The Future of Ballistic Missiles

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With a Foreword by Amb. David J. Smith

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Table of Contents

Foreword v

Executive Summary vii

Abbreviations ix

Introduction 1

Beyond the Cold War 1

- Transformation to Meet 21st Century Challenges 3
- Missions and Targets 5

Ballistic Missiles as Long Range Precision Strike 10

- Background 10
- Current U.S. Ballistic Missile Capabilities 11
- Future U.S. Ballistic Missile Capabilities 12

Comparative Analysis of Capabilities 17

- Assessment Criteria 18
- The Context: Comparative Utility in Effects-Based Operations 23

Treaty and Policy Issues 26

- Treaty Issues 26
- Policy Issues 28
- Policy and Treaty Issues: Summary Implications 35

Conclusions 35

Appendix: Ballistic Missile Background 39

Notes 41

The Future of Ballistic Missiles

Foreword

This examination of the future of ballistic missiles concludes that they have enduring value; both in their traditional nuclear role and in their potential as more diversified long-range precision strike platforms.

The December 2001 *Nuclear Posture Review* (NPR) underscored a continuing need for our existing strategic nuclear triad, albeit at numbers considerably lower than the 6,000 warheads allowable under START. But how much lower can we go when the factors shaping future U.S. nuclear requirements remain fluid and difficult to pin down? For example, the Bush administration clearly recognizes that the United States and Russia have no difference between them analogous to systemic conflict that underlay the Cold War era strategic competition—and yet Russia continues to invest serious resources in the production of strategic weapons. Thus while any Russian threat to U.S. security may be residual and not terribly likely, it is nonetheless very real and must be addressed at some level. Similar questions about the People's Republic of China's modernizing strategic posture, Iran's nascent nuclear program, or North Korea's defiant nuclear status can be asked.

To traverse this shifting landscape, the United States has decided to manage risk by pursuing flexibility. Part of this effort involves a "capabilities-based" approach that skillfully combines existing capabilities, available technological innovations and new, flexible concepts of operation to deliver tomorrow's capability today. The authors of this study present a persuasive case that ballistic missiles are an existing capability well worth examining in this light. For example the NPR endorses maintenance of a responsive infrastructure. An important part of that infrastructure is the U.S. ability to add warheads to the existing land and submarine based ballistic missiles (ICBMs and SLBMs respectively) projected to remain in the force structure. The U.S force structure is likely to include 500 Minuteman III ICBMs and 14 nuclear-powered submarines with Trident D-5 SLBMs.

That said, the U.S. must also transition its forces to deal with post Cold War situations very different from the one for which our current ballistic missiles were designed. Multiple potential adversaries—some of them transnational groups, not countries—now present realistic and increasingly lethal threats to U.S. worldwide interests, forces overseas, allies and, as we learned on 9/11, the U.S. homeland. They are spread around the globe, some in remote locations, and they could force us into simultaneous conflicts.

These diffuse threats are also increasingly lethal. The proliferation of weapons of mass destruction (WMD) and related technologies, modern communications, and rapid transportation render potential adversaries ever more lethal on a global level and, therefore, capable of pursuing their aims on the world geopolitical stage hitherto denied them. The U.S. could face threats of WMD delivered by a variety of means, innovative but effective techniques such as the use of airliners on 9/11, shielding from U.S. intelligence gathering efforts, and remote, dispersed locations far away from U.S. forces. Destruction of WMD sites will require new weapons that not only destroy the site and its contents, but that do so in ways that minimize chemical, biological or radiological effects. Moreover, mindful of current U.S. capabilities, many potential adversaries have turned to hard and deeply buried sites to maximize the survival probability of key assets. Other targets may be mobile or rapidly relocatable. And, in certain circumstances, many targets could become time urgent.

Part of the effort to address this emerging threat spectrum is identified in the 2002 *National Security Strategy of the United States of America*: long-range precision strike.

> We must continue to transform our military forces to ensure our ability to conduct rapid and precise operations to achieve desired results [including] by developing assets such as long-range precision strike capabilities.

During the extensive interviews conducted for this study, the authors found a consensus on the need to develop long-range precision strike capabilities to meet the evolving challenges we face.

While existing platforms, including ballistic missiles, provide the United States with some capabilities against emerging threats, research and development on still newer technologies for long-range precision strike must continue apace to maintain the effectiveness of the U.S. force structure.

Seen in this way, none of the ballistic missile based long-range precision strike ideas put forth in this study should be seen as competition to other long-range precision strike efforts, in particular other existing capabilities, a new ICBM or other innovative concepts.

With regard to other existing capabilities, long-range bombers, forward-based aircraft on land or sea, cruise missiles or, under certain circumstances, special operations forces, all offer strengths and weaknesses, as do ballistic missiles. This study draws these comparisons. Here it suffices to note that many of the circumstances that might one day call for long range precision strike—e.g., the need to act quickly in a distant theater based on tactical intelligence, the need to strike at "global" range with minimum risk to U.S. or allied lives—are addressed by the capabilities that could be inherent in our ballistic missile force. The capabilities ballistic missiles offer for long-range precision strike, coupled with the enduring need for traditional deterrence add up to a good case for a follow-on ICBM.

In the longer term, altogether new technologies may replace or complement ballistic missiles and other strike options. Work on the most promising technologies must continue apace if we are to stay ahead of evolving threats. In sum, we should not see any particular system as the "answer" to the need for long-range precision strike. Rather we should acknowledge the need for a toolbox of capabilities that can be mixed and matched to provide the optimal U.S. military response to whatever form the threat in question takes.

In stocking our toolbox, we must avoid the temptation to forego capabilities available in the near term in favor of the promise of technologies to come. Of course, the future almost always brings better technologies. But we also know that the rapidly evolving capabilities of potential adversaries call for U.S. long-range precision strike capabilities in the near term. Therefore, an effective capabilities-based transition must meet near-term challenges while preparing to add capabilities as U.S. technologies become available. Proceeding with near term options will provide needed capabilities today and help maintain interest and support for the long-range precision strike capabilities of tomorrow. It is in that vein that this study offers some ideas about how ballistic missiles could contribute to the U.S. toolbox.

Amb. David J. Smith

The Future of Ballistic Missiles

Executive Summary

The Soviet Union's collapse has been the harbinger of a new and different security environment. Regional powers, some with global aspirations, and non-state actors have become the principal focus of U.S. defense policy. This diffusion of the threat profile has also come at a time when what were once thought to be "lesser" threats are becoming increasingly lethal. Driving this trend is the proliferation of weapons of mass destruction (WMD), ballistic missiles, and advanced conventional capabilities. Given this shift in climate, the question for U.S. defense planners is this: how well does the U.S. force structure, designed for the Cold War, address the 21st century security environment? This study examines this question with a particular emphasis on the role of ballistic missiles.

In response to this new security environment, the George W. Bush administration has endorsed the transformation of the U.S. force posture to meet the ill-defined but metastasizing threat. Emerging from the transformation agenda is a clear need for the United States to field sophisticated long-range precision strike capabilities to meet these ever dangerous and diffuse threats.

Accordingly, the study examines how ballistic missiles can address some of the missions and targets upon which long-range precision strike capabilities would be used. While clearly not exhaustive, the list of missions discussed here include: traditional deterrence, WMD neutralization, strategic decapitation, offensive counterforce, and defense suppression. The mission areas identified suggest a group of target types that are of particular interest for long-range strike such as traditional military targets, hard and deeply buried targets, mobile and rapidly relocatable targets, and chemical and biological weapons sites. Ballistic missiles may also play a role as space launch vehicles and in support of ballistic missile defense (BMD) efforts, for instance, by delivering missile defense sensors into space, boosting interceptors or serving as target delivery vehicles in the course of BMD technology development.

Today's ballistic missiles are capable not just of the nuclear roles for which they were designed, but also of kinetic kill missions using the inert warheads developed for reliability testing. However, for ballistic missiles to be established truly as transformational weapons systems, several technical and planning issues—all feasible—must be addressed to provide for their employment as long-range precision strike capabilities. These include:

- the development of new types of payloads—or "front ends"—appropriate for nuclear and non-nuclear strike missions;
- improvements in accuracy and maneuverability;
- the ability to perform in-flight retargeting for the defeat of mobile and rapidly relocatable targets; and
- the development of more flexible operational concepts for ballistic missile employment.

The study explores the utility of ballistic missiles for future missions by examining how they fare against other existing capabilities, for example, manned bombers/tactical aircraft and cruise missiles. This assessment of existing capabilities is based on seven criteria: promptness, payload, range, risk to U.S. personnel, accuracy, assured control, and assured delivery. We considered special operations forces for

long-range precision strike missions, concluding that this formidable capability indeed has a role to play, but not directly comparable to that of ballistic missiles.

In addition, the study examines the policy and treaty issues involved for the employment of ballistic missiles as long-range precision strike capabilities. No issue is found to be a "show-stopper," but they merit careful thought and, in some cases, concrete action to address them. Policy and treaty issues can be addressed as follows:

- Planning to use ballistic missiles for long-range precision strike must include well developed operational concepts that, among many other things, address overflight issues.
- Technical personnel should consider carefully whether the new front ends discussed in this study can be designed within the telemetry encryption limitations of the START Treaty.
- Many problems associated with ICBMs in new roles could be minimized by basing on the U.S. coasts and/or on Guam as an alternative to existing silos.
- The United States might be able to use the provisions of the START Treaty, as well as confidence and security building measures built upon them, to allay Russian concerns. Real progress on joint early warning might be both an enabler in this regard, and of significant value in its own right.

