Avionics Magazine*, August 2002 (available online at

Beyond these sorts of platform-modernization improvements, the most important capability enhancement to the current heavy bomber force since the 1991 Persian Gulf War has been making all the bombers capable of employing inexpensive, unpowered guided munitions such as the through-weather JDAM and, in the case of two B-52s in 2003, LGBs. During the Operation Desert Storm air campaign, B-52Gs flew about 3.6 percent of the US strike sorties, but delivered almost 32 percent of the American air-to-surface tonnage. But of the roughly 26,000 tons of ordnance dropped by B-52s in ODS, only the 35 CALCMs launched on the opening night—less than 53 tons—were guided.[75]

By comparison, during Operation Iraqi Freedom in 2003, B-1Bs were typically loaded with 24 JDAMs and used as "roving linebackers" to provide on-call fire support for US ground forces.[76] In addition, the two B-52Hs equipped with Litening targeting pods were able to employ LGBs from altitudes of 39,000 feet, in one instance delivering laser-guided bombs on a target on 1,000 feet in front of friendly ground forces.[77] The capability of the two older bombers to carry JDAM also provided a limited capability against time-sensitive targets (TSTs), a capability the B-2/JDAM combination first demonstrated in 1999 against relocatable Serbian radars and SAMs under what was termed "flex targeting." For example, on April 7, 2003, Coalition forces received an intelligence tip that top Baathist leaders, possibly including Saddam Hussein, were meeting in a bunker in Baghdad's al-Mansour district. It took some 35 minutes to verify the tip, make a decision to strike it, select a platform to make the attack, and pass the

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http://www.aviationtoday.com/cgi/av/show_mag.cgi?pub=av&mon=0802&file=0802b1b.htm); and, Boeing, "B-1B Background" available at http://www.boeing.com/defense-space/military/b1-lancer/b1binfo.html). The B-1 software upgrade replaces Jovial with Ada code.

74 Also worth noting is that the B-1B's SAR-image resolution is 3 meters (as compared with 10 meters for the B-2's current radar), and the Air Force has considered a Block F upgrade that would improve the B-1's resolution to one foot.

75 Thomas A. Keaney "Gulf War Airpower," *Joint Force Quarterly*, Autumn 1993, p. 32.

76 Hebert, "The Long Reach of the Heavy Bombers," p. 24.

77 Hebert, "The Long Reach of the Heavy Bombers," p. 26.

target information to an E-3 AWACS (Airborne Warning and Control System). Twelve minutes later, a B-1B delivered four JDAMs on the bunker, reducing it to a smoking crater.[78]

By 2003 all the US heavy bombers in operational units were capable of delivering inexpensive, through-weather guided bombs. True, a squadron of Barksdale AFB B-52Gs had acquired a capability for conventional precision attack with CALCM back in 1988, and 35 of these multi-million-dollar rounds were expended against Iraqi targets in January 1991. But it was not until the B-2 achieved IOC in April 1997 with the predecessor to JDAM—the GPS-Aided Munition (or GAM)—that comparatively inexpensive guided bombs first appeared on a US heavy bomber, and it took a few more years for this capability to migrate to the B-52 and B-1. Only after it had, and after JDAMs became available in large numbers (thousands as opposed to hundreds), does it seem plausible to suggest that the US bomber force as a whole had finally transitioned into the guided-munitions era. And with that transition came a large increase in conventional effectiveness. In 1993 a DSB task force concluded that in Desert Storm guided weapons (principally LGBs) had improved effectiveness by factors of 12-20 on a "tonnage per target kill basis."[79] The proliferation of JDAM across the combat-coded fleet of US heavy bombers presumably entailed a similar increase in effectiveness.

It appears both feasible and sensible, then, to keep at least a portion of the existing bomber inventory in the active inventory for several more decades. If their sensors, command-and-control (C2) linkages, and computational capabilities are kept up to date with timely modernization, these "legacy" platforms can also be expected to provide the US military with useful LRS capabilities through 2025 or longer. The B-52s and B-1s cannot, of course, survive in defended enemy airspace. They are vulnerable even to older radar-guided SAMs such as the Russian-built SA-2, -3, -6, -8, to say nothing of more advanced SAMs such as the Russian SA-10 and SA-20. Nevertheless, in

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78 "B-1 Pilot Telephone Interviews," DoD news transcript, April 8, 2003, http://www.defenselink.mil/transcripts/2003/tr20030408-t408phin.html; Adam J. Hebert, "The Baghdad Strikes," *Air Force Magazine*, July 2003, pp. 49-50.

79 Alexander H. Flax and John S. Foster, Jr., *Report of the Defense Science Board Task Force on Tactical Air Warfare* (Washington, DC: OUSD/AT&L, November 1993), p. 17.

benign airspace, the long ranges and large payloads of the two older bombers can provide hours of on-station time in the vicinity of friendly surface forces, just as the B-1Bs did during the drive of the US 3rd Infantry Division (ID) and 1st Marine Division to Baghdad in 2003. Especially in the case of the 3rd ID, the ability of platforms such as the B-1B to provide round-the-clock, all-weather fire support with precision weapons proved to be a lethal combat multiplier. As the 3rd ID noted in its after-action report:

> Throughout OIF, air support had a major impact on the battlefield. Air support proved highly successful both in shaping operations as well as in the close fight. The division utilized air support for a number of different missions including shaping, armed recce [reconnaissance], counterfire, and CAS [close air support].
>
> Joint direct attack munitions (JDAM) repeatedly proved . . . [their] value as an all weather weapon. JDAM was the weapon of choice for troops in contact and to destroy structures in an urban environment.[80]

During OIF, B-1Bs are reported to have flown only about one percent of the sorties while delivering some 22 percent of the guided weapons.[81]

There are two other reasons for supposing that some of the existing heavy bombers will remain on active service into the 2030s, if not longer: (1) the prospective RDT&E cost of developing a next-generation LRS system, and (2) the likelihood that a follow-on system will not be procured in large numbers. Based on the B-2 and F/A-22 programs, and JSF development so far, most observers believe that the RDT&E bill for developing a next-generation LRS platform would be in the neighborhood of $20-35 billion. The upper end of this estimate reflects the fact that, if the vehicle is designed to sustain Mach numbers of 3-4, a new class of radar-absorbing materials will have to

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80 *Third Infantry Division (Mechanized) After Action Report: Operation IRAQI FREEDOM*, July 2003, pp. 29, 30.

81 "B-1B Background," on Boeing's website. B-1s expended over 4,000 JDAMs during OIF.

be developed. As for likely procurement quantities of a next-generation LRS system, the broad trend since the B-52 has been that the numbers of each new bomber procured, whether long- or medium-range, have been declining. Boeing produced 744 B-52s; the Mach 3 XB-70 was cancelled after a crash following a mid-air collision in 1966; a total of 100 B-1Bs were produced in the 1980s; and the B-2 buy, originally planned for 132 aircraft, was reduced to 21. The same downward trend in quantities procured has occurred with medium-range bombers. Over 1,600 B-47s were produced for SAC, but only 86 Mach 2.0 B-58s and 76 FB-111s.

These observations suggest two points about any future LRS system. First, developing a next-generation platform is likely to be costly, regardless of whether the system is manned or unmanned. Second, the upper limit on the number of platforms that might be procured is probably no more than 100, and as few as 50 would be a more plausible number. Hence, like the B-2, the unit cost of any next-generation LRS platform is likely to be high. The driver underlying these dour conclusions is the strong preference, since the Vietnam War, of an Air Force dominated by fighter generals for short-range systems.[82] And, barring a profound change in the dominant Air Force culture, there is no good reason to think this preference will change anytime soon.

American LRS systems appear destined to be, at best, a mixture of older and, at most, a small number of newer systems for some decades to come. Even if actions are taken in the near-term to begin developing a next-generation platform, that new system is unlikely, barring a disruptive technological breakthrough that cannot yet be foreseen, to be fielded in sufficient numbers to justify wholesale retirement of the current heavy-bomber inventory.

Keeping many of the existing bombers in service for decades to come is an entirely bad outcome. Much like a diversified stock portfolio, each platform in the bomber force provides a different paring of likely "risks" and expected "returns," which means that some elements in the mix may be more adaptable to the next contingency than oth-

[82] See Colonel Mike Worden, *Rise of the Fighter Generals: The Problem of Air Force Leadership 1945-1982* (Maxwell AFB, AL: Air University Press, March 1988), especially pp. 211-28.

ers.[83] The use B-1Bs as roving linebackers in Operation Iraqi Freedom is a case in point. By removing the front-bay fuel tank, the plane could be loaded with 24 JDAMs. Having fully loaded B-1Bs loiter at slow speeds and medium altitudes gave them on-station times of several hours and reduced airframe wear and tear. But when a B-1 needed to respond to a time-sensitive target, the afterburner-equipped bomber could fold its wings, accelerate, and get to the release point faster than either of the other bombers.

Nonetheless, neither the inevitability of a mixed LRS force, nor the benefits of having a diversified portfolio of platforms, argues that the United States can afford to defer moving forward to develop a next-generation system. The remainder of this chapter will lay out the broad case for the continuing importance of LRS and the need to begin moving ahead sooner rather than later. The first part of the argument is about maintaining strategic advantage by denying enemies sanctuaries and imposing costs on them.

NON-NUCLEAR STRATEGIC ATTACK, DENYING SANCTUARIES, IMPOSING COSTS

In 1993 the historian Geoffrey Perret concluded that, although the long-range bomber had justified the establishment of an independent American air force, they had become “irrelevant,” the “essential combat aircraft of the 1990s” being the fighter-bomber.[84] This fighter-centric attitude ignores the strategic advantages LRS can provide the United States in the 21st century.

Ever since the World War II bombing campaigns against Germany and Japan, LRS has been an area of considerable American advantage. One need not, for instance, embrace the controversial and questionable claim that the Anglo-American Combined Bomber Offensive (CBO) of 1943-45 defeated Nazi Germany, much less ignore the enormous contributions to Allied victory in Europe of the USSR’s prodigious efforts on the Eastern Front during 1941-45, to recognize that

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[83] For an understandable account of modern portfolio theory, see Burton G. Malkiel, *A Random Walk Down Wall Street* (New York: W. W. Norton, 1999), pp. 199-212.

[84] Geoffrey Perret, *Winged Victory: The Army Air Forces in World War II* (New York: Random House, 1993), pp. 463-64.

the CBO precluded continental Europe from being a Nazi sanctuary and imposed rising air-defense and other costs on the German war machine. As Richard Overy concluded on the 50th anniversary of Allied victory World War II:

> There has always seemed something fundamentally implausible about the contention of bombing's critics that dropping almost 2.5 million tons of bombs on tautly-stretched industrial systems and war-weary urban populations would not seriously weaken them. Germany and Japan had no special immunity. Japan's economy was devoured in the flames; her population desperately longed for escape from the bombing. German forces lost half of the weapons needed at the front, millions of workers absented themselves from work, and the economy gradually creaked almost to a halt. . . . For all the arguments over the morality or effectiveness of the bombing campaigns, the air offensive was one of the decisive elements in Allied victory.[85]

Looking ahead, the question those inclined to let US capabilities for long-range strike atrophy must answer is: Given the uncertainties of the future, including the possibility of the People's Republic of China (PRC) emerging as a military rival by the 2020s, why would the United States *not* retain a robust capability to hold targets deep in the enemy heartland at risk and impose the costs of trying to defend targets there?

During the US-Soviet Cold War, the standard answer was, of course, that the main function of "strategic" arms—which were equated by American strategists with long-range, offensive, nuclear systems virtually from the outset—was to avert or deter their use because nuclear weapons could serve "almost no other useful purpose."[86]

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[85] Richard Overy, *Why the Allies Won* (New York: W. W. Norton, 1995), p. 133.

[86] Bernard Brodie, "Implications for Military Policy," *The Absolute Weapon: Atomic Power and World Order*, Frederick S. Dunn, Bernard Brodie, Arnold Wolfers, Percy E. Corbett and William T. R. Fox, ed. Bernard Brodie (New York: Harcourt, Brace, 1946), p. 76; also Bernard Brodie, "The Development of Nuclear Strategy," *International Security*, Spring 1978, p. 65.

In an important sense, the Soviets never embraced this view. Whereas American thinking about nuclear use tended to stop when the first nuclear weapons were used in Europe or against either superpower's homeland, the Soviets, who viewed the failure of nuclear deterrence as a real possibility, were far more serious in preparing to deal with the consequences, including how to maximize their political and economic position in the aftermath of nuclear war. Nevertheless, post-Cold War interviews with senior Russian defense officials makes it clear that by the early 1970s the Soviet General Staff had concluded that nuclear employment "had to be avoided if at all possible," and by 1981 that nuclear use in Europe would be "catastrophic as well as counterproductive to combat operations."[87]

In the current era of conventional guided munitions, however, effective attacks against "strategic" targets (in the pre-Hiroshima or Clausewitzian sense of using military force to achieve ultimate political ends) are again possible without necessarily or automatically incurring the widespread destruction of nuclear war.[88] The idea that "non-nuclear weapons with near zero miss" could provide the "National Command Authority with a variety of strategic response options as alternatives to massive nuclear destruction" was advanced as far back as 1975 by the report of the Long Term Research and Development Planning Program (LRRDPP).[89] Albert W. Wohlstetter, who chaired one of the three LRRDPP working panels and was largely responsible

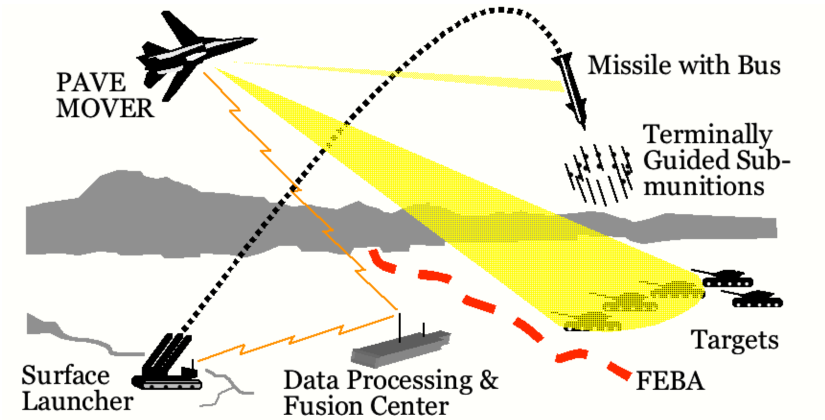
[87] John G. Hines, Ellis M. Mishulovich, and John F. Shill, *Soviet Intentions 1965-1985*, Vol. I, *An Analytic Comparison of U.S.-Soviet Assessments during the Cold War* (McLean, VA: BDM Federal, September 22, 1995), pp. 23-4. According to General-Colonel Andrian A. Danilevich, at a 1972 exercise General Secretary Leonid Brezhnev was visibly shaken when asked to authorize a retaliatory nuclear strike against the United States, even though the General Staff assessed the US first strike as having killed 80 million Soviet citizens, destroyed 85 of the USSR's industrial capacity, and decimated Soviet ground forces and non-strategic aviation (ibid.).

[88] "According to our classification, then, tactics teaches *the use of armed forces in the engagement*; strategy, *the use of engagements for the object of the war*"—Carl von Clausewitz, *On War*, eds. Michael Howard and Peter Paret (Princeton, NJ: Princeton University Press, 1976), p. 128. "The original means of strategy is victory—that is, tactical success; its ends, in the final analysis, are those objects which will lead directly to peace" (ibid., p. 143).

[89] D. A. Paolucci, *Summary Report of the Long Range Research and Development Planning Program* (Falls Church, VA: Lulejain and Associates, February 7, 1975), DNA-75-03055, pp. iii, 45.

for drafting the summary report, was especially adamant about finding alternatives to nuclear use. By then the Air Force had expended over 28,500 LGBs in Southeast Asia.[90] These new guided munitions had not only proven accurate and reliable from their initial combat use in 1968, but had been an important factor in the defeat of North Vietnam's massive conventional invasion of South Vietnam in the spring of 1972.

Figure 5: Assault Breaker Concept



One of the notions the LRRDPP report explored was possibility of combining surveillance of enemy territory from remotely piloted vehicles with conventional munitions, possibly delivered by missiles and using INS/GPS-aided guidance to achieve circular error probables (CEPs) under 15 feet, in order to attack targets in rear areas.[91] Three years later the Defense Advanced Research Projects Agency established the Assault Breaker program with the aim of exploiting the kinds of technologies explored by the LRRDPP to offset the superiority of Warsaw Pact (WP) conventional forces in tanks, armored personnel carriers, and artillery. The Assault Breaker concept (Figure 5) was to use these technologies to attack follow-on echelon forces before they

[90] Headquarters US Air Force, Management Information Division, *United States Air Force Statistical Digest: Fiscal Year 1974*, 29th Edition, April 15, 1975, Table 37, p. 73.

[91] Paolucci, *Summary Report of the Long Range Research and Development Planning Program*, pp. 29-30, 32, 44.

could be brought to bear against North Atlantic Treaty Organization (NATO) forces in the event of a WP attack on NATO.[92]

On the one hand, while NATO embraced a version of this concept under the rubric of Follow-On Forces Attack (FOFA), a comprehensive Assault Breaker system was not fielded by Cold War's end. On the other hand, the prospect that American technology might offset the massive Soviet investment in conventional forces begun after the 1962 Cuban missile crisis caused acute concern within the Soviet General Staff about the USSR's capacity to hold up its end of the military competition with the United States. As Marshal N. V. Ogarkov, then head of the General Staff, stated in 1984:

> . . . rapid changes in the development of conventional means of destruction and the emergence in the developed countries of automated reconnaissance-and-strike complexes, long-range high-accuracy terminally guided combat systems, unmanned flying machines, and qualitatively new electronic control systems make many types of weapons global and make it possible to sharply increase (by at least an order of magnitude) the destructive potential of conventional weapons, bringing them closer, so to speak, to weapons of mass destruction in terms of effectiveness.[93]

The broad implication of these developments is that, by the 1980s, the maturation of non-nuclear guided munitions—when integrated with the sensors, C^2, data linkage, and computational capacity to inform "smart munitions" with "precision information"—promised to

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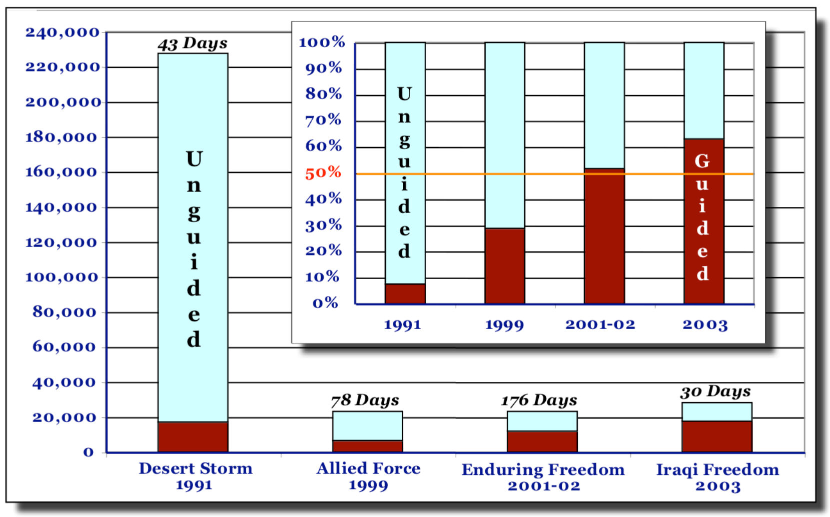
[92] William J. Perry, "Perry on Precision Strike," *AIR FORCE Magazine*, April 1997; online at http://www.afa.org/magazine/April1997/0497perry.html. This article reports remarks Secretary of Defense Perry addressed to the Precision Strike Association in Washington, DC, on January 15, 1997; Richard H. Van Atta, Michael J. Lippitz, et al., *Transformation and Transition: DARPA's Role in Fostering an Emerging Revolution in Military Affairs*, Vol. 1, *Overall Assessment* (Alexandria, VA: Institute for Defense Analyses, April 2003), p. 19.

[93] Marshal of the Soviet Union N. V. Ogarkov, "The Defense of Socialism: The Experience of History and the Present Day," *Krasnaya Zvezda [Red Star]*, May 9, 1984, pp. 2-3; trans. Foreign Broadcast Information Service, *Daily Report: Soviet Union*, vol. III, no. 4, annex no. 054, May 9, 1984, p. R19.

change modern warfare in some fundamental ways. For one thing, the growing lethality of laser-guided and INS-GPS aided munitions promised to render close battle so deadly that combatants would begin to move away from traditional close battle. Interestingly, even the improvised explosive devices (IEDs) widely used since 2003 by Islamic insurgents in Iraq since 2003 can be understood as a means of avoiding close battle against American forces. Another possibility, as already mentioned, is that guided munitions will make strategic attack, once again, a usable military option. In contrast to the Cold War, strategic attack need no longer be limited to deterrence.

Figure 6: US Guided versus Unguided Munitions Expenditures in Four Air Campaigns, 1991-2003[94]



94 The main sources for Figure 6 are: Gulf War Air Power Survey (GWAPS), Vol. V, *A Statistical Compendium and Chronology*, Part 1, *A Statistical Compendium* (Washington, DC: US Government Printing Office, 1993), pp. 553-554; USAF, "Air War over Serbia (AWOS) Fact Sheet," Washington, DC, January 31, 2000; HQ USAF/XOOC (Checkmate), "ISO Joint Staff 'Quick Look' After-Action Review Panel," December 15, 1999; William Arkin, "Weapons Total from Afghanistan Includes Large Amount of Cannon Fire," *Defense Daily*, Vol. 213, No. 42, March 5, 2002; and, Lieutenant General T. Michael Moseley, *Operation IRAQI FREEDOM—By the Numbers* (Prince Sultan Air Base, Kingdom of Saudi Arabia: US Central Air Forces, April 30, 2003).

Because the US military is currently so far ahead of any other nation in moving into the guided-munitions era, these implications mostly apply to American forces. As Figure 6 indicates, even the American military did not embrace precision warfare at the campaign level going into the 1991 Persian Gulf War, although guided munitions were concentrated against certain key target sets (Iraqi air defenses, nuclear program, leadership targets, airfields, etc.). While a shift in this direction was evident by 1999, not until 2001-02 did guided munitions constitute the majority of American expenditures in a major air campaign. Nevertheless, the broad trend in US munition expenditures since 1991 is clear, particularly the order-of-magnitude reduction in unguided expenditures after Desert Storm.

The 2001 Quadrennial Defense Review committed the Department of Defense to seeking transformational changes in American military capabilities. But the 2001 QDR also recognized that not all changes in military capabilities are transformational in the sense of maintaining or improving "U.S. military preeminence in the face of potential disproportionate discontinuous changes in the strategic environment."[95] Within this context, the report identified six operational goals for DoD's transformation efforts—goals that were judged transformational because they focused on emerging challenges and the opportunities they created. One of those six goals was characterized as:

> Denying enemies sanctuary by providing persistent surveillance, tracking, and rapid engagement with high-volume precision strike, through a combination of complementary air and ground capabilities, against critical mobile and fixed targets at various ranges and in all weather and terrains.[96]

In discussing this goal, the 2001 QDR added that pursuing it would demand emphasis on "manned and unmanned long-range precision strike assets, related initiatives for new small munitions, and the ability to defeat hard and deeply buried targets."[97]

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[95] DoD, *Quadrennial Defense Review Report*, p. 30.

[96] DoD, *Quadrennial Defense Review Report*, p. 30.

[97] DoD, *Quadrennial Defense Review Report*, p. 44.

Given the preceding chapter's review of LRS developments since 1991, one can argue that OSD has done little—at least in the "white world" of openly acknowledged programs—to focus the Air Force on the long-range aspects of denying enemies sanctuary. There is the possibility, of course, that the next long-range system is being developed as an unacknowledged "black" program. Recall that Lockheed's Skunk Works received a full-scale engineering-development contract for the F-117 in November 1978 and the first F-117 squadron was activated at Tonopah within the Nellis AFB range complex in 1982, but the existence of the F-117 was not officially announced until November 1988.[98] Hence it is possible that criticizing OSD for the apparent absence of any progress on long-range strike beyond the Air Force's next-generation bomber funding wedge is unwarranted.

Why such a system would need to be developed entirely unacknowledged is, however, far from obvious, especially in light of Air Force discussions since 2001 of a regional bomber as an interim solution. From the standpoints of dissuading the emergence of high-end military competitors and imposing costs on any who cannot be dissuaded, hiding the development of LRS capabilities focused on denying enemies sanctuary deep in their own territories appears questionable as a matter of effective strategy. The most plausible conclusion, therefore, is that, even though the 2001 QDR rightly identified denying sanctuary as both a strategic goal and an area in which the United States should seek enduring preeminence, little has been done to move forward since that time.

That said, the broad strategic reasons for maintaining, if not expanding, American capabilities for conventional LRS should, by now, be reasonably apparent. First, the combination of long-range platforms and guided munitions not only provides an alternative to nuclear use but a capability that can be used for warfighting as opposed to deterrence. In fact, the very usability of conventional LRS may exert a more dissuasive effect on some adversaries than nuclear weap-

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[98] Lockheed Corporation, "We Own the Night," *Lockheed Horizons*, No. 30, May 1992, pp. 9, 19, 24. *Lockheed Horizons* was an irregular magazine published by Lockheed before the company's merger with Martin Marietta. The May 1992 issue was the next-to-last one published and was devoted entirely to the F-117. Officially the Skunk Works is the Advanced Development Programs of the Lockheed Martin Aeronautics Company.

ons. Again, one is hard pressed to understand why the United States military should allow its advantage in LRS erode.

Second, non-nuclear LRS can deny enemies sanctuaries deep in their own territory. Insofar as the United States has inherited the role of a global policeman, however uncomfortably this responsibility may sit on American shoulders, the perception on the part of opponents that the US military can strike targets throughout their homeland should, in most (but not all) cases, have dissuasive and deterrent value.

Third, the US ability to hold targets in the enemy heartland at risk promises to impose costs on any adversary nation whose leaders decide to try to defend their deep targets. During the Cold War, one of the main arguments for going ahead with the B-1 (and, later, the B-2) was to impose the huge costs of maintaining territorial air defenses on the Soviets. The Troops of the National Air Defenses (originally *PVO Strany*, later *Voyska PVO*) were established as a separate service in 1948. This service persisted to the Cold War's end whereas the United States began deemphasizing continental air defenses in the mid-1970s to reduce costs—a decision that certainly made sense given the lack of effective defenses against Soviet ballistic missiles.[99] The point emphasized to senior US defense officials in 1976 was that the B-1, by posing a stressing challenge to the USSR's air defenses, would maximize US leverage over Soviet military expenditures, channeling them into defense rather than offense, thereby posing the least direct threat to the United States.[100] Thus, whereas the US defense establishment was able to decrease its territorial air defense burden by the early 1980s due to a greater willingness to rely on deterrence, the USSR's defense establishment chose to continue bearing the full burden of territorial air defenses.

99 Lt. Col. Lester W. Grau and Jacob W. Kipp, "Maintaining Friendly Skies: Rediscovering Theater Aerospace Defense," *Aerospace Power Journal*, Summer 2002, pp. 38-42.