The study concludes that, although ballistic missiles are generally perceived of as Cold War weapons, they have much to offer 21st century U.S. defense planners. While there are obviously some missions for which other strike platforms are more appropriate, there are other circumstances, equally as plausible, in which the promptness, accuracy and range of ballistic missiles could be attractive.

Abbreviations

ABM	Anti-Ballistic Missile
ADR	Annual Defense Report
AFB	Air Force Base
AFSPC	Air Force Space Command
ATACMS	Army Tactical Missile System
BMD	Ballistic Missile Defense
BMDS	Ballistic Missile Defense System
BWC	Biological Weapons Convention
C^3	Command, Control, and Communications
C^4ISR	Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance
CALCM	Conventional Air-Launched Cruise Missile
CAV	Common Aero Vehicle
CEP	Circular Error Probable
CONOPS	Concept of Operations
CSBM	Confidence and Security Building Measure
CWC	Chemical Weapons Convention
DOD	Department of Defense
GPS	Global Positioning System
HDBT	Hard and Deeply Buried Target
ICBM	Intercontinental Ballistic Missile
INF	Intermediate Nuclear Forces Treaty
INS	Inertial Navigation Systems
IRBM	Intermediate-Range Ballistic Missile
JDAM	Joint Direct Attack Munition
MIRV	Multiple Independently Targetable Reentry Vehicle
MRBM	Medium-Range Ballistic Missile
MTCR	Missile Technology Control Regime
NPR	Nuclear Posture Review
NPT	Nuclear Non-proliferation Treaty
ORS	Operational Responsive Spacelift
QDR	Quadrennial Defense Review
RNEP	Robust Nuclear Earth Penetrator
RV	Reentry Vehicle
SAC	Strategic Air Command
SAM	Surface to Air Missile
SLBM	Submarine-launched Ballistic Missile
SLV	Space Launch Vehicle
SOF	Special Operations Forces
SRBM	Short-Range Ballistic Missile
SSBN	Ballistic Missile Submarine (Nuclear)
SSGN	Guided Missile Submarine (Nuclear)
START	Strategic Arms Reductions Treaty
TSV	Trajectory Shaping Vehicle
USSTRATCOM	U.S. Strategic Command
WMD	Weapons Of Mass Destruction

The Future of Ballistic Missiles

Introduction

During the Cold War, strategic nuclear forces, particularly ballistic missiles, were a core element of the U.S. defense posture. Now, however, the circumstances have changed; the Soviet Union's collapse was the harbinger of a new and different security environment. Regional powers, some with global aspirations, and non-state actors have become the principal focus of U.S. defense policy. This diffusion of the threat profile has also come at a time when what were once thought to be "lesser" threats are becoming increasingly lethal. This trend is driven by the proliferation of weapons of mass destruction (WMD), ballistic missiles, and advanced conventional capabilities. Given this shift in climate, the question for U.S. defense planners is this: how well does the U.S. force structure, designed for the Cold War, address the 21st Century security environment? The question is particularly acute with respect to that totem of the bipolar confrontation, the ballistic missile.

This study took a phased approach to understanding the potential roles for ballistic missiles in the U.S. military posture. First, after a thorough literature review, we conducted an extensive set of interviews with senior U.S. defense officials (both civilian and military).[1] From this data, we identified a clear interest in long-range precision strike that dictates U.S. interest in an array of mission areas and target types. In phase two, we outlined existing and prospective U.S. ballistic missile technologies. Next we constructed a comparative view of how select U.S. capabilities—ballistic missiles, manned bomber/tactical aircraft, cruise missiles, and special operations forces (SOF)—might address requirements for long-range precision strike. This phase demonstrated the importance of context in discussing the relative merits of each capability; in other words, how a "toolbox" of capabilities could be utilized in a modern effects-based war plan. Finally, based on an understanding of how ballistic missiles could be used for long-range precision strike, we identified and mapped the legal and policy terrain that the U.S. would have to navigate in order to exercise these options.

We conclude that the future of ballistic missiles—in nuclear and non-nuclear strike roles, as space launch vehicles (SLV), and as ballistic missile defense (BMD) interceptor boosters—is promising. As General Lance W. Lord, commander of the Air Force Space Command (AFSPC), noted in a discussion of the conventional uses of ballistic missiles:

> It's quite possible that the conventional application of that kind of technology will be an attractive option for the future. How these plans will emerge and how combatant commanders will choose to use those is something we'll think about.[2]

In short, ballistic missiles provide unique existing and potential capabilities that can contribute significantly to future deterrence, not only as nuclear delivery systems, but also as conventionally armed systems and boosters for space assets and BMD-related missions. Perhaps the most problematic issues for the use of ballistic missiles in the future revolve around political and treaty constraints.

Beyond the Cold War

Although the United States remains the world's preeminent military power, it cannot afford to be complacent. The American military establishment is engaged in an arduous but necessary reformulation of its defense posture to meet post-Cold War realities. One of those realities is the proliferation of weapons of mass destruction and ballistic missile technology. As Dr. J. D. Crouch, Assistant Secretary of Defense for International Security Policy, noted in a January 2002 briefing, "the proliferation of nuclear, biological, and chemical weapons and ballistic missile delivery systems continues unabated." At the time, he stated that 12 nations have nuclear weapons programs; 13 have biological weapons; 16 have chemical weapons; and 28 have ballistic missile technology.[3] The production or acquisition of WMD—and ballistic missiles to deliver them—is an achievable objective for many states, and even some non-state actors, despite obstacles posed by multinational agreements like the Biological Weapons Convention (BWC), the Chemical Weapons Convention (CWC), the Nuclear Non-Proliferation Treaty (NPT), and the Missile Technology Control Regime (MTCR).

A number of states see clear advantage in possessing WMD, ballistic missiles and other advanced weapons because their ambitions conflict with America's global interests, commitments and responsibilities. As President Bush suggested:

> Some states, including several that have supported and continue to support terrorism, already possess WMD and are seeking even greater capabilities, as tools of coercion and intimidation. For them, these are not weapons of last resort, but militarily useful weapons of choice intended to overcome our nation's advantages in conventional forces and to deter us from responding to aggression against our friends and allies in regions of vital interest. In addition, terrorist groups are seeking to acquire WMD with the stated purpose of killing large numbers of our people—without compunction and without warning.[4]

Moreover, the Bush administration is concerned that "rogue" regimes and other proliferators may share military and WMD technology with non-state actors bent on harming the United States. Speaking at West Point in June 2002, President Bush summarized this concern:

> The gravest danger to freedom lies at the perilous crossroads of radicalism and technology. When the spread of chemical and biological and nuclear weapons, along with ballistic missile technology—when that occurs, even weak states and small groups could attain a catastrophic power to strike great powers.[5]

Recent developments in North Korea and Iran highlight this trend.[6] In 2002, North Korea acknowledged a secret program to enrich uranium, then dismantled International Atomic Energy Agency monitoring equipment at the Yongbyon nuclear facility and withdrew from the NPT. Pyongyang also remains a principal source of ballistic missiles and associated technology for those countries that aspire to missile capability.[7] Iran has announced that it will reprocess spent nuclear fuel and mine uranium in an effort to expand its nuclear program, a move which U.S. officials state demonstrates Iranian ambition to develop nuclear weapons.[8]

These concerns are exacerbated since traditional state challengers and non-state actors are becoming better armed in all respects.[9] The trade in advanced conventional weapons like anti-ship cruise missiles makes U.S. power projection a more risky proposition and increases the lethality that small states, or even some non-state actors, can bring to bear. Mass media, world-wide telecommunications, ease of international travel, a globalized financial system, and states like Russia and China willing to sell high technology have enabled the growing power of these threats.[10] All of this suggests that while the U.S. military will likely remain dominant on the "traditional" battlefield for some years, the U.S. homeland, our allies, and our vital interests will still face grave threats.[11]

Transformation to Meet 21st Century Challenges

In response to this new environment, the President has endorsed the transformation of the U.S. force posture to meet the ill-defined but metastasizing threat. As the President noted in the September 2002 *National Security Strategy of the United States of America*, the United States must:

> …continue to transform our military forces to ensure our ability to conduct rapid and precise operations to achieve decisive results….
>
> Before the war in Afghanistan, that area was low on the list of major planning contingencies. Yet, in a very short time, we had to operate across the length and breadth of that remote nation using every branch of the armed forces. We must prepare for more such deployment by developing assets such as advanced and remote sensing, long-range precision strike capabilities, and transformed maneuver and expeditionary forces.[12]

The Donald Rumsfeld Pentagon articulated this approach in the 2001 Quadrennial Defense Review (QDR) and Nuclear Posture Review (NPR).[13] Those reviews identified an approach to managing the risk associated with an uncertain threat. In the minds of U.S. defense decisionmakers, that perspective has been reinforced by 9/11 and the war on terrorism.

During the Cold War, defense planning used a "threat-based" approach. That is, the United States could design its force, doctrine, and tactics to meet those of a single identified enemy—and a reasonably predictable one at that. However, that basis for planning is less valid today based on a security environment in which we cannot be sure when, how, or against whom we might have to use conventional military forces or nuclear forces. Moving away from this threat-based approach, the Bush administration has adopted a "capabilities-based" approach that focuses on how potential adversary or adversaries might fight.[14] In this view, the United States would need a "toolbox" of military capabilities and the flexibility to mix and match them. For its part, the NPR's approach to capabilities-based planning introduced the concept of a "New Triad" in which the traditional strategic nuclear forces were subsumed within the notion of strategic offensive forces (both conventional and nuclear).[15]

In the new context outlined in the QDR and NPR, the old two major conflict force sizing construct gave way to new priorities: U.S. forces must be able to defend the United States, deter aggressors in critical areas, defeat aggression in overlapping major conflicts, and conduct a limited number of small-scale operations.[16] At heart, this revision is a way of managing risk, preserving today's necessary capabilities, bringing new technologies online tomorrow, and pursuing truly "transformational" systems that will shape a 21st Century force.