100 "B-1 DSARC [Defense Systems Acquisition Review Council] III Decision," draft memorandum to the secretary of defense from Robert Ellsworth, 1976, p. 2. This memorandum was drafted in the Office of Net Assessment by A. W. Marshall and James G. Roche. At the time Roche was one of Marshall's military assistants, and Ellsworth was one of two deputy secretaries of defense under Rumsfeld.

Obviously there is no guarantee that a disproportionate burden could be imposed upon future US adversaries by continuing improvements in American capabilities for non-nuclear LRS. What can be said, though, is in the absence of such improvements the possibility of imposing disproportionate costs on a major military competitor will be lost. Beyond the costs of forcing the opponent to hide key military facilities and systems, the Russian S-300 (SA-10 using the NATO designation) has been an expensive system to procure, demands skilled personnel to operate to its full potential, and is costly to maintain. In fact, these characteristics go far to explain why this SAM never proliferated as rapidly or widely outside Russia as many Western analysts feared. While the S-400 follow-on is presently still in development, a single battalion with 32 ready-to-fire missiles has been estimated to run over $150 million a copy.[101]

These, then, are the basic strategic grounds for concluding that the United States should retain or expand its current preeminence in non-nuclear long-range strike. The next part of the argument is to begin addressing the timing and urgency of actions aimed at moving forward.

HEDGING AGAINST A SECOND NUCLEAR AGE AND ASIAN GEOGRAPHY

Given the degree to which the United States has become bogged down in a bloody insurgency inside Iraq since the president declared major combat over in May 2003, is there any pressing need to begin investing in new LRS capabilities in the near-term? Conventional strike aircraft, whether long- or short-range, can contribute little beyond providing fire support to US soldiers and marines on the ground in Iraq and Afghanistan. Bombers and fighter-bombers are not the ideal military instruments for achieving such goals as penetrating the networks of Iraqi insurgents, finding Osama bin Laden, or winning the war of ideas in the Islamic world. As American casualties continue to mount, are there not more urgent priorities than LRS?

[101] Yegor Belous, trans. Dmitry Sudakov, "Russian To Sell Strategic Bomber Planes to China," *On-line Pravda*, January 17, 2005; John A. Tirpak, "The Double-Digit SAMs," *AIR FORCE Magazine*, June 2001, p. 49.

The answer, of course, is that however much of a "long, hard slog" the "global war on terrorism" in Afghanistan and Iraq has become, the Defense Department still has to maintain a prudent balance between the needs of the moment and the foreseeable challenges of the mid- to long-term.[102] A point to remember is that al Qaeda, its affiliates, and the insurgents in Iraq have been forced to resort to such measures as suicide attacks against innocent civilians and IEDs precisely because they cannot take on the American military in open battle. It would surely be short-sighted for the United States to neglect the high-end military capabilities, including long-range strike, that have left Islamic jihadists and insurgents with so limited and desperate a range of options.

As for the challenges of the mid- to long-term, is it very likely that America's position of political, economic and military preeminence will persist indefinitely? China is the one nation with the economic resources to field advanced military capabilities that could directly oppose those of the United States, and there is mounting evidence that modernization by People's Liberation Army (PLA) is not only moving in this direction but developing capabilities specifically designed to counter American power-projection capabilities. One example is the fielding of an anti-radiation version of the SA-10, the FT-2000, which is designed to target US standoff surveillance assets such as the E-3 AWACS (Airborne Warning and Control System) as well as standoff jamming aircraft. Other examples can be seen in the purchase of a wide range of advanced Russian equipment for technological exploitation and incorporation into Chinese forces. "Beijing's purchase of advanced Russian weapon systems . . . has included Su-27 and Su-30 fighter aircraft; AA-12 air-to-air missiles; SA-10, SA-15, and SA-20 surface-to-air missiles; 3M-54E Novator Alpha antiship cruise missiles; KILO submarines; SOVREMENNYY destroyers; and associated weapon systems."[103]

Admitting that China is making across-the-board investments in advanced military capabilities is not tantamount to predicting that the United States and China will become military rivals. "An increasingly

[102] Donald H. Rumsfeld, "Global War on Terrorism," memorandum to Gen. Dick Myers, Paul Wolfowitz, Gen. Pete Pace, Doug Feith, October 16, 2003.

[103] *Report to Congress on PRC Military Power* (Washington, DC: DoD, 2004), p. 30.

capable PLA does not necessarily mean China is an emerging threat."[104] Indeed, a goal of American foreign policy is to dissuade China's leaders from moving the PRC toward becoming a military rival to the United States in coming decades, and it remains entirely possible that they can be convinced that being a cooperative and transparent member of the international community is in China's best interests.

However, it is also true that China's leaders are highly secretive, have staked their legitimacy on high rates of continuing economic growth, and that transparency is anathema to the PLA's "doctrinal emphasis on concealment and deception."[105] Chinese authors "consistently express suspicions about foreign powers, especially the United States, Japan, and India," and they fear that foreign powers "would prefer to divide China if given the opportunity."[106] Chinese foreign-policy experts see the world moving toward a new multi-polar order in which the current hegemon, the United States, will decline, becoming roughly equal in power with China, the European Union, Japan and Russia in the 2020s.[107] In the meantime, they foresee danger for China comparable to that the smaller Chinese states faced during the Warring States era (475-221 B.C.) when the Qin hegemon subdued all its weaker rivals.[108] On this view, China's strategic goal is to continue gaining national power until it can assume its rightful place in the emerging, multi-polar world order while avoiding being crushed by a predatory and dangerous United States.

Again, although this decidedly Chinese outlook does not necessitate eventual confrontation or conflict between the United States and the PRC, the *potential* for misunderstanding and military rivalry certainly exists. There are, after all, many prospective flash points that

[104] Mark A. Stokes, *China's Strategic Modernization: Implications for the United States* (Carlisle, PA: Strategic Studies Institute, September 1999), p. 140.

[105] Stokes, *China's Strategic Modernization*, p. 145.

[106] Michael Pillsbury, *China Debates the Future Security Environment* (Washington, DC: National Defense University Press, 2002), p. xvii.

[107] Pillsbury, *China Debates the Future Security Environment*, p. xl.

[108] Pillsbury, *China Debates the Future Security Environment*, pp. xxxv, xxxix, xl, 7, 9-10, 55-6.

could lead to confrontation and conflict. One is access to natural resources such as oil and natural gas; China has gone from being a net oil exporter to a net oil importer over the last decade, and its need for imported oil (and oil products) is expected to "increase sharply over the next two decades."[109] Further, projections of PRC energy demands, to include Persian Gulf sources, presume continued high rates of economic growth. During 2001-03, China accounted "for one-third of global economic growth (measured at purchasing-power parity), twice as much as America."[110] According to official statistics, China's economy grew 9.5 percent in 2004, slightly faster than the 9.3 percent reported the previous year.[111] But Chinese economic growth is a two-edged sword. On the one hand, continued economic growth at this pace will increase China's needs for foreign oil. On the other hand, a significant economic slow down in China could imperil other economies, particularly in Asia, and raise questions about the legitimacy of the Chinese Communist Party to govern. In short, there are great uncertainties about the path China will end up following over the next two or three decades.

Until American leaders can be reasonably confident that US-PRC military competition or conflict can be avoided, there is little choice other than to hedge against these possibilities. A robust capability for long-range strike is one area of military competence in which the United States ought to hedge against the prospect of a hostile China with strategic depth and staying power. Furthermore, because major American weapon systems such as the F/A-22 have taken two decades to get from concept validation to IOC, it appears prudent to begin moving forward in the very near-term.

The eventual emergence of a hostile China armed with advanced weaponry is by no means the only development that could lend further

109 Ronald Soligo and Amy Jaffe, "China's Growing Energy Dependence: The Costs and Policy Implications of Supply Alternatives," Baker Institute Working Paper, February 11, 2004, p. 3. During 1994-2004, China's oil demand doubled, but its domestic production grew more slowly ("A Hungry Dragon," *The Economist*, A Survey of the World Economy, October 2, 2004, p. 12).

110 "The Great Fall of China?" *The Economist*, May 13, 2004, at http://www.economist.com/opinion/displayStory.cfm?story_id=2668015.

111 "China's Economy Grows 9.5% in 2004," *China Daily*, January 25, 2005, online at http://www.chinadaily.com.cn/english/doc/2005-01/25/content_412097.htm.

urgency to the need to begin developing next-generation LRS systems. One all-too-likely possibility is the further proliferation of nuclear weapons. The Indians first tested a nuclear device in 1974, making India a "threshold" nuclear power until May 1998, when it conducted five more underground tests (including at least one thermo-nuclear detonation). Pakistan responded with its own nuclear tests in September 1998, and by 2002 both states were assessed to have small inventories of nuclear weapons (up to 50 weapons) and delivery means. In addition, Pakistan is now known to have provided assistance via a "private" proliferation network to North Korea, Libya and Iran.

Iran and North Korea appear to be two other countries in which nuclear non-proliferation has been breaking down, despite Libya's willingness to abandon its nuclear program. Iran's leaders appear determined to acquire nuclear weapons as do North Korea's. By 2002 the Central Intelligence Agency (CIA) estimated North Korea to have two nuclear bombs and the current estimate—subject to the usual uncertainties—is that the North Koreans now have a greater capability than CIA's 2002 estimate.[112]

Unless North Koreans can be convinced to give up their nuclear weapons and Iran's ayatollahs to abandon their efforts to acquire them, the likely consequences for the international order are not encouraging. As Henry Kissinger recently wrote:

> In the American view—which I share—the spread of nuclear weapons, especially in regions of revolutionary upheaval, will produce a qualitatively different world whose perils will dwarf the worst nuclear nightmares of the Cold War. Such a world is all too likely to culminate in a cataclysm followed by an imposed international regime for nuclear weapons.[113]

Paul Bracken had, of course, written in 2000 about the consequences for the balance of power in Asia that could arise from the un-

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[112] Glenn Kessler, "N. Korean Estimate To Rise," *The Washington Post*, April 28, 2004; "Goss: North Korea's Nuclear Capability Grows," CNN.com, posted February 17, 2005.

[113] Henry A. Kissinger, "Iran: A Nuclear Test Case," *The Washington Post*, March 8, 2005, p. A15.

checked proliferation of nuclear weapons by a growing number of Asian countries. In fact, he broached a broader challenge than nuclear proliferation, even though he tied them together under the rubric of a "second nuclear age." His broader concern was the prospect that Asian nations, having asserted themselves economically in the late 20th century, would now begin seeking nuclear and other cutting-edge weaponry as "disruptive technologies" whose eventual effect would be to "thwart" Western—first and foremost American—military preeminence in Asia.[114] On the view that Western domination of Asia dates from the landing of Vasco da Gama in India in 1498, Bracken suggested that the world after 1991 was not entering "a post-Cold War era but a post-Vasco da Gama era" in which the main trend would be growing resistance by rising Asian "economic tigers" to Western military dominance.[115]

Nevertheless, at the heart of this prospective trend was the issue of nuclear proliferation. Bracken's "second nuclear age" described a situation regarding weapons of mass destruction very different from the essentially two-player nuclear balance that dominated the Cold War era of the "first nuclear age."[116] Thus, Bracken's 2000 article, "The Second Nuclear Age," fully supported Kissinger's judgment that "as nuclear weapons spread into more and more hands, the calculus of deterrence grows increasingly ephemeral," deterrence "less and less reliable," and it becomes "ever more difficult to decide who is deterring whom and by what calculations."[117]

As much as the United States and its NATO allies would prefer to talk North Korea, Iran and other nuclear aspirants out of their programs, the fact is that countries such as Iran have strong incentives for

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114 Paul Bracken, "The Second Nuclear Age," *Foreign Affairs*, January/February 2000, pp. 146-47.

115 Bracken, "The Second Nuclear Age," p. 148.

116 Paul Bracken, "The Second Nuclear Age: How Much Has Changed, How Much Remains the Same?" November 17, 2002 [Draft 2], pp. 6-8. This paper focused on nuclear weapons. That said, Bracken observed that whereas game theory supported a "waiting" strategy in the case of two nuclear rivals, with three players "there are no known satisfactory solutions . . . that do not take account of communication, trusts, and commitment," all which may be lacking in real-world situations in Asia in coming decades (ibid., p. 7).

117 Kissinger, "Iran: A Nuclear Test Case," p. A15.

seeking weaponry that will undermine Western influence and military dominance. The Iranian ayatollahs have now had two opportunities to witness directly across their western border the effectiveness American conventional arms and, in contrast to the Chinese, they surely must realize that their chances of developing symmetric military capabilities with which to oppose American forces in open battle are slim. As Kissinger put it in 2005, nuclear weapons offer Iran "a shield to discourage intervention by outsiders in its ideologically based revolutionary foreign policy," which includes support for terrorist organizations such as Hezbollah.[118] This view of why Iran's ayatollahs are seeking nuclear weapons certainly fits with Bracken's worries about a post-Vasco da Gama era in Asia. As Fred C. Iklé told a senate subcommittee immediately after the May 1998 Indian nuclear tests, "the global spread of technology is a force far too powerful, too elemental, to be stopped with dikes and dams built with the parchment of arms control treaties."[119]

Long-range strike, by itself, is unlikely to solve the challenges of Bracken's post-Vasco da Gama era. At the same time, a robust capability to find and attack nuclear facilities and forces worldwide, regardless of enemy air defenses, might help the United States to navigate the dangers of a nuclear "arc of instability" stretching from Israel to North Korea. If nothing else, the ability to strike anywhere on the globe within minutes from the continental United States might be particularly valuable since it would greatly reduce the time within which nuclear facilities or forces, once found, could be moved or hidden.