The QDR identified six critical operational goals that reflect the need to balance risks within this transformation effort:

- Protecting critical bases of operations (U.S. homeland, forces abroad, allies, and friends) and defeating WMD weapons and their means of delivery;
- Protecting information systems and conducting effective information operations;
- Projecting and ensuring the security of U.S. forces in challenging environments;
- Denying enemies sanctuary by providing persistent surveillance and the threat of rapid engagement through a combination of complementary air and ground capabilities;
- Maintaining and protecting space systems; and

- Developing an effective joint Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C^4ISR) capability.[17]

The new strategy does not equate risk reduction with the acquisition of additional forces; but rather emphasizes the need to implement changes in capabilities, concepts of operations, and organizational designs.

These operational goals clearly demonstrate that long-range strike capabilities will play an important role in dealing with future security challenges. As the Bush administration has pointed out, long-range strike capabilities are necessary for several reasons. In June 2001, at the request of Defense Secretary Rumsfeld, the Department of Defense (DoD) completed a Conventional Forces Study noting the importance of long-range capabilities for future operations.

> Bringing forces and fire to bear quickly is important, with an emphasis on the "quickly." We may not be able to determine when operations must begin, but we want to gain control of the tempo of operations rapidly thereafter. Time is absolutely crucial in a military operation. We may not have the ability, or may not have the foreknowledge to have forces exactly where they should be in anticipation of an operation. . . . Even if you have not taken the time or don't have the time or don't have the conditions to build large-scale, tactical, short-range strike forces, you still want the ability to strike early, and that means striking with long-range forces and forces with long-range munitions.[18]

The 2002 Annual Defense Report (ADR) pointed out, "The global U.S. military posture must be reoriented for a new strategic environment in which U.S. interests are global and new challenges, particularly *anti-access and anti-denial threats*, are emerging."[19] Recent U.S. campaigns in Afghanistan and Iraq should not lead military planners to the conclusion that the United States will always have substantial time to build up forces and be guaranteed widespread access to a given theater. Thus long-range capabilities may play a vital role in establishing a military presence in a particular hostile region.[20]

Long-range strike capabilities similarly play a part in denying enemies sanctuary. In the 2002 ADR Secretary Rumsfeld suggested:

> A key objective of transformation is to develop the means to deny sanctuary to potential adversaries—anywhere and anytime. This will require the development and acquisition of robust capabilities to conduct persistent surveillance of vast geographic areas and long-range precision strike—persistent across time, space, and information domains and resistant to determined denial and deception efforts. Denying enemies sanctuary will also require the ability to insert special operations and other maneuver forces into denied areas and to network them with long-range precision strike assets.[21]

Ultimately, as Secretary Rumsfeld argued, "the ability to project power at long ranges is essential to deter threats to the United States and, when necessary, to disrupt, deny, or destroy hostile entities at a distance."[22]

Finally, as the NPR suggests, conventional long-range precision strike capabilities are critical because they are a more versatile option than nuclear weapons in the event of a challenge to the United States or its allies. They also send a signal to potential adversaries that the United States can respond with a broad array of capabilities, thereby enhancing deterrence.[23] In January 2003 President Bush directed U.S. Strategic Command (USSTRATCOM) to assume responsibility for four new missions, including global strike, integrated missile defense, integrated information operations, and global C^4ISR.[24] Admiral James O. Ellis, commander of USSTRATCOM, elaborated on this new global strike mission in April 2003 testimony:

> USSTRATCOM's newly assigned global strike mission extends our long-standing and globally focused deterrent capabilities to the broader spectrum of conflict. We will incorporate conventional, non-kinetic, and special operations capabilities into a full spectrum contingency arsenal and into the nation's strategic war plan to further reduce our reliance on nuclear weapons. This innovative approach will enable the command to deliberately and adaptively plan and rapidly deliver limited-duration, non-nuclear combat power anywhere in the world. Our intent is to provide a wide range of advanced options to the President in responding to time-critical, high-threat, global challenges and, thereby, raise even higher the nuclear threshold….
>
> Global strike will provide the nation the ability to engage priority targets by moving rapidly from actionable intelligence, through adaptive planning, to senior-level decision-making and the delivery of kinetic or non-kinetic effect across thousands of miles. It can provide what may be the most critical element early in the fight—time. As a regional combatant commander assembles and moves forces into position or needs to strike into temporarily denied areas, USSTRATCOM can provide early planning and tangible, long-range combat capability….
>
> We continue to study concepts such as conventional ballistic missiles, Common Aerospace Vehicles, hypersonic aircraft, and unmanned combat aerial vehicles that could play a significant role in improving our global strike capabilities in the mid to long-term.[25]

In sum, the United States faces a very different security environment from that of previous decades. More challengers exist, both traditional state-based competitors and non-state actors, and the means at their disposal to harm the United States, its allies, and other interests abroad has increased dramatically. This "democratization of destruction" makes it imperative that the United States field sophisticated long-range precision strike capabilities, both nuclear and non-nuclear, to meet these ever dangerous and diffuse threats. In response to this environment, the United States has begun to balance risks and identify the necessary capabilities it must possess to meet its national security objectives. In that context, we can begin to discuss the likely missions and targets that long-range strike platforms would be called upon to address.

Missions and Targets

In addition to the continuing requirements associated with "traditional" deterrence, several important new missions and targets for long-range strike emerge from the previous discussion of the new security environment. Indeed, the NPR drew attention to the limitations of the present U.S. nuclear force:

> Today's nuclear arsenal continues to reflect its Cold War origin, characterized by moderate delivery accuracy, limited earth penetrator capability, high-yield warheads, silo and sea-based ballistic missiles with multiple independent reentry vehicles (MIRVs), and limited retargeting capability. New capabilities must be developed to defeat emerging threats such as hard and deeply buried targets (HDBT), to find and attack mobile and relocatable targets, to defeat chemical or biological agents, and to improve accuracy and limit collateral damage. Development of these capabilities, to include extensive research and timely fielding of new systems to address these challenges are imperative to make the New Triad a reality.[26]

Based on a broad array of interviews we have been able to identify the mission areas and target types that appear to be of most concern for those charged with enhancing the United States' long-range strike options. This list clearly is not exhaustive, but it does identify the centers of gravity that are consistent with the new strategic environment.

Table 1. 21st Century Missions and Targets

Missions	Targets
Traditional Deterrence	Traditional Military Targets
WMD Neutralization	Hard and Deeply Buried Targets
Strategic Decapitation	Mobile and Rapidly Relocatable Targets
Offensive Counterforce	Chemical and Biological Weapons Sites
Defense Suppression	
Space Launch/BMD	

Missions

Traditional Deterrence

Despite the collapse of the Soviet Union, traditional deterrence remains important in U.S. defense planning.[27] U.S. defense policy goals include strategic forces to: 1) assure allies and friends of U.S. resolve to fulfill its security commitments; 2) dissuade adversaries from pursuing programs and operations that could threaten U.S. interests; 3) deter aggression and coercion by deploying forces that can defeat and impose severe penalties for an adversary's initiation of hostilities; and 4) decisively defeat any adversary if deterrence fails.[28] As outlined in the NPR, the existing nuclear arsenal "provide[s] credible military options to deter a wide range of threats, including WMD and large-scale conventional military force. [They] possess unique properties that give the United States options to hold at risk classes of targets [that are] important to achieve strategic and political objectives."[29]

Even though their numbers will be reduced over the next decade, U.S. strategic nuclear forces will serve a "continuity of deterrence" role in the future.[30] For instance, although conflict with Russia is no longer considered an immediate contingency, the mix within the active U.S. nuclear stockpile will allow the United States to respond accordingly should relations with Russia or, perhaps, China sour.[31] The near-term ability to reconstitute a larger force credibly is resident in the downloaded intercontinental ballistic missiles (ICBM) and submarine-launched ballistic missiles (SLBM) that remain part of the active force. The need for a responsive force within the active stockpile is also a product of the unique character of the U.S. nuclear infrastructure, most notably the lack of an active warhead production capability and the need to sustain an aging stockpile. Should U.S. nuclear force planners need to respond relatively quickly to changes in the international environment, the responsive force should provide an acceptable glide path—particularly at a time in which the United States would require 24-36 months before it could conduct a nuclear test, for example in support of a new weapon design.[32] Moreover, the extant potential in deployed ICBMs and SLBMs may be the principal source of flexibility in the responsive infrastructure should political, budgetary or technical impediments limit progress on "New Triad"-type strategic capabilities. Thus, the flexibility inherent in a responsive force and credible nuclear infrastructure allows this, or future, administrations to increase or decrease the size of the force, at whatever pace is deemed appropriate, in response to the international climate.

The structure and size of the U.S. nuclear force may dissuade "rogue states" or other adversaries from acquiring or using WMD. Sizable nuclear forces, in tandem with a responsive infrastructure, might also dissuade aspiring peer competitors and assure the American people and security partners that the United States will not be subject to coercion and will always be able to project its power to defend forward bases, friends, and allies. Thus, existing nuclear weapons will continue to serve as guarantors of American power in the decades to come. To the extent that manned bombers like the B-52 and B-2 are increasingly tasked with conventional roles, the assured capability inherent in dedicated nuclear delivery vehicles as part of the ICBM and SLBM force will be a clear demonstration of U.S. intent to retain a robust nuclear capability.