The final challenge against which improved long-range strike can hedge is to mitigate the risks and vulnerabilities of dependence on theater bases. Theater basing for short-range systems faces two basic challenges: first, the political issue of gaining access to overseas bases in the territories of nations in proximity to the theater of operations; and, second, the military problems of sustaining operations from these

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118 Kissinger, "Iran: A Nuclear Test Case," p. A15.

119 Available online from the website of the Federation of American Scientists (FAS) at http://www.fas.org/spp/starwars/congress/1998_h/s980513-ikle.htm. A more recent observation is that the US invasion of Iraq in 2003 may have had the unintended consequence of encouraging nations such as Iran "to redouble their bombing-building" efforts ("Win Some, Lose Some," *The Economist*, June 5, 2004, p. 25).

bases should the enemy attack them.[120] For whatever reasons, nations with bases close enough for short-range systems might refuse to grant access.[121] In 2003, even though Turkey permitted some Coalition operations from within its borders, the Turkish government was unwilling to allow the American 4th Infantry Division to utilize its sovereign territory to mount a thrust into northern Iraq.

The military problem is the growing vulnerability of in-theater bases to enemy attack. For instance, a 1999 study by two RAND analysts, John Stillion and David Orletsky, found that even small nations could afford the weaponry to disrupt US operations from nearby air bases. In the case of US land-based strike aircraft operating from four airfields lacking shelters, they estimated that for about $1 billion an adversary could buy enough cruise and ballistic missiles with guided submunitions to attack all the aircraft at these bases "between 6 and 12 times each" with results so destructive to equipment and disruptive of sortie generation that the USAF might be forced abandon bases within the enemy's reach.[122] They concluded, therefore, that continued dependence primarily on short-range platforms operating from bases as much as 1,500-2,000 nm from enemy territory might not be viable in the long-term against smart, determined adversaries. Stillion and Orletsky recommended shifting, instead, to greater reliance "on a fleet of long-range aircraft operating from permanent bases" beyond the reach of affordable adversary ballistic and cruise missiles with modern submunitions.[123]

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[120] These problems were first highlighted as a major operational challenge for future US force projection in 1997: see National Defense Panel, *Transforming Defense: National Security in the 21st Century* (Arlington, VA: National Defense Panel, December 1997), pp. 1, 11, 12, 21, 35.

[121] In 2002, Chris Bowie's judgment was that when one took "into account the inter-related factors of aircraft characteristics, aircrew fatigue, combat mission profiles, aerial refueling requirements, sortie rates, and aircrew to aircraft ratios," land-based, short-range aircraft typically required "bases within 1,000 to 1,500 nautical miles of enemy borders to conduct effective operations"—Christopher J. Bowie, *The Anti-Access Threat and Theater Air Bases* (Washington, DC: CSBA, 2002), p. ii.

[122] Stillion and Orletsky, *Airbase Vulnerability to Conventional Cruise-Missile and Ballistic-Missile Attacks*, p. 27.

[123] Stillion and Orletsky, *Airbase Vulnerability to Conventional Cruise-Missile and Ballistic-Missile Attacks*, p. 60.

In 2002, Christopher Bowie explored a wide range of possible counters to the emerging problems of access to theater bases close enough for short-range strike aircraft. These countermeasures included diplomatic engagement to ensure political access, developing available bases and prepositioning consumables, dispersal, rapid suppression of anti-access threats, large man-made sea bases, active defenses, and increased reliance on long-range systems that could be based outside the reach of the opponent's anti-access systems. After examining all these options, Bowie reached two fundamental conclusions. First, the growing risks to US global power projection due to over-reliance on large, fixed theater bases is a problem of the joint force, not just of the Air Force. OEF and OIF both underscored the increasing dependence of the joint force on precision strike, and land and naval forces also have dependencies on forward bases.[124] Second, the investment patterns in Figure 4 argue that the Air Force is betting too heavily on short-range strike. Hence Bowie suggested that OSD would be wise re-evaluate the reliance in the plans of the military services—especially the Air Force—to hedge against the possibility of having to operate from long ranges in future anti-access environments.[125]

In sum, the possibility of military competition or conflict with China or other rising Asian powers, the prospect of nuclear weapons in the hands of unstable Asian states with links to terrorist organizations, and the emerging risks to US force projection of heavy dependence on theater basing argue that the need to begin moving forward in LRS is more urgent than most in the US defense establishment have been willing to admit. Insofar as defended airspace is concerned, the only survivable long-range platforms are the 21 B-2s, of which no more than 16 are available for combat operations at any one time. Sixteen airframes are not much of a hedge. Further, even one or two nuclear weapons delivered by short-range missiles could pose an unprecedented threat to theater bases and forward-deployed forces. The United States has never mounted combat operations against a nuclear-capable opponent.

Last but not least, there is the geography of Asia. Theaters of operations in Asia present distances that are at least double those over

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[124] Bowie, *The Anti-Access Threat and Theater Air Bases*, p. 66. Naval aviation, even when operating from aircraft carriers, is dependent on the Air Force's land-based tankers.

[125] Bowie, *The Anti-Access Threat and Theater Air Bases*, p. 66.

which short-range strike aircraft operated during the major air campaigns of 1991, 1999, 2001-02 and 2003. Table 1 contrasts US operational experience starting in 1991 with the one-way strike distances American forces could face in coming decades. Consider Ahmed Al Jaber Air Base (AB) in Kuwait. The great-circle distance from Al Jaber to Kabul in Afghanistan is under 1,200 nm, although during OEF USAF fighter-bombers based there had to fly somewhat longer distances to avoid Iranian airspace. But with multiple air refuelings and "pep pills" (stimulants) to keep aircrews alert during sorties lasting 6-7 hours, short-range platforms were able to conduct strike operations over these distances. Nevertheless, the combat radii to strike targets in Afghanistan from Kuwait did not approach long-range as characterized in Figure 1. At most an F-16 or F-15E sortie from Al Jaber to Afghanistan in October 2001 would fall in the gray area between short - and medium-range.

Table 1: One-Way Distances for Strike Operations in OEF and OIF versus Prospective Future Asian Contingencies[126]

Route	Nautical Miles	Kilometers
Distances Encountered during ODS, OEF and OIF		
Al Jaber, Kuwait, to Kabul	1,175 nm	2,175 km
Thumrait, Oman, to Kabul	945 nm	1,750 km
Al Jaber to Baghdad	315 nm	585 km
Diego Garcia to Baghdad	2,910 nm	5,390 km
Possible One-Way Strike Distances for Future Operations in Asia		
Kadena, Okinawa, to Fujian Province	540 nm	1,000 km
Kadena to Yongbyon, NK	810 nm	1,505 km
Kadena to Beijing	990 nm	1,835 km
Thumrait to Tehran	1,090 nm	2,025 km
Thumrait to Karachi	2,660 nm	4,925 km
Guam to Fuijian Province	1,650 nm	3,055 km
Guam to Yongbyon, NK	1,870 nm	3,460 km
Guam to Beijing	2,180 nm	4,035 km
Diego Garcia to Tehran	1,715 nm	3,175 km

In 1991, B-52Gs did fly sorties from the British airfield at Diego Garcia in the Indian Ocean, as well as from bases in England and Spain. In all three of these cases, the combat radius involved was in the neighborhood of 3,000 nm, and the distance had a significant ef-

[126] All distances shown are great-circle routes without adjustments for political boundaries, and have been rounded to the nearest 5 nm or 5 km.

fect on sortie rates when compared with those achieved by B-52Gs operating out of Jeddah in Saudi Arabia during Desert Storm. The Jeddah B-52s faced a mission radius of around 700 nm and achieved a sortie rate of nearly 1.3 missions/day, whereas the same bomber operating from Diego Garcia, Spain and England averaged less than 0.5 missions/day.[127] This comparison illustrates the impact long mission distances can have on sortie rates and, consequently, on the ability to concentrate, or mass, the effects of precision strikes in time.

Looking ahead to future military operations in Asia in Bracken's post-Vasco da Gama era, it is instructive to consider the North Korean nuclear facility at Yongbyon. With Kadena AB on Okinawa, Yongbyon is within the reach of short-range aircraft. Without Kadena, the nearest field could be as far away as Anderson on Guam, which would add another 1,000 nm to the one-way, great-circle distance to the target. Even greater increases occur in the case of targets located deep in China, as opposed to conveniently arrayed along the PRC's coast. Further, a base such as Kadena could eventually be lost either for political reasons or due to enemy attack. Either way, dealing with a China contingency using strike assets based as far away as Guam looks like a task for long-range, as opposed to short-range, systems.

Hedging sufficiently against mid- to long-term challenges is always difficult when involved in on-going military operations in the present. It is not at all clear, however, that the Defense Department as a whole recognizes the urgency of moving ahead on LRS. And, as indicated in the previous chapter, the problem is not money but priority and focus.

GAPS: EMERGING OR TIME-SENSITIVE TARGETS AND 24/7 STEALTH

The last part of the argument identifies gaps in current American LRS capabilities. The most important of these concerns the US capacity to attack emerging, time-sensitive, fleeting, or moving targets.

Prior to the 1991 Persian Gulf War, there was little appreciation for the revolutionary potential of guided air-to-ground munitions out-

[127] The primary source for the sortie-rate comparison is GWAPS, Vol. V, Part 1, *A Statistical Compendium*, pp. 346, 556-97.

side a few proponents in the US Air Force, including those who had witnessed the effectiveness of LGBs in Southeast Asia during 1968-73. As an indication of just how accurate and reliable LGBs proved during this period, from February 1, 1972, to February 28, 1973, the USAF dropped over 10,500 LGBs in Southeast Asia; of this total more than 5,100 (49 percent) were assessed as direct hits and an additional 4,000 (38 percent) achieved estimated CEPs of 25 feet.[128] RAND analysts who reviewed this data assessed the results as having been "spectacularly good."[129]

Impressive as the 1972-73 results were, after the Vietnam War few in the Air Force believed that LGBs or other guided munitions could supplant large quantities of "dumb" bombs in extended air campaigns. There were a number of reasons for this attitude. LGBs could only be employed through clear air; laser illumination of the target was required to impact as opposed to being fire-and-forget (or even launch-and-leave); and, the advent of improved bombing computers in fighters such as the F-16 led many to see the "smart jet" accurately delivering "dumb bombs" as a superior solution given the perceived high cost of LGB guidance kits.

In light of this history, it was not unreasonable for Iraqi Air Force leaders to presume prior to 1991 that hardened aircraft shelters would allow its aircraft to survive airfield attacks by US forces. The best-known successes of LGBs in Southeast Asia had been against lines-of-communications targets, notably the Paul Doumer and Thanh Hoa bridges. Prior to January 1991 LGBs had not been employed on any significant scale against hardened aircraft shelters, and there was ample evidence to suggest that unguided bombs would rarely be accurate enough to penetrate the modern shelters on Iraqi airfields. Statistically, if unguided bombs were employed in large quantities against hardened shelters, there might be an occasional lucky hit, but no systematic destruction of sheltered aircraft.

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[128] Major Donald L. Ockerman, *An Analysis of Laser Guided Bombs in SEA (U)* (Thailand, 7th Air Force Tactical Analysis Division, June 28, 1973), Air Operations Report 73/4, pp. ii and 2.

[129] R. L. Blachly, P. A. CoNine and E. H. Sharkey, *Laser and Electro-Optical Guided Bomb Performance in Southeast Asia (LINEBACKER 1): A Briefing* (Santa Monica, CA: RAND Corporation, October 1973), R-1326-PR, p. v.

Toward the end of the first week of Operation Desert Storm, Coalition air forces had succeeded in gaining effective air control, but the majority of the Iraqi Air Force remained a force-in-being, its aircraft hunkered down inside hardened shelters. This situation prompted a Coalition decision to begin a systematic shelter-busting campaign against Iraqi airfields relying primarily on F-111Fs equipped with Pave Tack laser-designation pods.[130] Pave Tack's imaging infrared detectors enabled F-111F crews to acquire, recognize, and attack point targets day or night. This unexpected use of 2,000-pound-class hard-target-penetrating LGBs to bust Iraqi aircraft shelters soon prompted the Iraqis to begin attempting to fly their advanced aircraft to refuge in Iran.[131]

Nor was the vulnerability of aircraft shelters the only surprise that guided munitions inflicted on for the Iraqis in 1991. Later in the campaign Coalition air power provided Iraqi ground forces with a similar shock by demonstrating that main battle tanks and other heavy ground-force equipment could be destroyed by 500-pound LGBs even when protected by deep sand berms.

Iraqi mobile launchers for extended-range variants of Russian SS-21 (Scud B) ballistic missiles, however, proved to be a different matter in Desert Storm. The Iraqis deployed their mobile launchers to concealed locations or "hides" before the Coalition air campaign kicked off on January 17. Once loaded with a missile, an individual launcher emerged just long enough to drive, usually at night, to a pre-surveyed launch position, set up, fire, and then race back to a hide. Since most of the hides were not located by the war's end, these mobile launchers provided the paradigm of an emergent, time-sensitive target. Moreover, despite wartime aircrew and special operations forces (SOF) kill claims totaling some 100 Iraqi mobile launchers, Gulf War Air Power Survey researchers concluded that "few, if any" were actu-

[130] The first F-111F attacks on Iraqi aircraft shelters with LGBs occurred the night of January 23, 1991, and were against Al Asad airfield. Gulf War Air Power Survey data indicated that 19 F-111Fs dropped GBU-24A/Bs on shelters at Al Asad that night. The GBU-24A/B consisted of a Paveway III guidance kit and a BLU-109/B hard-target warhead.

[131] After Desert Storm, however, the Iranians did not return any of the aircraft that managed to avoid US F-15Cs and reach safety at Iranian fields.

ally destroyed by Coalition aircraft or SOF (although numerous decoys, both high and low quality, were eliminated).[132]

The contrast with guided-weapon effectiveness in 1991 against Iraqi aircraft shelters and heavy ground-force equipment is striking. The Iraqis made extensive efforts to hide their mobile-missile launchers from Coalition forces. In addition, once a missile had been fired, launcher and crew began driving away from the launch site within minutes. Even the F-15E, which had the best sensor suite of any Coalition aircraft in 1991, lacked the resolution to give the crew much chance of acquiring a mobile launcher racing toward its hide. A revealing statistic is that while nearly half of 88 total launches were observed by aircrews orbiting nearby on night time "Scud patrols," these crews only managed to prosecute their response to the point of ordnance release in eight of the 42 observed launches.[133]

Looking back, LGBs provided the accuracy and reliability to attack fixed targets in clear air; JDAMs added the capability for fire-and-forget attack of fixed targets even through adverse weather. Except for very hard or deeply buried targets, these two munitions rendered the air attack of fixed targets a largely "solved" problem. [134]

By comparison, emergent, time-sensitive, and moving targets appear to remain a work-in-progress. Their status, moreover, depends on the state of the hider-finder competition at any point in time. Because that competition centers on information, and because there will always be ways for hiders to deny crucial targeting information to finders through concealment, deception and numerous other stratagems, this class of targets gives every indication of being an inherently

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[132] Keaney "Gulf War Airpower," p. 30. This GWAPS finding remains disputed. Wayne Downing, who commanded US Special Operations Forces (SOF) in Desert Storm, stated in 2002: "I know that SOF took out six to eight Scuds" ("The Tip of the Spear," *Newsweek*, November 25, 2002). Also to be stressed is that even if no launchers were destroyed, Coalition efforts to locate and destroy them suppressed launch rates and contributed to more important goals such as keeping Israel from entering the war.

[133] Gulf War Air Power Survey, Vol. II, *Operations and Effects and Effectiveness*, Part 2, *Effects and Effectiveness* (Washington, DC: US Government Printing Office, 1993), pp. 335-36.

[134] John A. Tirpak, "Roche Plots a Course," *AIR FORCE Magazine*, October 2001, p. 67; "Roche Sorts It Out," *AIR FORCE Magazine*, March 2002, p. 39.

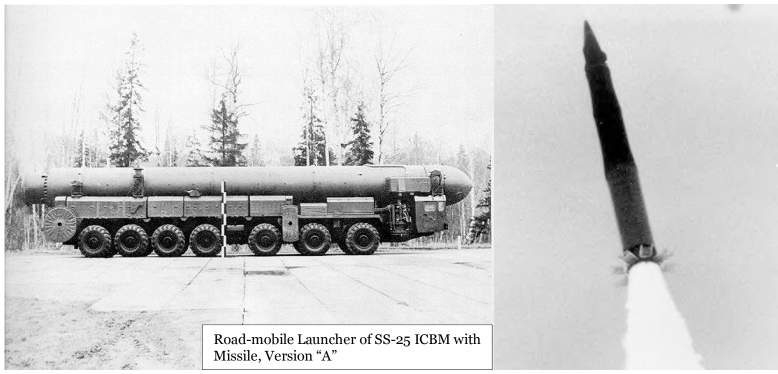
open-ended, if not intractable, problem. It follows, then, that emergent, time-sensitive and moving targets present the attacker with an information problem that is unlikely to be solved once and for all—especially by purely technological advances such as bringing laser or INS/GPS-aided guidance to maturity.

This situation has far-reaching implications for LRS. Consider targets that are hidden most of the time, only vulnerable to attack during brief intervals when must expose themselves to fire on or otherwise engage US forces. It is possible that such targets will always be located in littoral areas or close enough national borders for their fleeting moments of vulnerability to be observed by standoff surveillance platforms such as the E-8 Joint Surveillance Target Attack Radar System (Joint STARS) orbiting outside defended airspace. However, it is difficult to believe that military planners of countries with the geographic depth of China or Russia would fail to grasp the advantages of placing at least some important assets deep inland, well beyond the reach of American standoff surveillance short-range strike systems. Nor, given both demonstrated American proficiency against fixed targets and the difficulties US forces have experienced with more fleeting targets such as Iraq "Scud" launchers in 1991, is it plausible that future adversaries will neglect doing everything possible deny "precision" targeting information to American forces.

Rather, trends over at least the last decade indicate that the competition between hiders and finders is intensifying, with particular attention being paid by prospective American adversaries to mitigating or neutralizing US capabilities for precision strike. For example, after the Cold War ended the Russians continued deploying SS-25 road-mobile, single-warhead ICBMs, building to an estimated peak of 360 operational missiles. They are currently estimated to have 315 SS-25s in service based at locations as deep in Russia as Novosibirsk and Irkutst.[135] When field deployed, these mobile ICBMs can be dispersed over wide areas and readily hidden from surveillance.

[135] "Russian Strategic Nuclear Forces," Russian Nuclear Forces Project, January 3, 2005, online at http://russianforces.org/eng/missiles). This project was started in 1991 by a group of young Russian scientists at the Center for Arms Control Studies.

Figure 7: Russian SS-25 "Topol" Road-Mobile ICBM[136]



While the Chinese have rarely been forthcoming about their missile programs, there are indications that they are also pursuing concealment and mobility to enhance survivability. Typical of the Chinese approach to nuclear forces, their DF-4 (CSS-3) ICBMs are hidden in caves, and their DF-21A (CSS-5) medium-range ballistic missiles are road mobile.[137] In addition, much of the infrastructure for Chinese nuclear-weapon production is concentrated in the center of the country in Sichuan and Gansu provinces.[138] As for PRC conventional ballistic missiles, the short-range CSS-6s (DF-15s) fired near and over Taiwan during 1995-96 are launched from wheeled transporter erector launchers (TELs), have been deployed in large numbers (600+) opposite Taiwan by the PLA's Second Artillery Corps, and may have CEPs of 30-45 meters.[139] Indeed, so extensive has been the build-up of PRC

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[136] Sources: Russian Federation photos online at the FAS website (http://www.fas.org/nuke/control/start1/text/image/rfphotos); also at Global Security's website (http://www.globalsecurity.org/wmd/world/russia/rt-2pm.htm).

[137] "Table of Chinese Nuclear Forces, 2002," Natural Resources Defense Council, online at http://www.nrdc.org/nuclear/nudb/datab17.asp.

[138] Rodney W. Jones and Mark G. McDonough with Toby Dalton and Gregory Koblentz, *Tracking Nuclear Proliferation: A Guide in Maps and Charts, 1998* (Washington, DC: Carnegie Endowment for International Peace, 1998), p. 62.

[139] In the mid-1990s firings, the Dong Feng-15 (East Wind) demonstrated a CEP of around 300 meters. The lower CEP of 30-45 assumes terminal guidance. By 1999, the Chinese had flight tested a GPS trajectory reference system, developed an integrated NAVSTAR GPS and GLONASS receiver (GLON-

conventional ballistic-missile forces opposite Taiwan that one long-time observer of Chinese military programs described it as the "most daunting . . . in the world," adding that this threat will only grow as the PLA adds first-generation land-attack cruise missiles.[140]

The broad trend evident in these force developments is that foreign militaries that been paying close attention to evolving US conventional capabilities and are moving toward mobility, periodic relocation, camouflage and concealment, hardening, underground facilities, geographic dispersal, and positioning deep inside defended airspace to improve the survivability of their military systems and facilities. A telling example was the success the Serbs had in 1999 in keeping relocatable elements of their air defense system alive by displacing SAM launchers and radars as little as a few hundreds of yards overnight. These small displacements blurred the precise coordinates of these targets inside the cycle time of the NATO air-tasking-order (ATO) process, which meant that they could survive strikes by systems such as TLAM that targeted coordinates.[141]

The mix of capabilities the US military will need to cope with this adverse trend will vary from opponent to opponent and from conflict to conflict. Once again, the underlying dynamic is a hider-finder competition, one that will continue to be played out on two distinct levels for the foreseeable future. On one level, American strike aircraft use stealth to hide from enemy air defenses; on the other, the opponent exploits such counters as mobility, concealment and geographic dispersal to try to hide forces and facilities from US strike systems.

Given the open-ended character of the underlying hider-finder competition, it is not difficult to discern growing gaps in American

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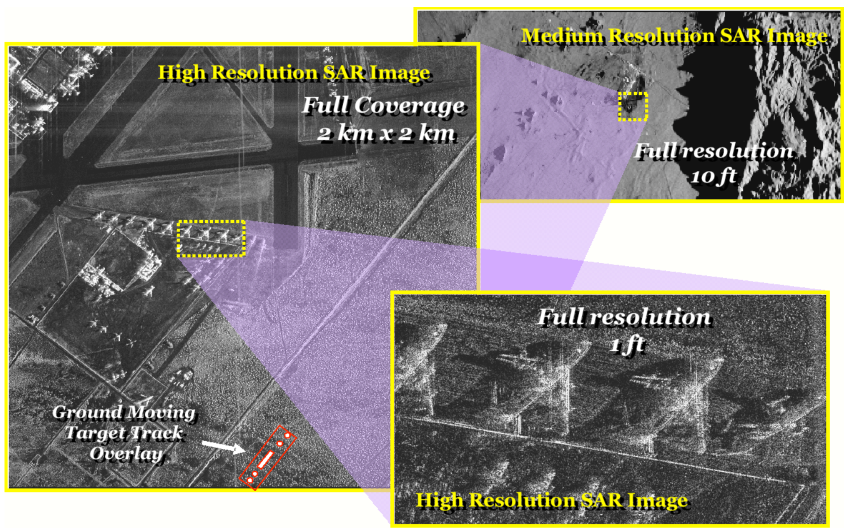
ASS being the Russian version of GPS), and conducted research on digital scene-matching terminal guidance that could provide 5-12 meter accuracy for PRC ballistic missiles (Stokes, *China's Strategic Modernization*, p. 92).

140 Mark A. Stokes, "The Growing PRC Missile Threat: Options for Taiwan Missile Defense," US-Taiwan defense-industry conference, San Antonio, TX, February 12-14, 2003, slide 4. Stokes was an assistant air attaché in Beijing during 1992-95.

141 Author's notes from discussion with Colonel Tony Imondi, 509th Bomb Wing, Whiteman AFB, MO, August 13, 1999. Imondi was the Operations Group commander of the B-2 wing at Whiteman during Operation Allied Force.

LRS capabilities as adversaries become more skilled in denying targeting information on their military forces and infrastructure. If adversaries are likely to confront US forces more and more with emergent, time-sensitive, fleeting, or even moving targets, then the ability to persist relatively deep inside enemy airspace while waiting for such targets to reveal themselves will be at a premium. The resulting need is not *just* for long range, although this attribute can always be converted to loiter time in areas wherein such targets are expected. Beyond persistence, the sensor resolution to identify targets and the means to put munitions on them quickly, before they disappear, are also needed. Further, if either surveillance or guided munitions are provided by air vehicles operating inside defended enemy airspace, then the survivability of those platforms is also an important requirement.

Figure 8: SAR Resolution: 10 Feet-1 Foot[142]



Adequate sensor resolution is perhaps the easiest of these interlocking requirements to assess. Prior to Desert Storm, flight tests in the United States against a Russian-built Scud TEL revealed that with the vehicle parked at a location whose coordinates were known to aircrews prior to takeoff, even the F-15E had a limited chance of acquir-

[142] Source: Raytheon.

ing the target unless the missile was erected.[143] Sensor technology has, of course, advanced since 1991. However, in light of justifiable American sensitivity to collateral damage based on misidentifying targets, SAR resolutions of 1-foot or less are probably a minimum for the long-term if attack radars and other imaging sensors are to supplant "eyes on target." The B-2's current SAR resolution of 10 feet (see the upper righthand image in Figure 8) is an order-of-magnitude short of this goal (Figure 8, lower righthand image).

Turning to survivability, the only strike platforms now capable of operating inside defended airspace are the long-range B-2 and the short-range F-117 and F/A-22. The F/A-22 Raptor's combination of stealth, "supercruise" (non-afterburning sustained speed of Mach 1 or higher in level flight), and air-to-air capability undoubtedly make it "the most survivable airplane ever to fly."[144] As F/A-22 proponents have stressed, its low observability plus its "capability to fight" enemy interceptors will "put stealth in the daytime."[145] The inability of the F-117 and B-2, if located by enemy fighters, either to outmaneuver or to engage them with air-to-air missiles explains why the Air Force has only been willing to operate these planes inside enemy airspace at night. In the B-2's case, however, this limitation could be mitigated by adding a capability to target enemy fighters with radar-guided missiles such as the AIM-120 Advanced Medium-Range Air-to-Air Missile (AMRAAM).[146]

While tradeoffs between speed of attack and persistence are not as easy to evaluate, it is far from evident that speed wins out overall. Consider, as a brief thought experiment, a B-2 and F/A-22 each being appraised of a time-sensitive target 100 nm away. Assuming both platforms are at high altitude and equipped with small diameter bombs (SDBs) that can be released by either plane at least 40 nm from the target, then the B-2 will need just over seven minutes to get to the

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143 GWAPS, Vol. II, Part 2, *Effects and Effectiveness*, pp. 334-35. The Touted Gleem test involved an F-15E, F-111F, and a LANTIRN-equipped F-16.