Since these weapons already exist, the principal challenge is ensuring their safety and reliability. The NPR outlined steps to ensure the reliability and life extension of ICBMs and SLBMs. While the Peacekeeper will be deactivated over a 36-month period beginning in 2002, the Minuteman III will be retained in the current force structure. Planned service life extension programs are intended to extend Minuteman III's life to 2020, well beyond this country's traditional planning cycle—formal or informal.[33] The Air Force is also undertaking a study to address alternatives for a follow-on ICBM to examine a new land based strategic deterrent for an initial operational capability by 2018.[34] Prospects for a new SLBM are projected even further into the future, possibly around 2029, to match the schedule for a follow-on ballistic missile submarine (SSBN). Currently, the Trident D-5 SLBM is undergoing a life extension program to upgrade guidance and missile electronics systems, along with continued production of D-5 missiles to prevent a shortage in the next decade.[35] In the end, ballistic missiles are vital to a credible nuclear deterrent and, for that reason, they will continue to play this vital role in the New Triad along with other strategic forces, such as manned bombers.[36]

WMD Neutralization

WMD in the hands of powers hostile to the United States constitute a threat to the U.S. homeland, forward deployed forces and American allies around the world. U.S. strategic capabilities, both conventional and nuclear, may contribute to deterring an adversary's use of WMD—either through the promise of decisive retaliation or by rendering the adversary's ultimate goals unattainable. However, deterrence is an uncertain calculus. U.S. planners must understand that opponents may choose to use WMD against U.S. targets despite their best efforts to forestall it. In that case, the United States must seek to deny an adversary the use of his WMD or at least act so as to limit the damage such an attack might achieve. That requirement means offensive counterforce designed to destroy and degrade an adversary's WMD employment options. The unique nature of WMD as a target for offensive military action, e.g., the need to contain dispersal and prevent unintended casualties or environmental damage, means that planning and preparation for these types of targeting problems must be thorough. It also suggests specialized payloads tailored to mission. Furthermore, a proven ability to address these threats effectively in turn strengthens deterrence and lessens the chance that such force may have to be used.

Strategic Decapitation

A timely strike against an adversary's leadership is another likely future mission for U.S. defense planners.[37] Successful strikes against an adversary's leadership should be predicated on a thorough understanding of the adversary's strategic command and control as well as accurate and reliable intelligence about the leadership's whereabouts and the nature of the target. It is crucial that U.S. planners contemplating decapitation strikes do so with the knowledge of the strategic impact their operational decisions will have. For example, strategic attacks on an enemy's leadership in some cases might forestall WMD use in a regional conflict—however under different circumstances, such an attack might devolve WMD release authority to enemy commanders more willing to use it. This need for extraordinary clarity of both tactical data and strategic purpose suggests that the opportunities for exercising truly effective strategic decapitation operations might be only fleetingly available. In that context, both the decisionmakers and the weapons systems they choose to employ must operate with utmost efficiency and promptness.

The value of such decisive promptness should be evident from recent conflicts. Recent U.S. operations in Iraq, Afghanistan, and other locations against leadership targets document both the importance of such options and the difficulty of conducting them promptly enough to capitalize on fleeting opportunities presented by even the most advanced intelligence capabilities. According to a recent Air Force report, leadership targets represented approximately one-third of the “time sensitive target” missions in the recent war with Iraq.[38]

Offensive Counterforce

When deterrence fails, it might fall to the United States to achieve a favorable outcome by using military force. The United States has faced this situation in the recent past. As described by distinguished British historian Sir Michael Howard, Iraq’s invasion of Kuwait was “a classic example of the failure of deterrence making necessary the exercise of compellence.”[39] However, tomorrow’s foes may not be as accommodating as was Saddam Hussein who allowed the United States months to build up its forces in the region. As noted earlier, one of the rationales behind U.S. interest in long-range strike capabilities is the likelihood that future adversaries will try to deny the U.S. access to the theater of operations. This could include WMD attacks on ports and airfields, attacks against carrier battle groups or even terrorist attacks at U.S. homeports and bases intended to delay embarkation. In those or similar circumstances, long-range strikes become an essential capability to bridge the gap until America’s superior conventional forces can be brought to bear.

Long-range strikes against enemy offensive forces are one way of making credible the U.S. ability to destroy that which the opponent values—in the case of many regimes the military force through which they retain power and threaten others. Targeting command and control is a way U.S. warfighters might paralyze an adversary's forces, limiting the execution of his offensive options until such time as those forces can be destroyed. Offensive counterforce capabilities, especially those capabilities that can be executed promptly—in minutes rather than hours—are particularly significant for responding to surprise attack or to an opponent operating on a timeline such that he feels capable of achieving an a *fait accompli*. For example, North Korean long-range artillery is capable attacking urban Seoul from its current emplacements. In the event of a conflict with North Korea, the United States and South Korea would certainly consider stopping a barrage against the civilian population of Seoul a critical objective. In addition to destroying artillery pieces, eliminating their critical command and control nodes would almost certainly be required.

Defense Suppression

The United States characteristically seeks to carry the battle to the enemy. At the same time our adversaries emphasize defensive measures focused at protecting their assets. The ability to, at a distance, “roll up” an enemy’s defenses before they can engage U.S. forces may be crucial—particularly since many potential opponents view the United States as excessively “casualty adverse” and seek to kill U.S. soldiers, sailors, or airmen as a strategic objective. Long-range strikes could work with forces in theater, paving the way for follow-on air or surface attacks. For example, during the 1991 Gulf War and the recent war with Iraq, once U.S. forces were deployed in large numbers, cruise missiles were launched to perform a defense suppression role. Ballistic missiles could perform some of this role. This might also allow a commander to make maximum use of potentially limited resources, e.g., in flight refueling tankers, for offensive operations.

Space Launch and Ballistic Missile Defense

Although not exactly equivalent to the other mission areas cited above, two other missions exclusively for ballistic missiles are worth noting here. First is the potential role of missile boosters as SLVs. As the Commission to Assess United States National Security Space Management and Organization concluded, “the present extent of U.S. dependence on space, the rapid pace at which this dependence is increasing, and the vulnerabilities it creates, all demand that U.S. national security space interests be recognized as a top national security priority.”[40] In the future, the ability to reconstitute the U.S. constellation of space assets rapidly may prove decisive.[41] Without Global Positioning System (GPS) navigation, highresolution imagery, and signals intelligence via communications satellites, campaigns like Iraqi Freedom would be significantly more difficult and costly to pursue. AFSPC has thus made “quick-response space” a top priority.[42] Existing ballistic missiles are proven, reliable, and highly capable space launch vehicles. For example, decommissioned Peacekeeper ICBMs could yield a significant lift capability.[43]

The second unique missile mission area would be supporting U.S. interest in a ballistic missile defense system (BMDS). President Bush decided last December to field a limited land and sea-based missile defense system to defend against medium and long-range missiles. This supplements existing and prospective defenses against short-range ballistic missiles, as part of a spiral development program that will bring deployment of future systems as they become ready. Ballistic missile stages in a variety of booster combinations could be utilized to deliver missile defense sensors into space or boost interceptors, just as they can serve as target delivery vehicles in the course of BMD technology development.

Targets

The mission areas identified above suggest a group of target types that are of particular interest for long-range strike: traditional military targets; HDBT; mobile and rapidly relocatable targets; and chemical and biological weapons sites. Rapidly acquiring a long-range strike capability against such targets would be truly transformational, providing a necessary leap in the U.S. ability to pursue global interests and responsibilities.

Traditional Military Targets

The majority of important military targets are relatively soft, locatable, and vulnerable to ballistic missile attack. These include supply depots, staging areas, logistic nodes, major troop formations, command and control facilities, fixed radars, surface to air missile (SAM) sites, and so forth. Some of these targets would be vulnerable to missiles with today’s accuracy and could be significantly damaged by kinetic or conventional warheads. Given current capabilities, many dispersed or hardened targets might require a nuclear weapon. In many cases, operational effectiveness might be degraded by the threat of a missile attack with little or no tactical warning. Moreover, during the period when U.S. air superiority may still be contested, a long-range precision strike capability could give the United States the ability to strike at vital traditional military targets without putting U.S. air crews at risk. For instance, long-range precision strike capabilities could be used for defense suppression paving the way for the introduction of other air assets.

Hard and Deeply Buried Targets

The members of the defense establishment interviewed for this study consistently placed HDBTs as the top priority for long-range precision-strike. Finding ways to hold HDBTs at risk is a major defense priority because, as the NPR notes, “at present the United States lacks adequate means to deal with these strategic facilities.”[44]

According to recent intelligence estimates, more than 70 countries now use underground facilities for military purposes, with over 10,000 facilities worldwide. Approximately 1,400 of these facilities house strategic sites, including WMD facilities, ballistic missile basing, and leadership or top echelon command and control.[45] HDBTs are classified into three categories—“cut and cover,” simple tunnels, and deeply buried facilities—that can range in depth from 20 m to 1 km below ground.[46] For instance, North Korea is renowned for its tunneling ability. North Korea has hundreds of hardened artillery sites just north of the demilitarized zone, uses hardened facilities to house underground air and naval facilities, and, according to some sources, has built a uranium-enrichment plant underground.[47]

At present, the ability to destroy HDBTs is limited. Conventional penetrating weapons can destroy "cut and cover" HDBTs, which represent the majority of these facilities worldwide. But, as the NPR pointed out, the U.S. capability to address HDBTs remains limited, and "in general, current conventional weapons can only 'deny' or 'disrupt' the functioning of HDBTs," and they "are not effective for the long-term physical destruction of deep, underground facilities."[48] It should be noted, however, that in many cases the complete destruction of the HDBT is not necessary to achieve the functional defeat of the target. That is, the operational capability of the facility can be degraded sufficiently by targeting and destroying surface features, such as air ventilation systems, communication lines, and entrances. This may inhibit personnel from entering and leaving the facility and trap military assets underground where they cannot be accessed.