144 Grant, "In Defense of Fighters," p. 42.

145 Tirpak, "The Raptor as Bomber," p. 33.

146 As noted in CSBA's September 2004 backgrounder, if the B-2 was upgraded with a modern computer architecture, an AMRAAM capability could be added (Watts, "Moving Forward on Long-Range Strike," p. 17). In the case of the F-117, adding radar–guided missiles would probably not be feasible.

release point. If the F/A-22 is supercruising at Mach 1.5-plus, it should be able to reach the release point in half that time. The question then becomes: how often is the difference between seven and 3.5 minutes to weapon release likely to allow the target to escape?

One can, of course, imagine tactical circumstances in which this time differential would spell the difference between a successful strike and a missed opportunity. However, if the TSTs in question are only 600 nm inside defended airspace, the F/A-22 would have to have come off a tanker, headed straight for the target at a subsonic speed, and only accelerated to supercruise for the last 100 nm of the profile in order to complete the strike with enough fuel make it back to the tanker. True, aerial refueling can extend the reach of short-range fighter-bombers so long as the portion of the profile inside enemy airspace does not exceed their unrefueled combat radii. But in the absence of stealthy tankers that permit aerial refueling inside defended airspace, the distance any strike platform can reach into airspace protected by enemy fighters and SAMs is limited to the aircraft's unrefueled combat radius.[147] In the case of the F/A-22, this distance is 400-600 nm, depending on how much of the profile is flown supercruising at Mach 1.5.[148] Nor, in this situation, would the F/A-22 have much persistence in the vicinity of targets at depths of 500-600 nm inside defended airspace. A B-2 with the computational capacity to be freed from a preplanned blue line and armed with AMRAAM for self defense, on the other hand, could conceivably provide persistence at this depth—especially if F/A-22s and other systems were able to put pressure on enemy fighters.

The argument has been made by those defending short-range fighters that the greater reach and persistence of long-range systems is only valuable in "a narrow class of scenarios where basing concerns and extreme inland ranges" stretch out the combat radius required and air defenses are so light as to "take attrition out of the equation," as was the case with the B-1 in OEF.[149] If, however, exploiting mobil-

[147] In 2004, Lockheed Martin proposed low-observable airframe that could be used for a number of missions, including aerial refueling (David A. Fulghum, "Striking Concepts," *Aviation Week & Space Technology*, November 29, 2004, pp. 26-7).

[148] Tirpak, "The Raptor as Bomber," p. 33. This article gives the unrefueled combat radius of the F/A-22 as 595 nm on an all-subsonic mission profile.

[149] Grant, "In Defense of Fighters," p. 43.

ity, concealment, underground facilities and strategic depth to frustrate US strike capabilities is where potential US adversaries are headed, then this argument collapses. Ballistic and cruise missiles can be positioned considerable distances inside defended airspace; increased adversary exploitation of emergent and time-sensitive targets appears to demand greater American capacity for being able to loiter in the vicinity of those targets; and while the deep targets may not be huge in numbers, they may turn out to be those the other side is most concerned to preserve or, in the case of "loose nukes," the one US political leaders will be most concerned to strike.

In the mid- to long-term, the United States faces growing gaps not merely in being able to strike deep but to have the persistence to find and prosecute emergent and time-sensitive targets deep inside defended airspace beyond the reach of short-range systems. Survivability there being part of the equation, the lack of "24/7 stealth" may argue in the long run for favoring unmanned as opposed to manned LRS solutions. Nevertheless, the Air Force's inclination to bank so heavily on short-range, manned solutions appears fundamentally short sighted.

To be as clear and hard to misinterpret as possible, the capability gaps highlighted in this discussion are neither an argument for ending F/A-18E/F or F/A-22 production, nor for canceling the F-35 Joint Strike Fighter or the Joint Unmanned Combat Attack Systems (J-UCAS). To the contrary, these gaps argue for better balance between long- and short-range strike in DoD's investment portfolio for the mid- to long-term. Even if one is persuaded that long-range strike is a strictly Air Force issue, and that the Navy should be accorded a free pass on this matter from a resource standpoint, the investment data in Figure 4 documents that the portfolio has been unbalanced since the late 1990s, and there is every reason to expect that it will remain so unless some hard decisions about priorities and balance are made in the near-term. That, in short, is the strategic question raised by the overall argument of this chapter. Without some adjustment of the Defense Department's default priorities, it is difficult to see how the United States can retain its current preeminence in LRS, reduce reliance on nuclear weapons, deny prospective enemies sanctuaries, shape their investments by forcing them to spend more on defending against American LRS capabilities, hedge against a second nuclear age and Asian geography, or close the LRS capability gaps just identified.

Finally, by way of transitioning to the next chapter's task of narrowing the bewildering array of LRS options, the operational requirement to be able to loiter inside defended airspace and use "staring" surveillance to acquire fleeting targets when they reveal themselves, while remaining close enough to strike them in minutes, warrants further elaboration. Even a cursory review of TST problems during OEF and OIF reveals instances of lengthy delays between target acquisition and munitions impact. In some notable instances, these delays were not minutes but "hours to days" due to the insistence of the secretary of defense and combatant commander on avoiding collateral damage and attaining high certainty about the target prior to the decision to strike.[150] The reasons for these long delays varied, but included having lawyers vet the legitimacy of targets and insisting that the target be verified visually by SOF rather than relying on Global Hawk or Predator imagery. What these problems reveal is that the largest source of delays in sensor-to-shooter timelines stems from human decision making, not from the speed of the delivery platform or the munition being employed. For political and cultural reasons, it is unlikely that the possibility of human decision makers introducing delays of hours to days into strike operations will disappear anytime in the foreseeable future. If so, then the inclination of some to seek hypersonic cruise vehicles or missiles in order to reduce sensor-to-shooter timelines is unlikely to justify either the cost or technical risks of developing them. Instead, long-dwell inside defended airspace appears to be a much more sensible criterion for sorting through LRS options than platform or munition speed.

[150] Major General David Deptula, "Operation Enduring Freedom—Highlights, Challenges, and Potential Implications: Some Observations from the First 60 Days," December 2001, slide 3. Deptula was the director of the Combined Air Operations Center for OEF from September 23 to November 23, 2001.

III. Narrowing the Options

This final chapter addresses a simple question. Assuming the decision is made to begin developing one or more new LRS systems sooner rather than later, what sort of options make sense? There are aspects of making such choices—notably the survivability tradeoffs between cruise speed and signature—that cannot be resolved by the kinds of analyses offered in this report. In such cases, the best that can be done is to identify areas in which some hard-nosed operational and engineering analysis will be required.

With this caveat in mind, the direction of this chapter will be to utilize the strategic imperative to maintain the American advantage in LRS, the operational challenges stemming from emergent and time-sensitive targets, affordability, and technical feasibility to narrow the range of near-term options. The goal is to move beyond the bewildering array of choices the Air Force has been exploring—everything from new variants of existing bombers to hypersonic cruise vehicles and orbital space "planes"—and neck down to a few plausible candidates.

PROMPT GLOBAL STRIKE

The goal of "prompt" global strike from the continental United States (CONUS) has long appealed to the US Air Force. Arguably, in the 1950s Strategic Air Command achieved a capability for global strike with nuclear weapons directly from CONUS bases as B-52s and KC-135 tankers entered operational service in numbers. As ICBMs began to come on line in the early 1960s, SAC's nuclear-strike capability became prompt (that is, its land-based ICBMs were able to strike targets in the USSR within 35 minutes) even though the bomber leg of the Cold War nuclear triad provided over half of the US nuclear warheads until 1971.[151]

Since then, the Air Force has explored various ways of achieving prompt non-nuclear global strike, including basing weapons in space and using intercontinental ballistic missiles with conventional warheads. One of the earliest possibilities explored was the idea of placing small space vehicles ("buses") containing 15-20 long, dense, inert rods in elliptical orbits around the earth; once there, rods could be "deorbited" on command and their kinetic energy on impact used to destroy terrestrial targets such as Soviet hardened missile silos.[152] With orbital apogees perhaps 40,000 miles above the earth's surface, the velocity change ("delta vee") required to put these rods on trajectories that would intersect the GPS coordinates of terrestrial targets would have been low. But the kinetic energy the rods could have transferred to targets on impact was tremendous given terminal velocities in neighborhood of 6 kilometers/second. In addition, the down-range footprint on the earth's surface of a given bus from apogee could extend several thousand miles, and the prospects of effective defense against rods on their way down was virtually nil.

From 1978 to 1988, a total of perhaps $70-80 million was spent exploring this concept, including test shots against the Kwajalein Atoll from Vandenberg AFB in California.[153] In the end, however, the program met staunch opposition from Air Force fighter generals who were not interested in seeing SAC develop a non-nuclear global-strike capability. As a result, the program was terminated in 1988. Moreo-

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[151] According to the National Resources Defense Council's historical data, 1971 was the first year in which the number of nuclear warheads on US ICBMs and SLBMs exceeded the total from SAC's fully generated bomber force (online at http://www.nrdc.org/nuclear/nudb/datainx.asp).

[152] Gerry Sears, interview, May 30, 2000. Sears was the program manager during the decade this program existed. During the Cold War it was a black program. Not until a 1998 did open discussion of employing hyper-velocity rods from orbit against surface targets begin occurring.

[153] Sears, interview, May 30, 2000.

ver, the response time was not as prompt as most who heard about the program were inclined to assume.

The latest global-strike program aimed at prompt, non-nuclear, global strike is a DARPA-Air Force demonstration known as FALCON (*F*orce *A*pplication and *L*aunch from *CON*US). FALCON is a basket of things, including maneuverable glide vehicles (CAVs), a small launch vehicle, and a hypersonic cruise vehicle. The broad agency announcement (BAA) issued for FALCON in mid-2003 offered this overview of its aims and approach:

> DARPA and the Air Force share a vision of a new transformational capability that would provide a means of delivering a substantial payload from within the continental United States (CONUS) to anywhere on Earth in less than two hours. This capability would free the U.S. military from reliance on forward basing to enable it to react promptly and decisively to destabilizing or threatening actions by hostile countries and terrorist organizations.
>
> The Government's vision of an ultimate prompt global reach capability (circa 2025 and beyond) is engendered in a reusable Hypersonic Cruise Vehicle (HCV). It is envisioned that this autonomous aircraft would be capable of taking off from a conventional military runway and striking targets 9,000 nautical miles distant in less than two hours. It could carry a 12,000-pound payload consisting of Common Aero Vehicles (CAVs), cruise missiles, Small Diameter Bombs (SDBs) or other munitions. HCVs as part of the future U.S. force structure will provide the country dominant capability to wage a sustained campaign from CONUS on an array of time-critical targets that are both large in number and diverse in nature while providing aircraft-like operability and mission recall capability.[154]

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[154] DARPA, "FALCON *F*orce *A*pplication and *L*aunch from *CON*US," Broad Agency Announcement (BAA), Phase I, Proposer Information Pamphlet (PIP) for BAA Solicitation 03-35, July 29, 2003, p. 1.

Although FALCON's aim of achieving a dominant position in LRS is certainly a plausible strategic goal, its hypersonic cruise vehicle is, to say the least, ambitious. To achieve a strike distance of 9,000 nm in a flight time of two hours requires a cruise speed around Mach 8, which is a considerable leap beyond the Mach 3 SR-71. The cruise altitudes for a Mach 8 HCV are likely to be around 100,000 feet—literally on the edge of space (the sky overhead turns black by 80,000 feet and the earth's curvature is visible). The requirement to be able to take off from conventional runways adds further complexity: most likely the vehicle would have to have two separate propulsion systems.

The CAV mentioned in the FALCON BAA is to have a total weight of 2,000 pounds with approximately 1,000 pounds of munitions payload, and is to be able to achieve impact speeds of approximately 4,000 feet per second in order to be able to defeat hard and deeply buried targets (HDBTs).[155] Likely payloads include a single rigid penetrator for HDBTs, six Wide Area Autonomous Search Munitions, or four SDBs. While CAVs could be delivered from the HCV, they were portrayed in the 2003 BAA as a separate LRS option when married to a Small Launch Vehicle (SLV). The goal for the SLV is to be able to place small satellites "into a diverse family of low Earth orbits (including Sun synchronous orbits)".[156] DARPA and the Air Force hope the mature SLV will be capable of boosting an Enhanced CAV to a global range of 9,000 nm (with approximately 3,000 nm cross range) at a total launch cost of less than $5 million.[157] Again, these are extraordinarily ambitious goals.

As noted in the first chapter, however, Congress has developed concerns about FALCON. Apparently worried about how the Russians and Chinese might "misinterpret" American efforts to develop conventional munitions that could be delivered "worldwide from and through space," Congressional appropriators inserted language in the FY 2005

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155 DARPA, "FALCON *F*orce *A*pplication and *L*aunch from *CON*US," pp. 5, 7.

156 DARPA, "FALCON *F*orce *A*pplication and *L*aunch from *CON*US," p. 4. "Sun-synchronous orbits are retrograde low-Earth orbits (LEO) inclined 95° to 105° and typically used in remote-sensing missions to observe Earth"—Jerry Jon Sellers, ed. Wiley J. Larson, *Understanding Space: An Introduction to Astronautics* (New York: McGraw-Hill, 1994), p. 150.

157 DARPA, "FALCON *F*orce *A*pplication and *L*aunch from *CON*US," pp. 8-9.

defense budget that led to all weaponization activities being excluded from the FALCON program.[158]

To put these Congressional concerns in context, while Article IV of the 1967 treaty on the use of outer space prohibited placing "in orbit around the Earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction," it made no mention of placing conventional munitions in orbit.[159] Nor did the treaty, which entered into force in October 1967, mention, much less ban, intercontinental ballistic missiles that had to travel through space to deliver nuclear warheads against the United States or the Soviet Union. Nevertheless, at least some Congressional appropriators in 2004 were clearly concerned about how FALCON and CAV would be perceived by other nations.[160]

How should these sorts of options for LRS in the mid- to long-term future be assessed? The notion from the late Cold War of placing conventional munitions in orbit—even ones as relatively benign as dense, inert rods that would concentrate kinetic energy against terrestrial targets when deorbited—faces several problems when viewed from the perspective of early 21st century requirements for prompt global strike. At the operational level, elliptical orbits with apogees well above the geosynchronous altitude of 36,000 kilometers (19,865 nm) were needed to give each bus a large attainable footprint on the earth's surface. But one consequence of using orbits as high as 40,000 nm was that the response times from apogee would be typically 6-8 hours, which is not even as prompt as FALCON's Mach 8 HCV.[161] As

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[158] DoAF, *Fiscal Year (FY) 2006/2007 Budget Estimates: Research, Development, Test and Evaluation (RDT&E) Descriptive Summaries*, Vol. II, pp. 801-02; Lewis, "Selected Space Programs in the 2005 Appropriations Process," p. 7.

[159] The "Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies," 1967, available online at http://www.state.gov/t/ac/trt/5181.htm.

[160] Despite Congressional concerns over FALCON in 2004, the head of Air Force Space Command endorsed the program in his March 2005 Senate testimony as an "incredible capability" to provide the warfighter with global reach "against high payoff targets" (General Lance W. Lord, Statement before the Senate Armed Services Committee, Strategic Forces Subcommittee, March 16, 2005, p. 19).

[161] Sears, interview, May 30, 2000.

for political drawbacks, the prospects that fielding such a system would increase significantly the chances of making a military competitor or adversary out of the Chinese—or the Russians—argue that it is not a very attractive option today. If RDT&E on CAV raises Congressional concerns about Russian or Chinese misinterpretation of US intentions, then orbiting a constellation of inert rods would surely be seen as highly provocative and counterproductive as far as the foreign-policy goal of not making a military rival of the PRC is concerned.

However, if the broader aim is to begin moving forward in the near-term on LRS, then the more immediate concerns with a Mach 8 HCV are the technical risks and likely high development costs of such a platform, even if it could have commercial utility. Unquestionably a Mach 8 cruise vehicle able to operate from existing runways and strike targets 9,000 nm away within two hours would be tremendous leap forward in platform performance and propulsion.

Some progress in the required propulsion technology has been made. In late 2004, after eight years of development and $230 million of investment, the National Aeronautics and Space Administration (NASA) succeeded in achieving Mach 10 with its scramjet-powered X-43A research vehicle.[162]

Whether an operational version able to meet the range, payload, and other requirements in the original FALCON vision could be fielded by 2025 is another question. In NASA's scramjet successes in 2004, the X-43A only separated from its Pegasus booster rocket and began free hypersonic flight after the Pegasus/X-43A "stack" had been dropped from a B-52 at 40,000 feet and the Pegasus had ascended to around 100,000 feet. Moreover, the scramjet engine at the heart of these tests only produced forward thrust for about 10 seconds.[163] Fielding a vehicle that can take off from a current military runway, climb to a high enough altitude with sufficient velocity for hypersonic flight, sustain Mach 8 for two hours on internal fuel, and deliver a 12,000-lb payload to a range of 9,000 nm represents an enormous

[162] "NASA's X-43A Scramjet Breaks Speed Record," NASA Release 04-373, November 16, 2004.

[163] "NASA Hyper-X Program Demonstrates Scramjet Technologies: X-43A Flight Makes Aviation History," NASA, FS-2004-10-98-LaRC, October 20, 2004, p. 3.

challenge. Even former Air Force secretary Hans Mark cautioned in 1999 that an aircraft this exotic would probably be "far in the future."[164] The 9,000 nm strike-range requirement is especially daunting when compared with existing turbojet engine technology.

Betting that such a vehicle can be developed and delivered to operational service within reasonable funding constraints by 2025 appears, therefore, to be a huge gamble. In the meantime, should Bracken's second nuclear age dawn in full force and the post-Nagasaki taboo on nuclear use be broken, future American presidents might very well need a capability for prompt, global, non-nuclear strike before 2025. From this perspective, an intercontinental ballistic missile with a conventional payload offers the shortest time from launch to impact—under 35 minutes—along with the least technical risk. In considering the FALCON program as articulated in the 2004 BAA, the prudent thing to do would be to accelerate work on CAV to bring it to IOC well before 2015. Should Bracken's second nuclear age materialize within the next 10-15 years, CAVs could be placed on Peacekeepers and furnish the prompt global strike envisioned in FALCON. If time permits, then perhaps the SLV/CAV alternative could be fielded instead.

To ally fears in other capitals—Moscow, Beijing, and Pyongyang, among others—about US intentions, any Peacekeeper/CAV or SLV/CAV systems placed on alert could be relocated well away from CONUS locations containing nuclear-tipped ICBMs. Vandenberg AFB in California might be a sensible choice. If the deployment of either system was accompanied by appropriate declaratory statements, the prospect that actual use might be misconstrued as a nuclear attack could be minimized even for those with the missile-warning and threat-assessment capabilities to detect the launch and compute the impact area in real time. At the end of the day, even these measures might not suffice to allay worries about US intentions or any actual use of such a capability being misconstrued. Nevertheless, should the post-1945 taboo against nuclear use be broken—even once, and even if not used against the United States or American forces—one suspects that the sorts of concerns that led Congressional appropriators to constrain FALCON in 2004 would be quickly forgotten.

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[164] John A. Tirpak, "Mission to Mach 5," *AIR FORCE Magazine*, January 1999.

In any event, a prompt global response capability constitutes, at best, a niche capability. The promptness of systems such as Peacekeeper/CAV or the FALCON hypersonic cruise vehicle might well be invaluable in a narrow class of situations. Strong indications of imminent nuclear use by a state with a small nuclear force is one. Loose nuclear or other weapons of mass destruction in a failed state might be another. Notice, though, how dependent both ballistic missiles and Mach 8 cruise vehicles are likely to be on targeting information from off-board sources. Launched from CONUS, they provide little or no capability to address the central problem surfaced in the preceding chapter of both being able to dwell in the target area long enough to wait for emergent targets to reveal themselves or to be close enough to strike them within a few minutes as opposed to 30-35 minutes or a couple hours. Consequently, the situations in which it will be imperative to get from launch to impact-on-target in 35 minutes, or even two hours, are likely to occur rarely—once in blue moon.

PAYLOAD FRACTIONATION

The B-1B and B-2A were both designed with the capacity to deliver large, heavy payloads. A B-2 loaded with 80 500-lb JDAMs has a munitions payload around 40,000 pounds; the deliverable payload of a B-1 with 24 2,000-lb JDAMs approaches 50,000 pounds. In both cases, these loads can be carried in internal weapon bays.

Prior to the advent of modern guided munitions, these large payloads made eminent sense. Most unguided bombs—particularly those dropped from bombers flying straight-and-level at medium or high altitude—missed. As a result large numbers of bombs had to be used in order to achieve the desired effects against many, if not most, targets. Hence the understandable desire for large payload capacities in heavy bombers.

One option for future LRS systems would be to insist on payload capacities comparable to those found in the B-1 or the B-2. In an era in which guided munitions have made it possible for American airmen to think in terms of targets-per-plane rather than planes-per-target, internal munitions payloads as large as those available with the B-1 and B-2 no longer appear necessary. Not only were both aircraft designed years—in the B-1's case, more than two decades—before inexpensive guided munitions such as JDAM were available for American heavy bombers, but ongoing developments are underway to reduce substantially the size and weight of individual guided bombs.

The Air Force's GBU-39/B Small Diameter Bomb program is the most obvious example of this evolving trend toward payload fractionation, meaning being able to substitute several smaller munitions for each larger munition a strike platform would carry today. The aims of the SDB development include "providing increased kills per sortie on current and future aircraft platforms," facilitating "multiple kills per pass," and minimizing the "potential for collateral damage."[165] To illustrate the increase in the number of aim-points an individual aircraft could target on a single strike sortie due to substituting 250-lb class SDBs for larger munitions, consider the F/A-22.[166] The plane's two center weapon bays can accommodate two 1,000-lb JDAMs or eight SDBs. The Small Diameter Bomb, therefore, will increase the number of aim-points the plane could cover on a single sortie with internal carriage by a factor of four when the new munition becomes available.[167]

This gain is not, of course, cost free. With a fourfold or more reduction in the explosive weight of the munition, greater accuracy may be required to achieve the same kill probability against a particular target as compared with a 2,000-lb JDAM or LGB. In addition, as the number of guided munitions a platform can carry increases, so does the amount of targeting information it requires per sortie. Again, in the case of the F/A-22 shifting from two 1,000-lb JDAMs to eight SDBs, the increase in targeting information/sortie grows by a factor of four.

The principal implication of the payload fractionation trend is that munitions payloads of 40-50,000 pounds probably are no longer

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[165] DoAF, *Fiscal Year (FY) 2006/2007 Budget Estimates: Research, Development, Test and Evaluation (RDT&E) Descriptive Summaries*, Vol. II, p. 939.

[166] Boeing, the manufacturer of the GBU-39/B Small Diameter Bomb, gives its weight as 285 pounds (http://www.boeing.com/defense-space/missiles/sdb/sdb_back.htm). The Air Force plans to field the SDB on the F-15E in FY 2006, and the current estimate for the SDB's procurement is 24,000 munitions and 2,000 racks, each of which can take four SDBs.

[167] Lockheed Martin engineers, among others, believe that stealthy external carriage of additional munitions or fuel tanks is also feasible.

necessary in LRS platforms. Payloads of 10-20,000 pounds will probably suffice. One consequence of this fact is that the platform itself can be substantially smaller. For example, a subsonic unmanned strike platform with the same range as the B-2 but designed around a 20,000-lb payload could conceivably have gross-takeoff and empty weights no more than 40 percent of the B-2's. Besides making the smaller strike platform cheaper, smaller size could also help to reduce its signature.

THE RELATIVE COSTS OF STANDOFF VERSUS DIRECT ATTACK

A decade or two ago, standoff air-to-ground munitions, which were powered, and direct-attack munitions, which were not, could be easily distinguished on the basis of whether they provided the aircraft employing them some standoff distance from the target at release or launch. A cruise missile such as CALCM could reach targets hundreds of miles away, whereas direct-attack munitions such as LGBs simply fell to earth, following ballistic trajectories, which meant that they generally had to be released within, at most, a mile or two from the target—well within the reach of anti-aircraft artillery (AAA) and infrared (IR) SAMs concentrated there.

The AGM-65 Maverick and the laser-guided bomb, both of which were first used by US fighter-bombers in Southeast Asia, readily illustrate this traditional distinction between standoff and direct-attack air-to-surface munitions. The Maverick had a television or imaging-IR sensor in the nose whose image was displayed in the pilot's cockpit via a datalink. Once the AGM-65 had been fired, the pilot could begin maneuvering away from the target, but could still acquire it and lock-on as the Maverick got closer and closer. While maximum AGM-65 ranges varied considerably depending on the altitude and speed of the launch aircraft, 8-9 nm was, and remains, feasible for a fighter-bomber flying nap-of-the-earth. Maverick, therefore, enabled pilots to stand off from point defenses at or near the target. By comparison, LGBs offered no appreciable standoff as generally employed by Air Force F-4s in Southeast Asia. LGBs were delivered using dive-bombing passes directly at and over the target, and laser illumination was required until bomb impact. Although highly accurate, LGBs did not provide any significant standoff distance from the target.

Today, this classic distinction between standoff and direct-attack air-to-ground munitions is rapidly breaking down. The clearest example is the GBU-39/B Small Diameter Bomb. The GBU-39/B is an unpowered guided munition. While still in development, the Air Force expects it to achieve IOC on the F-15E, the SDB's threshold platform, before the end of FY 2006.[168] Although unpowered, the SDB comes equipped with a range extension system consisting of thin wings that open into a diamond configuration after release. Range varies, of course, with the altitude and speed of the delivery aircraft, but Boeing currently gives the SDB's reach as greater than 60 nm.[169] Needless to say, 60 nm gives any air vehicle employing SDB ample room to maintain a substantial distance from the target area. The munition is also true fire-and-forget (as opposed to launch-and-leave as in the case of Maverick). Given the long standoff distances afforded by the SDB, one can begin to understand why it may be the one weapon system capable of attacking advanced SAMs such as the SA-20. SDB, in short, shatters the traditional distinction between standoff and direct-attack air-to-ground munitions.

There is, however, another longstanding difference between standoff weapons such as TLAM or CALCM and direct-attack munitions such as JDAM or, in the near future, SDB that seems likely to persist: namely, the much higher unit cost of land-attack cruise missiles compared to smart bombs. There are many reasons why the unit-acquisition prices (RDT&E plus procurement) of cruise missiles such as CALCM and TLAM have been $2-3 million per round, whereas the comparable cost for the INS/GPS-aided JDAM has been less than $30,000 per round.[170] These cruise missiles, due in part to their high price tags, are procured in much smaller quantities, include propulsion systems that free-fall munitions lack, and have required more expensive overhead infrastructures to keep them ready for operations.

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[168] DoAF, *Fiscal Year (FY) 2006/2007 Budget Estimates: Research, Development, Test and Evaluation (RDT&E) Descriptive Summaries*, Vol. II, p. 944.

[169] Boeing Integrated Defense Systems, "Small Diameter Bomb, or SDB" at http://www.boeing.com/defense-space/missiles/sdb/sdb_back.htm.

[170] The average unit-procurement price of the 4,201 TLAMs the Navy has bought is $1.965 million each. TLAM's successor, Tactical Tomahawk, and the Joint Air-to-Surface Standoff Missile (JASSM) are achieving unit-procurement prices well under $1 million per round. Even so, they are likely to remain an order-of-magnitude more expensive than the JDAM or the SDB.