Mobile and Rapidly Relocatable Targets

The NPR noted, "one of the greatest challenges today is accounting for the location uncertainty of mobile and relocatable targets."[49] These could include aircraft, ships, troop formations, mobile command, control, and communications (C^3) facilities, mobile WMD facilities, leadership, or missile launchers. The use of Iraqi Scud missiles to attack Israel and U.S. forces in Saudi Arabia during the Gulf War underscores the requirement for capabilities that can be employed against such elusive targets.[50] During Desert Storm, coalition aircraft carried out more than 1,500 strikes against Scud-related targets over a six-week period, but few, if any, mobile launchers were destroyed, and Iraq succeeded in launching almost 90 missiles.[51] The potential use of mobile missiles to deliver WMD further intensifies this need.[52] An effective BMDS and the capability to locate and destroy such targets are crucial to protecting U.S. allies, forces, and regional population centers.

Chemical and Biological Weapons Sites

Biological and chemical weapons capabilities have proliferated tremendously over the past decade, and serve as a formidable challenge to U.S. military planners. Many countries in the world see the development of WMD as an effective counter to U.S. conventional superiority. Destroying chemical and biological weapons sites can be a difficult task. Many are concealed or in HBDTs. However, even known vulnerable sites pose unique problems. Conventional weapons can destroy many chemical and biological weapons sites, but the primary concern is that such a strike could release agents and organisms into the environment. As a consequence, the development of "agent defeat" techniques has been central to DoD thinking over the past few years. Several agent defeat concepts are currently under study, including thermal and chemical neutralization of chemical/biological materials in production or storage facilities, as well as different types of kinetic penetrators to immobilize or deny access to these materials.[53]

The missions and targets identified in this study demonstrate the shape of U.S. interests in long-range precision strike. Based on this discussion of the current security environment and the potential missions and targets that emerge, it is important to examine existing ballistic missile capabilities as well as future enhancements to them to understand the roles required of missiles in the 21st Century defense.

Ballistic Missiles as Long Range Precision Strike

Background

A ballistic missile is a rocket that fires its engines and then allows momentum and the force of gravity to carry its cargo to its intended target.[54] Ballistic missiles are usually categorized according to their range as follows.[55]

Table 2. Missile Ranges

Missile Types	Range
Intercontinental Ballistic Missiles	Over 5,500 km
Intermediate-Range Ballistic Missiles	3,000 to 5,500 km
Medium-Range Ballistic Missiles	1,000 to 3,000 km
Short-Range Ballistic Missiles	Up to 1,000 km

Ballistic missiles can be based in a number of ways, most commonly as land-based (mobile or fixed) missiles or as SLBMs.[56] Most current long-range ballistic missiles employ two or more rocket motors, or stages, sequentially propelling the missile's flight.[57] Once the propulsion phase is completed, the missile continues along a ballistic trajectory. Modern long-range systems usually align, inertially stabilize, and release one or more reentry vehicles (RV). RVs are protected during reentry into the atmosphere by a heat shield and are designed to minimize atmospheric drag. During this terminal phase of the trajectory, the RV is moving at tremendous speeds measured in kilometers per second. See appendix for background on U.S. missile programs.

Today, countries throughout the world are developing ballistic missiles with a variety of ranges capable of delivering conventional and WMD payloads.[58] Increased U.S. concern with the proliferation of ballistic missile technology and WMD is a defining characteristic of the post-Cold war security environment.

Current U.S. Ballistic Missile Capabilities

Ballistic missiles are one of the most compelling assets available because of their unique characteristics. They offer unparalleled promptness, reaching most targets in the world from the United States within 30-45 minutes, and can deliver sizable payloads. They allow for a significant stand-off posture—in other words, the distance from the target at which the weapon can be launched—which lessens the threat to U.S. military personnel. Given their great reentry speed, they can penetrate air defenses. As General Lance W. Lord, commander of AFSPC, stated,

> The ICBM has quick time-of-flight, fast reaction, accuracy, timeliness—all the things that can go into a conventional role's spectrum of operations. Whereas we might have been reticent to look at that under a threat-based analysis in [today's] world, those kind of capabilities may have potential uses.[59]

The United States today possesses two types of long-range ballistic missiles—ICBMs and SLBMs.[60] Table 3 outlines the basic characteristics of these missiles.

Several changes to U.S. nuclear forces are underway as a result of the NPR and the Moscow Treaty, in which the United States and Russia each agreed to reduce their number of operationally deployed strategic nuclear warheads to between 1,700 and 2,200 by 2012.[61] The 50 Peacekeeper ICBMs are programmed for deactivation, which began in October 2002 and will continue over the next three years.[62] At present, five Peacekeepers have been deactivated and are under the control of Detachment 12 of the Air Force Space and Missile Center in Albuquerque, New Mexico. Once the deactivation is completed, a total of 80 Peacekeepers will be in storage, which includes backups to the original 50 deployed. While the Peacekeeper is being removed from the active force structure, it is not being destroyed and could be assigned new roles in the future.

Table 3. Existing U.S. Ballistic Missiles[63]

	Range (km)	Throw Weight (kg)[64]	CEP (m)[65]
ICBMs			
Peacekeeper	9,600	3,800	90
Minuteman III	13,000	1,150	120
Minuteman II	9,600	730	370
SLBMs			
Trident D-5	12,000	2,800	90
Trident C-4	7,400	1,500	450

The Minuteman III will remain the backbone of the ICBM force, with 500 likely being retained. The Minuteman III is undergoing comprehensive modernization programs designed to extend its service life through 2020.

Currently, the Air Force has 200 first stage Minuteman II boosters, 275 second stage boosters, and 400 third stage boosters.[66] The first and second stage of Minuteman II are identical to those of Minuteman III missiles, the only difference being the size of the third stages and the front ends of the missiles.

The SLBM force is also undergoing transition. The Navy is converting all older Trident ballistic missile submarines: four to carry the Trident II (D-5) SLBM, and four to be converted into guided missile submarines (SSGN). This conversion will leave the United States with fourteen D-5 equipped ballistic missile submarines. The D-5 conversion means that all C-4 SLBMs will become excess to the present ballistic missile submarine force.[67]

In addition, the ability to "upload" existing missiles up to their full Cold War era compliment of RVs offers the United States at least some quantitative flexibility for addressing the concerns that have shaped planners' interest in a responsive infrastructure.

In short, the United States has a variety of ballistic missiles at its disposal. What role then is there for ballistic missiles? Answering that question first requires an understanding of what technology has to offer a future ballistic missile force.

Future U.S. Ballistic Missile Capabilities

Today's ballistic missiles possess both the nuclear capabilities for which they were designed, and a very real kinetic capability resident in the inert warheads used in the reliability testing program. By some estimates, a 500-pound dummy warhead, given its speed at impact (for a 40 degree reentry angle), contains the kinetic energy roughly equivalent to 700 pounds of high explosives.[68] Because we have a limited number of these dummy warheads, such a kinetic weapon could be available today. Although only a small number would be involved, this would demonstrate the post-Cold War utility of ICBMs and SLBMs for conventional operations.

One technical prerequisite for giving "test asset" ballistic missiles an employable conventional capability lies in the area of developing an operational concept that makes the asset useful to the warfighter. This includes appropriate command and control of missile launch units, targeting information assembled in data bases structured to support rapid response, dedicated missiles with the appropriate warheads—currently dummy warhead test assets—and operational plans which include the option for ballistic missile use are the basic requirements. These are essentially all changes in how we think about ballistic missiles and plan for their use rather than any change in assets now in hand.

Once ballistic missiles are established as conventional weapons systems, there are several technical avenues open to defense planners thinking about how current systems might be further adapted to address better U.S. interest in long-range striking power. The first is to design new front ends for specific strike options; the second to make ballistic missiles more accurate; the third to provide for in-flight retargeting, and the fourth to enhance the planning processes.

New "Front Ends"

Existing U.S. ballistic missiles were designed for nuclear missions and carry a variety of relatively high-yield nuclear weapons. However, the NPR stresses the need for non-nuclear and perhaps new nuclear strike capabilities as well. Accordingly, new types of payloads—or "front ends"—are appropriate for ballistic missiles to serve more effectively as long-range conventional precision strike platforms. Fitting nuclear ballistic missiles with new front ends is feasible according to the defense officials and engineers interviewed for this study.

New front ends may include kinetic energy weapons or conventional explosives designed for a range of traditional military targets.[69] As discussed in the introduction to this section, refitting some existing ballistic missiles with test warheads would provide an immediate kinetic capability with, accuracy enhancements expanding the possible set of targets. However, test warheads do not exist in abundance, since only enough were procured to support flight test operations. The same kinds of conventional munitions, such as anti-personnel, anti-armor, submunitions, etc., currently delivered by aircraft could also be delivered by ballistic missiles. In addition to these kinetic and conventional options, another option for ballistic missiles may be a dispersed fragment weapon. This weapon makes use of the high reentry velocity to achieve a high fragment striking velocity and uses a small amount of high explosive to spread the fragments across a large area. While potentially effective against a variety of surface targets, kinetic energy weapons and conventional explosives are limited by their depth of penetration before the weapon disintegrates, an issue particularly relevant to the defeat of HDBTs.

To increase effectiveness against HDBTs, ballistic missiles could be configured to deliver conventional earth penetrators. More sophisticated air-delivered bombs specifically designed for penetrating HDBTs are equipped with a hardened casing that protects the bomb's fusing from malfunctioning. However, existing conventional earth penetrators are relatively long and not suitable for ballistic missile delivery. These weapons have a large length to diameter ratio to facilitate penetration when impacting at airdrop velocities. On the other hand, ballistic missile RVs have the advantage of being able to achieve higher impact velocities, therefore, a high-speed penetrator could be designed with a length to diameter ratio more favorable for ballistic missile delivery. Looking to the future, some Air Force research is examining lighter weapons that are designed to achieve greater penetration by traveling at significantly higher velocities.[70]

In addition to conventional payloads, ballistic missiles might be useful as delivery vehicles for a new generation of nuclear weapons. The B61-11, first introduced in 1997, is the only existing earth penetrating nuclear weapon in the U.S. arsenal.[71] In two drop tests from approximately 40,000 feet, an unarmed B61-11 penetrated into frozen tundra approximately 6-10 feet, and some estimate it can penetrate to a depth of 15 to 25 feet in dry earth.[72] As the NPR pointed out, what this means is that "the targeting of a number of hardened, underground facilities is limited to an attack against surface features, which does not provide a high probability of defeat of these important targets."[73] Consequently, at the time of this writing, Congress is considering authorizing the Bush administration to explore the possibility of smaller nuclear weapons with more specialized functions.[74]

$15 million was appropriated for the research of a Robust Nuclear Earth Penetrator (RNEP), a "bunker-busting" nuclear weapon.[75] The study seeks to examine the possibility of taking the nuclear package of the existing B61 or B83 and putting it into a new penetrating body.[76] The RNEP could extend the set of HDBTs the United States can hold at risk. Should the decision be made to proceed with the RNEP, the Peacekeeper ICBM could be used for delivery.

In the future, new nuclear weapons may include weapons that are smaller, have greater penetrating ability, are cleaner, or are otherwise tailored to specific missions.[77] In short, as Dr. Stephen Younger, Director of the Defense Threat Reduction Agency, argued, the United States needs "a spectrum of weapons from advanced conventional weapons on ballistic missiles through low-yield precision nuclear weapons to strategic nuclear weapons to be able to hold some targets at risk."[78] Depending on constraints imposed by design, ballistic missiles could be configured to deliver this array of advanced weapons.

Improved Accuracy

The accuracy of ICBMs and SLBMs is sufficient for the delivery of existing nuclear payloads. But for ballistic missiles to be successful against many of the more difficult targets discussed here, improved accuracy will be essential. For instance, agent defeat weapons must be delivered with a high level of precision to be effective. Similarly, when targeting mobile and rapidly relocatable targets with conventional weapons, accuracy has to be maximized to achieve mission success.

Accuracy enhancements to ballistic missiles are possible in the near to medium term. The use of GPS is likely the most effective first step to increase accuracy. In the past, GPS was not used for ballistic missiles because military planners were concerned about the survivability of space and ground segments of GPS, the ability to maintain the system in a nuclear environment, and a Soviet capability to jam or spoof the GPS signal. Yet, as we have seen in the air campaigns in Afghanistan and Iraq, GPS-aided guidance has become a mainstay of U.S. military operations. Similar technology can be used in ballistic missiles. GPS could provide a positioning update in late midcourse, just before separation of the RV, to reduce significantly the circular error probable (CEP). GPS has already been used in this capacity during ICBM reliability tests under the Rocket Systems Launch Program.

Accuracy could further improve by providing GPS support to the guidance package on a maneuvering RV, such as a Trajectory Shaping Vehicle (TSV), discussed below. Such an enhancement could provide ballistic missiles with a level of accuracy comparable to air-delivered precision munitions that employ GPS-aided navigation.

A TSV would considerably enhance accuracy and increase the ability of ballistic missiles to defeat certain types of targets, such as terrain-masked targets (e.g., a target located behind a mountain), HDBTs, and mobile and rapidly relocatable targets. By adjusting the flight path, the TSV could "glide" through the air, according to some estimates, approximately 500 miles.[79]

This is best understood in comparison with the typical reentry of an RV. If, for example, ballistic missiles were equipped with new conventional payloads intended to strike military targets directly (in contrast to the air bursts of nuclear weapons typically employed in strategic targeting), then the ability to maneuver around surface features would be critical. An RV travels a ballistic course based on its trajectory at the end of boosted flight. However, terrain features, such as mountains or canyons, may be on the path to the target. Without a significant trajectory shaping ability, the principal avenues for addressing this problem are either to change the trajectory by moving the launch points (e.g., by using SSBNs) or to use alternative means of striking the target. However, a TSV could adjust its trajectory and maneuver over obstacles to strike the target. (See Figure 1) In some cases, SLBMs could provide some capability before TSV development is completed because submarines can be positioned more flexibly than land-based missile launchers.

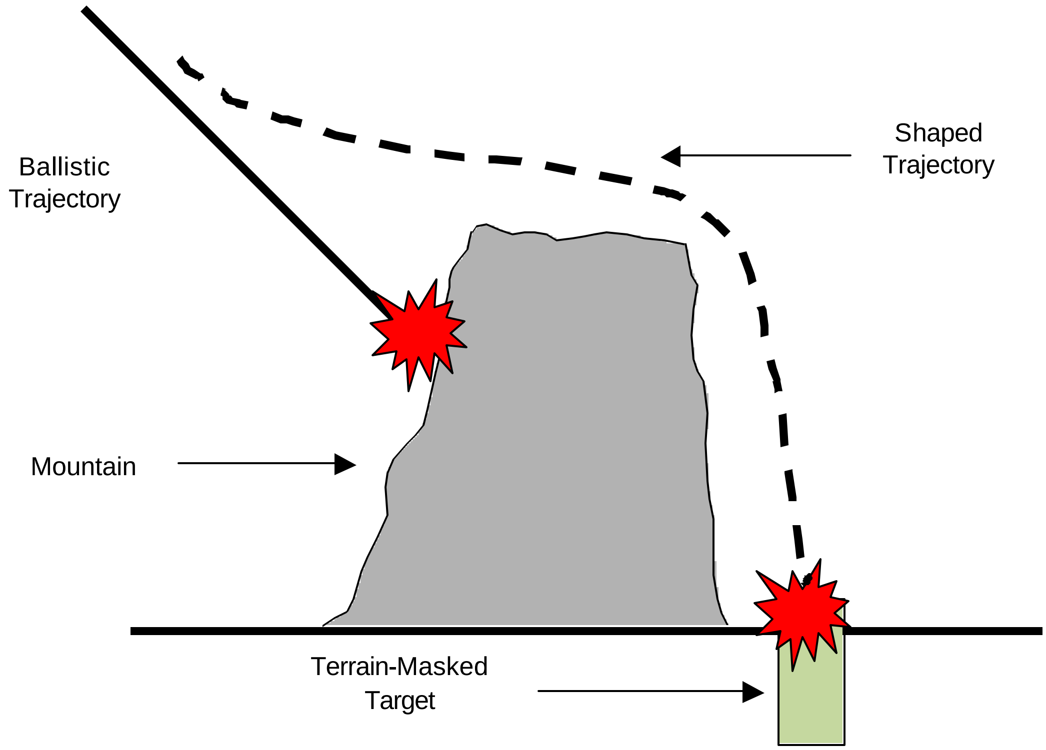


Figure 1. TSV Ability to Maneuver around Terrain-Masked Targets

A TSV capability would also enhance ballistic missile capability against HDBTs. First, by being able to maneuver within the atmosphere, TSVs could help control the impact velocity of an earth-penetrating weapon. Without the ability to slow some types of penetrators before they strike the Earth's surface, they would disintegrate on impact rather than burrowing into the ground, and thus fail to achieve the required effect.[80] Second, TSVs can achieve a near-vertical orientation and near-zero angle of attack, which may improve the probability of kill against some HDBTs. (See Figure 2)

A final forward-looking measure is the creation of a hypersonic glide vehicle or what is commonly referred to as a Common Aero Vehicle (CAV). The CAV is a reentry vehicle that could hold multiple targets at risk and deliver a variety of payloads, including penetrator warheads, small-diameter bombs, loitering attack cruise missiles, or unmanned aerial vehicles.[81] The greatest advantage of this glide vehicle is its ability to maneuver and stay in flight much longer than a TSV, due to its increased thermal protection. For instance, whereas the projected glide range of a TSV may be approximately 500 miles, with a reentry flight time on the order of 50 seconds, a CAV could glide for several thousand miles, staying in flight for up to 30 minutes.[82] Such a development could provide for greater accuracy. More importantly, because of its extended flight, a CAV would give defense planners more options in achieving long-range precision strike.[83] This concept is a long-term prospect, however, and would require substantial investment of resources and manpower to become a reality, although some funds have been allocated over the next four years for CAV research.[84]