There are also cultural reasons embedded in US flight-test practices. The American test community has spent decades developing standards and procedures biased toward being able to get a new manned aircraft through developmental and operational testing with losing any planes or test pilots. Applying these practices to cruise missiles has inevitably added to their costs. In the cases of Tacit Rainbow and the Tri-Service Standoff Attack Missile, intolerance of test failures played a role in the eventual cancellation of both programs.[171] In addition, the US defense acquisition system has shown remarkable resistance to efficiency improvements or to substantial reductions in the time required to field major military systems.[172] Demonstration and validation for what was then the Advanced Tactical Fighter began in 1986, but it still remains to be seen whether the first F/A-22 squadron will achieve IOC by December 2005, as planned.[173] For all these reasons, one suspects that American land-attack cruise missiles will remain an order-of-magnitude more expensive and fewer in numbers than direct-attack munitions like the JDAM and SDB for the foreseeable future.

This conclusion has at least one important implication for LRS options. A recurring suggestion for future LRS is to abandon penetrating platforms and, instead, rely on standoff cruise missiles fired from an "arsenal" plane orbiting outside the reach of enemy air defenses.[174]

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[171] In fairness, as military systems have become more complex and integrated, testing has become more challenging: see William B. Scott, A New Dawn," *Aviation Week & Space Technology*, November 29, 2004, pp. 54-7.

[172] While many of the acquisition-reform recommendations made by David Packard's 1986 blue ribbon commission on defense management have been implemented, the cycle time for fielding major weapon systems has shown no sign of shrinking. For the commission's views on acquisition reform, see *A Quest for Excellence: Final Report to the President by the President's Blue Ribbon Commission on Defense Management* (Washington, DC: June 1986), pp. xxi-xxvii.

[173] Christopher Bolkcom, "F/A-22 Raptor," Congressional Research Service, updated January 6, 2005, pp. 1-2.

[174] The missile likely to be available soonest for such an aircraft is the subsonic, radar-evading JASSM. However, if a decision was made to field an arsenal plane, one would undoubtedly want to develop a hypersonic standoff missile. DARPA, for example, did show interest in developing an "affordable" hypersonic missile in 1999 and Ron Sega, the Pentagon's director of defense research and engineering, told industry in 2003 that "hypersonics research could yield a swift-moving, air-breathing cruise missile within a decade" (Tir-

As recently as November 2003, the Air Force proposed an extended-range strike aircraft in its transformation "flight plan" based on a modified 747-400 that would employ land-attack missiles to strike hardened and deeply buried, chemical-biological-radiological-nuclear, and air-defense targets from beyond the range of theater air defenses.[175]

This option, however, appears to suffer from at least two fatal flaws. First, fielding a new platform for the standoff employment of long-range cruise missiles (even hypersonic ones) could only be a niche capability that would address no more than a tiny fraction of the aim-points and targets encountered in major air campaigns. The total expenditure of guided munitions in the four conflicts summarized in Figure 6 (page 37) comes to over 53,600 rounds. Of this total, TLAMs and CALCMs made up just over 3 percent; much cheaper LGBs and GPS-aided munitions (of which the vast majority were JDAMs), accounted for over 78 percent of the guided expenditures in these four campaigns. Based on these facts, it seems difficult to believe that a LRS platform along the lines of the Air Force's extended-range strike aircraft could be more than a bit player in a major campaign.[176]

Second, modifying a commercial transport to provide another set of platforms from which to fire land-attack cruises missiles from outside the reach of enemy defenses is simply unnecessary if older bombers such as the B-52 are going to remain in the active inventory into the 2030s or beyond. This redundancy swells to monumental proportions when one remembers that the US Navy already has a fleet-wide total of some 6,000 vertical launch system (VLS) cells, each of which is capable of launching a TLAM or Tactical Tomahawk, and is building toward a total of perhaps 10,000.[177] Moreover, the four Trident-class ballistic missile submarines (SSBNs) slated for conversion

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pak, "Mission to Mach 5"; Brian Berger, "Hypersonic Efforts Get an Extra Boost," October 20, 2003, available online at http://msnbc.com/id/3226817).

[175] DoAF, *The U.S. Air Force Transformation Flight Plan* (Washington, DC: HQ USAF/XPXC, November 2003), pp. 60, D-5.

[176] Interestingly, the extended-range strike aircraft was dropped from the 2004 edition of the Air Force's *Transformation Flight Plan*.

[177] These total are based on the VLS cells in Improved Ticonderoga cruises, Arleigh Burke destroyers, nuclear attack submarines, and the four SSBNs programmed for conversion to SSGNs.

to guided-missile submarines (SSGNs) will be able to launch TLAMs and other standoff missiles from a covert posture. In light of both the standoff missile capacity in the US Navy and the two older Air Force bombers, there appears to be no good reason for fielding an arsenal plane as well. This LRS option is one that should be mercifully laid to rest.

SPEED AND SURVIVABILITY

The final issue this chapter will raise is the tradeoff between speed and survivability. Supporters of the F/A-22 have stressed the plane's Mach 1.5-plus supercruise speed as an important tactical advantage for getting quickly within range of time-sensitive or other surface targets. If, however, the more central need is to be able to loiter deep inside defended airspace waiting for emergent or time-sensitive targets to emerge, then survivability against enemy SAMs and fighters seems to be the issue that should drive tradeoffs between signature and cruise speed.

In this regard, hypersonic cruise speeds, meaning Mach numbers of 5 or greater, do not offer appreciable dwell, regardless of the vehicle's range. When coupled, with the great technical risks facing a vehicle such as FALCON's Mach 8 HCV, the emergent/time-sensitive target problem suggests focusing on cruise speeds below Mach 5. Granted, a strike platform cruising at altitudes of 100,000 feet and speeds of Mach 7 or 8 would be extremely difficult to shoot down, and it might not even be necessary to invest much in signature reduction. Still, as attractive as hypersonic cruise may be to advance the state of aerodynamics and engine technology, a vehicle traveling at Mach 8 does not provide meaningful dwell or loiter. Bluntly stated, hypersonic offers little operational utility against problem of emergent/time-sensitive targets. These observations argue that the operationally useful speed regime for a future LRS system can be reduced to somewhere between Mach 0.7-0.9 (high subsonic) and less than Mach 5.

This speed range, in turn, can be further narrowed based on the likely high RDT&E costs of cruise speeds from Mach 2.5 to 5.0. Within this regime low observability will still be required for survivability, but the proven radar-absorbing materials used to make the F/A-22 the most survivable plane that has ever flown are limited to Mach numbers of 2.4-2.5. To insist upon cruise speeds between there and Mach 5 will require developing a whole new class of radar-absorbing materials and coatings. For this challenge, an RDT&E bill of even $40 billion might not suffice. Thus, the most sensible cruise regime for a next-generation LRS system which the Air Force could developing in the near-term would be Mach 0.7-0.9 to perhaps Mach 2.5.

Mach 0.7 to Mach 2.5 still leaves a lot of room for choice. Can a subsonic platform hope to survive in the mid- to long-term? If not, will a cruise speed around Mach 1.5 be adequate to survive enemy fighters and SAMs 24/7? Or is it necessary to push right to the limit of proven radar-absorbing materials and coatings and opt for Mach 2.4-2.5? As suggested at the beginning of this chapter, these are questions best left to hard-nosed operators and design engineers. They are certainly not matters that can be answered in this report beyond noting that there is genuine disagreement within industry over the answer. Nonetheless, the crucial point to recognize is that tradeoffs between stealth and cruise speeds below Mach 2.5 are about maximizing survivability, not being able to sprint to an individual target in a shorter period of time.

As a final observation about future LRS options, this chapter has not explicitly broached distributed solutions. An example might be to utilize a spaced-based radar (SBR) constellation to acquire targets deep in enemy airspace, pass the targeting information from SBR through a network to strike aircraft within the atmosphere, and have those airborne assets complete the rest of the kill chain. FALCON's HCV, instance, would probably operate in this distributed mode most of the time, although targeting information could come from a variety of sources, not just SBR. Here it is worth recalling that in OEF, targeting information against Taliban and al Qaeda forces was regularly supplied by SOF and controllers on the ground.

Why has there been no discussion of these sorts of spatially distributed solutions? The answer goes back to the thesis that the central problem facing LRS is being able to dwell or loiter deep in defended airspace for long enough periods of time for emergent and time-sensitive targets to reveal themselves. Once these fleeting targets are acquired, the tactical imperative would appear to be to strike them very quickly—within a very few minutes—hopefully before they can either engage US forces or disappear. For these situations, in which the desired sensor-to-shooter timelines are very short, calling in a strike platform from a long distance away does not seem to be the best solution. In such circumstances, one would want to be able to release munitions such as SDBs within minutes of acquiring the targets. Even a ballistic missile with CAVs could give fleeting target enough time to escape.

One could, of course, take the view that emergent and time-sensitive targets located deep in airspace defended by enemy SAMs and fighters is not the central problem facing LRS. In that case, distributed solutions would be more appealing. The second chapter of this report, however, identified emergent and time-sensitive targets as a central and growing gap in US LRS capabilities. On this view, distributed solutions are far less attractive and that is why they have not been offered as an attractive alternative.

IMPLICATIONS FOR MOVING AHEAD IN LRS

As discussed in the opening chapter, since the late 1990s the balance of DoD investments in short- and long-range strike systems has been heavily weighted in favor of the former. This bias is evident both for the Department of Defense as a whole and for the Air Force as the only service nominally in the LRS business. Notwithstanding the FALCON program and a next-generation-bomber wedge in the Air Force's out-year spending plans, there is little evidence that the junior service, now dominated by fighter generals, accords adequate priority or urgency to LRS. By all indications, Air Force leaders would far prefer to retain the existing bombers into the late 2030s or longer, and attempt to satisfy any increased demands for longer-range strike that may emerge between now and 2025-30 with a medium-range variant of the F/A-22 (the so-called regional bomber).

The first objection to these inclinations is that they give every sign of allowing an area of traditional American military advantage to atrophy. By failing to take steps in the near-term to expand US advantages in non-nuclear strike, particularly at long-range, they concede sanctuaries to prospective adversaries even though the 2001 QDR called specifically for denying enemies sanctuaries as a transformational goal. By neglecting the opportunity to expand American preeminence in non-nuclear long-range strike by being able to hold the full spectrum of potential adversary targets at risk, the United States forfeits the leverage to impose costs on prospective adversaries and channel some of their investments toward homeland defense as opposed to offensive capabilities.

Second, much of the urgency to begin in the near-term to move ahead in LRS, rather than coasting on the existing bomber fleet, stems from the need to hedge against Paul Bracken's second nuclear age and Asian geography. One of the foremost outcomes American foreign policy should seek to avoid is the emergence of China as a military competitor and rival to the United States in Asia. But this outcome may come to pass nonetheless, and prudent steps should be taken in the near-term to hedge against this possibility in the mid- to far-term. Similarly, the United States and its NATO allies should make every effort to prevent further nuclear proliferation, particularly among Asian powers with the economic strength and technology to field anti-access and area-denial capabilities that could greatly limit US ability to project military power from theater bases in Asia, where prospective one-way distances for future strike operations may be two or more times greater than American forces have faced in the military campaigns conducted since the terrorist attacks on the World Trade Center and the Pentagon in September 2001. Again, pressing ahead on long-range strike will certainly not preclude these problems, but doing so can build hedges to cope with them, and some rebalancing of US priorities between short- and long-range strike appears both necessary and urgent.

Last but not least, there are gaps in US LRS capabilities that need to be mitigated, if not closed. Increasing efforts by potential adversaries to exploit strategic depth, concealment and camouflage, mobility, periodic relocation, hardening, and deeply buried facilities to deny US forces targeting information is one gap—indeed, perhaps the most crucial to close in the long-term. Of course, this challenge's underlying dynamic is an ongoing competition between hiders and finders. The open-ended nature of this competition suggests that American technology is unlikely to close this gap once and for all. Instead, like the Cold War competition between acoustic detection and acoustic quieting waged under the seas by US and Soviet submariners, ongoing efforts will be needed to maintain a significant margin of advantage. Much the same can be said regarding the American need to move stealth into the daytime. Future advances in air defenses could gain enough of an upper hand to preclude 24/7 strike operations deep in defended airspace. What is clear, however, is that unless decisions are taken in the near-term to give greater priority and more resources to long-range strike, the United States is unlikely to sustain preeminence. Instead, the probable outcome can be summarized as strategic opportunities foregone and strategic challenges unmet.

These considerations are, of course, matters of long-term strategy, of being a sufficiently far-sighted competitor to retain advantage in a mission area that may well prove increasingly important in coming decades. Narrowing the wide range of prospective LRS options, which has been the main task of this final chapter, turns on more technical and operational matters. Few readers are likely agree with every step and assumption in the chain of reasoning that led to focusing on a speed range of perhaps Mach 1.4 to Mach 2.5. One could, for example, object that 24/7 survivability in defended airspace demands cruise speeds above Mach 3, and we have no choice but to swallow the RDT&E costs of developing radar-absorbing materials and coatings able to handle such Mach numbers. Even so, the argument of this chapter still demonstrates that operational needs such as 24/7 survivability with deep persistence, affordability, technical risk, and common sense can be used to reach reasoned judgments as to where the United States should head in LRS. Certainly some options, notably the arsenal plane, can be eliminated. What remains uncertain is whether the hard decisions will be made by the Department of Defense and the Congress to begin moving forward sooner rather than later. Again, the United States is not going to retire the current fleet of heavy bombers anytime soon. The nation will have a mix of LRS systems, platforms, and capabilities for the foreseeable future. The question is: What do we truly need to add to the portfolio for the mid- to long-term?