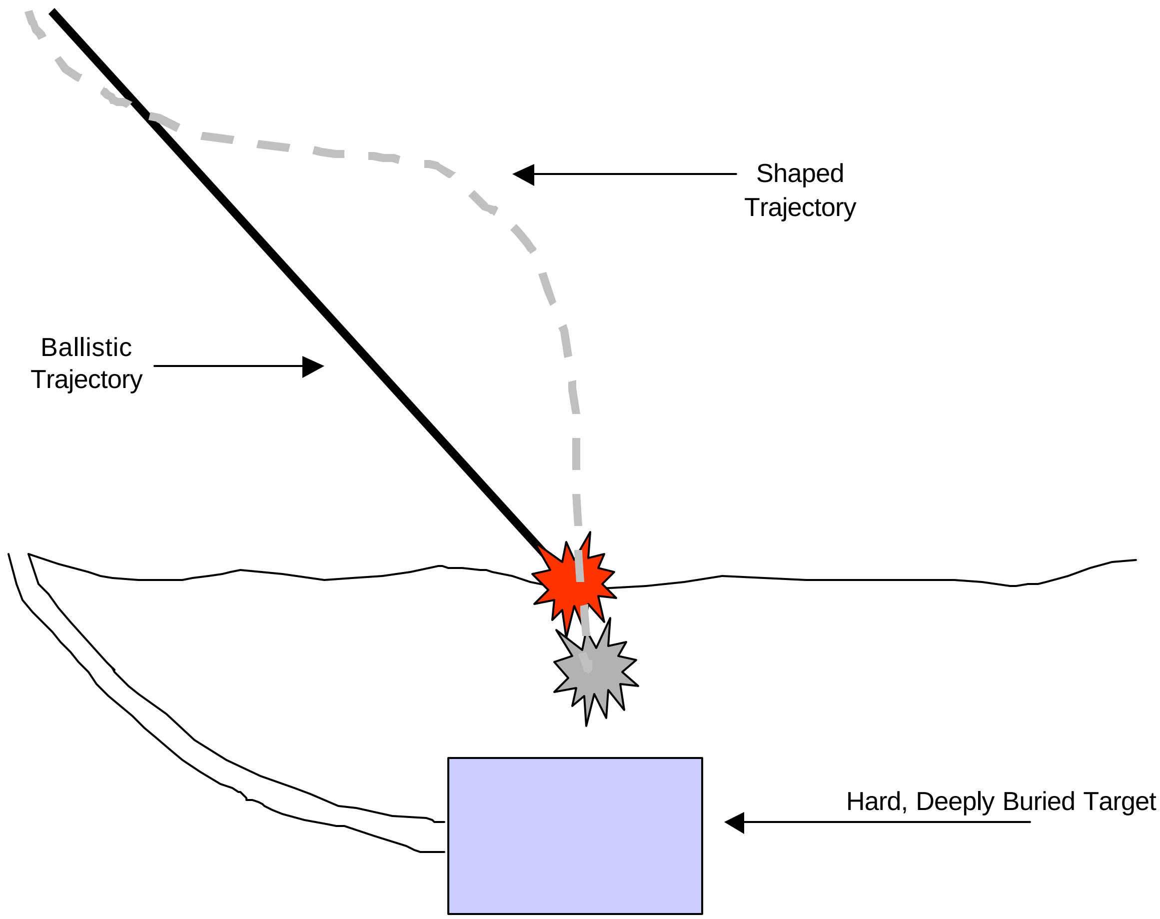


Figure 2. TSV Enhancement against HDBT

In-Flight Retargeting

The ability to perform in-flight retargeting of ballistic missiles is critical if the objective is defeating mobile and rapidly relocatable targets.[85] That is, the measures outlined above intended to improve ballistic missile accuracy may be substantial improvements against fixed targets, but if a target moves after the initial missile launch and the United States is unable to provide the missile with in-flight retargeting, then accuracy improvements will mean very little.

Exquisite intelligence is essential to in-flight retargeting and holding certain targets at risk. Admiral Ellis, Commander-in-Chief of USSTRATCOM, stated this clearly before the Strategic Subcommittee of the Senate Armed Services Committee in March 2002: "The challenges of HDBTs, strategic relocatable or time critical targets, advanced conventional weapons employment, and offensive operations targeting require a much greater fidelity in intelligence than we currently possess."[86]

With enhanced intelligence, inflight retargeting would also require a fairly rapid sensor-to-shooter cycle to allow for the transmittal of updated information. A TSV or CAV would also have to be equipped with a computer receiver, antenna, and computational capability to receive a retargeting message and execute the appropriate maneuver to modify the trajectory.

Planning and the Development of Doctrine

As important as technical development is the integration of this new capability into theater war planning. Up to now, ballistic missiles have been a part of the "strategic" strike system of the United States. Release authority has been at the Presidential level by virtue of the nuclear warheads involved; planning and command and control has been resident at USSTRATCOM. While it is premature to prejudge the way conventionally armed ballistic missiles should be integrated into the combatant commander's war plans, several observations are important at the outset. While planning for nuclear strikes is well-structured and supported following a decade of USSTRATCOM effort and four decades of Strategic Air Command (SAC) planning, the use of targeting and command and control infrastructure for limited use of conventionally armed ballistic missiles will require a parallel planning effort to that established for nuclear operations.

The availability of ballistic missiles for theater operations, just as the introduction of any major new military capability, requires the development of doctrine and the revision of operational plans for its effective incorporation into the combatant commanders' arsenal. The fact that numbers of ballistic missiles are small suggests that allocation among competing combatant commanders will be a challenge. The tendency for ballistic missiles to be valued for their promptness indicates that early employment under highly compressed time constraints will be a factor. The fact that ICBMs and SLBMs have been thus far exclusively associated with nuclear planning will create political barriers to conventional use that must be faced and countered. Even as the first ballistic missiles are configured to stand conventional alert with test asset dummy warheads, the full range of planning and doctrinal questions must have been faced for them to be considered operational and to have answered the questions that will surely arise in the political arena.

Operational concepts for conventional ballistic missile employment will have to develop incrementally as weapons effects testing, planning exercises, and war games expand commander's skills at integrating this new capability into their operations. By this process of learning while drawing operational utility from existing ballistic missile technology, the responsible commanders and their staffs will also constitute the core source of the advocacy required to obtain political support and funding for technical improvements needed to further refine ballistic missiles as precision strike systems.

Comparative Analysis of Capabilities

Our understanding of the utility of ballistic missiles for future missions benefits from a discussion of how ballistic missiles fare against other existing capabilities, for example, manned bombers/tactical aircraft and cruise missiles. We also considered SOF for long-range precision strike missions, concluding that this formidable capability indeed has a role to play, but not one directly comparable to that of ballistic missiles. This assessment of existing capabilities is based on seven criteria:

- Promptness
- Payload
- Range
- Risk to U.S. Personnel
- Accuracy
- Assured Control
- Assured Delivery

Assessment Criteria

Promptness

Promptness is determined by 1) time from decision to launch, and 2) time of flight to target. Ballistic missiles are the most prompt asset in the U.S. force structure today. They can be launched within minutes of a decision to do so. Moreover, ballistic missiles can reach their intended target within 30-45 minutes after launch. No other element of U.S. force structure offers comparable promptness from a standing start.

Promptness certainly plays a role against possible adversaries who seek to leverage advantages of time and geography. The United States is half a world away from our most serious potential adversaries, many of whom may seek to achieve a *fait accompli* or to take advantage of opportunities presented by the concentration of U.S. forces elsewhere on the globe. The United States risks being lulled into overconfidence by our successes in the Gulf War, Afghanistan, and Iraq. In each of these cases the United States had sufficient time to move its forces into the theater without serious opposition; in the Gulf War and Iraq, the U.S. had significant infrastructure advantages in theater as well. Future adversaries will likely learn from Hussein's mistakes and seek paths to victory that circumvent U.S. strengths and exploit U.S. weaknesses. If the U.S. possesses a clear ability to strike in short order at any point on Earth with proportionate conventional force, it could give potential adversaries reason to pause.

Manned bombers and cruise missiles can offer promptness when they are forward deployed and operating so as to maximize their reaction time. For instance, in the March 20, 2003 attack on Saddam Hussein's bunker, F-117s were available because they were already in theater and loaded with munitions. Similarly, Navy ships in the Persian Gulf and Red Sea were on station and available to launch 40 Tomahawk cruise missiles.[87] The strike took about three hours from intelligence reports to execution. On April 7, a B1-B bomber, already airborne and heading for other targets, was diverted to drop four 2,000-pound weapons about 45 minutes after U.S. intelligence received reports suggesting an Iraqi leadership meeting.[88]

While this performance was impressive, it should be recalled that the mobilization and deployment of forces to the region took several months to afford U.S. forces this level of promptness. Similarly, bomber missions from the United States require time for mission planning, lengthy flight time, overflight permissions, refueling aircraft on station, and lengthy turn-around times. Future defense planners will not always have time to deploy aircraft before a conflict begins, and bomber missions across the globe will be relatively costly and inefficient. Moreover, in case of a quick build up, our refueling capability may be dedicated to ferrying aircraft into theater instead of supporting long-range bombing missions from the United States.

Provided that sufficient care is taken in the construction of concept of operations (CONOPS), target sets, and so forth, ballistic missiles can retain their Cold War reputation as prompt weapons systems.

Payload

As illustrated in Table 4, ballistic missiles can deliver militarily useful payloads, ranging from 730 kg for Minuteman II to an impressive 3,800 kg for Peacekeeper. In contrast, existing Tomahawk cruise missiles carry a payload of 450 kg.

Table 4. Payload Capabilities[89]

Platform	Payload/Throw Weight (kg)
Bombers	
B1-B	19,100[1]/21,800[2]
B-52H	11,600[1]/16,400[2]
B-2	18,200[1]/14,500[2]
Ballistic Missiles	
Peacekeeper ICBM	3,800
Trident D-5 SLBM	2,800
Trident C-4 SLBM	1,500
Minuteman III ICBM	1,150
Minuteman II ICBM	730
Cruise Missiles	
Tomahawk	450[3]

Note: Figures for ballistic missiles are total throw weight. Figures for aircraft and cruise missiles are actual payload.

1 Total bomb loads based on 500-pound bombs.

2 Total bomb loads based on 2,000-pound bombs.

3 Conventional Air Launched Cruise Missile (CALCM): Variants include 2,000-pound class and 3,000-pound class blast fragmentation warheads.

Of course, cruise missiles can be effective against many traditional military targets, and can also contribute to attacks on HDBTs by attacking surface features (e.g., entrances, communications arrays, etc.). However, subsonic cruise missiles are limited in their penetrating effectiveness because of their low velocity. Moreover, there are targets against which existing cruise missiles are incapable of delivering sufficient ordnance. In many such cases ballistic missiles can deliver sufficient payload.

Ballistic missiles can, if required, deliver their traditional nuclear payloads. Alternatively, they could carry kinetic or conventional weapons that could be useful against traditional military targets like logistics nodes, C^3 facilities, major troop formations, and air defenses. Given improvements in accuracy and in-flight retargeting, ballistic missile payloads could be effective against mobile and rapidly relocatable targets, or against chemical and biological facilities. Easier HDBTs would be vulnerable to kinetic or conventional weapons that ballistic missiles could deliver. With improvements in accuracy, and with new custom-designed conventional penetrating weapons, the utility of ballistic missiles against HDBTs could parallel that of manned bombers in some cases.

All this said, however, manned bombers can deliver considerably greater payloads than ballistic missiles, and such payloads will be required for some targets or target sets. For instance, using 2,000-pound bombs as a comparative measure, the B-2 stealth bomber can carry up to 16, the B-52H up to 18, and the B-1B up to 24.[90] Combined with long range, depending on fuel load, these impressive loads can provide manned bombers with useful loiter time.

In sum, although manned bombers can deliver larger payloads than ballistic missiles, and will be necessary in some cases and more efficient in others, ballistic missiles can deliver militarily useful payloads in many cases.

Range

With intercontinental range from the United States, ballistic missiles are the ultimate stand-off weapon. The range of a ballistic missile is, to some extent, a trade-off with the weight of its payload, and such trade-offs will be a significant focus of operational decision-making for ballistic missile employment. Moreover, much of this study assumes new front ends, the weights and dimensions of which are yet unknown. However, rough estimates suggest that global reach is one of ballistic missiles' strongest points.

Ballistic missiles can be launched from a variety of locations. For ICBMs these include their traditional bases in the north central United States, the Pacific and Atlantic coasts, or a new launch site such as Guam. SLBMs could be launched from submarines in broad ocean areas or, subject to START Treaty limitations, from the same land bases available to ICBMs. For policy and treaty reasons discussed later, it is worth understanding the range implications of all of these options.

Table 5 provides distances from prospective ballistic missile launch points to an illustrative aim point within areas of potential interest. While existing ballistic missiles are currently deployed in the north central United States, as we will see later, their use for conventional ballistic missile launch is problematic because of overflight considerations and concerns with first and second stage debris. Accordingly, the table focuses on coastal basing and basing in Guam.

Table 5. Ranges from Prospective Launch Points to Areas of Interest

	North Africa	Middle East	Northeast Asia	Central Asia
Cape Canaveral, FL	8,900	11,300	12,000	12,300
Vandenburg AFB, CA	11,500	12,300	9,400	12,400
Guam	12,800	9,500	3,400	7,800

Note: Ranges measured in kilometers.

Given the ranges to areas of interest outlined above, Minuteman II and Peacekeeper provide global coverage, for all practical purposes, if based simultaneously on the Atlantic coast and in Guam, although Peacekeeper could deliver a significantly larger payload than Minuteman II. Lightening the payload of Peacekeeper would substantially increase the missile's range. Minuteman III can reach these areas of interest from any base on the Atlantic or Pacific coasts or in Guam. The Trident D-5 provides global coverage from broad ocean areas, assuming Pacific and Atlantic patrols.

For the purpose of this section, we have presented the ranges of ballistic missiles, aircraft and cruise missiles for comparison in Table 6.

Manned bombers also offer global range. However, range and, as discussed above, large payloads are achieved at the cost of promptness, overflight permissions, refueling, risk to aircrews, and lengthy turn around times.

Tactical aircraft can strike around the globe if efficient forward land or aircraft carrier basing is possible. For instance, in the Afghanistan war, the Air Force used bases in neighboring Uzbekistan and Kyrgyzstan, and footholds in Kuwait and Qatar were critical during the Iraq war. Moreover, depending on the geography and politics in the region, overflight permission from neighboring countries might be necessary, even to fly from carriers or well placed forward bases. As diplomatic difficulties with Turkey during the Iraq war indicated, U.S. planners cannot assume forward bases will always be available. Unable to use Turkish bases, the U.S. flew carrier-based sorties from the eastern Mediterranean and considered basing aircraft in Georgia, separated from Iraq by 400 km. of Turkey. (Turkey did grant overflight permission, but it cannot be taken for granted in the future.)

Table 6. Range[91]

Platform	Range (km)
Bombers	
B52-H	14,080[1]
B-2	9,600[1]
B1-B	9,840[1]
Tactical Aircraft	
F-117 Nighthawk	1,060[2]
F-16 Falcon	930[2]
F-18 E/F Hornet	2,346[2]
Ballistic Missiles	
Minuteman III ICBM	13,000
Trident D-5 SLBM	12,000
Peacekeeper ICBM	9,600
Minuteman II ICBM	9,600
Trident C-4 SLBM	7,400
Cruise Missiles	
Tomahawk/CALCM	2,500-3,200

1 Unrefueled range.
2 Unrefueled combat range.

Air launched cruise missiles can achieve global range when launched from bombers, as can sea launched cruise missiles, if Navy ships are within range.

Each of these capabilities brings something to bear in modern warfare, but for long-range precision strike, none matches ballistic missiles for efficient global reach.

Risk to U.S. Personnel

Employment of ballistic missiles poses the least risk to U.S. personnel of any long-range strike option considered here. The stand-off capability of sea-launched cruise missiles does not match that of ballistic missiles but is, nonetheless, significant, if naval forces are in place. This may take some time and, in future conflicts, the United States may not have the luxury of operating without threats to its Navy from anti-ship weapons, WMD, or attack by special operations or terrorists (e.g., the attack against the U.S.S. Cole in Yemen). Thus, the stand-off capability afforded by sea-launched cruise missiles cannot be counted upon in the early phases of all future conflicts.

Similarly, manned bombers and tactical aircraft place pilots at risk. Even in an environment of U.S. air superiority, there are risks from accident, friendly fire and sporadic enemy action. Thus, ballistic missiles offer the lowest risk to U.S. personnel, followed by sea-launched cruise missiles, which offer significant stand-off capability, and manned bombers place pilots at some risk.

Accuracy

Today's ICBMs and SLBMs are sufficiently accurate to fulfill their assigned strategic nuclear missions. However, for the more stressing missions and targets, ballistic missile accuracy would need to be improved. GPS guidance enhancement and TSVs may reduce the CEP of long-range ballistic missiles considerably, making them roughly equivalent to air-delivered precision munitions that employ GPS-aided navigation. As illustrated in Table 7, other weapons in the U.S. force mix already offer very high accuracy.

Table 7. Accuracy of Delivered Payload[92]

Platform	CEP (m)
Bombers/Air Delivered Bomb	
Joint Direct Attack Munition	13-30
Ballistic Missiles	
Peacekeeper ICBM	90
Trident D-5 SLBM	90
Minuteman III ICBM	120
Trident C-4 SLBM	450
Cruise Missiles	
Tomahawk/CALCM	2.5[1]

[1] Figure quoted is for CALCM.

In recent U.S. campaigns, cruise missiles have emerged as the stand-off weapon of choice. Improvements have been made that make them even more precise—a highly accurate guidance system can place the missile within a few feet of its intended target.[93] Similarly, the Joint Direct Attack Munition (JDAM) modification to air-delivered bombs provides between 13 m and 30 m CEP.[94] The presence of human pilots for decision-making has proven to be an advantage in some cases—just as in other cases, it is a liability due to increased risk.[95] Pilots, with their ability to "put eyes on target" can exercise a degree of judgement that has the potential to improve accuracy.[96]

Thus accuracy is a value influenced both by the platform and by the context in which it is used. In some cases the increased accuracy of a manned aircraft would be advantageous, in other cases the precision of a cruise missile or the speed and payload of a ballistic missile might determine the weapon selection. This is particularly true if improvements to the accuracy of ballistic missiles are pursued.

Assured Control

Often an overlooked criterion, it is important for the United States to maintain security and flexibility through assured control of its military assets. ICBMs offer the greatest degree of control because, until the moment of launch, they are based in the United States. Although 9/11 underscored that the United States is no longer a sanctuary protected by two oceans, it is far safer from attack, sabotage or civil strife than most other places on the planet, particularly those nearer to zones of conflict. Moreover, the communications infrastructure necessary to retarget and launch ICBMs is available, tested, and unlikely to be compromised. SSBNs at sea are also very secure, although reliable communications with them could have some operational implications.

Land based intermediate-range or medium-range ballistic missiles could be just as effective militarily, but long term basing rights may be difficult to obtain, and we may not be able to count on them under every contingency. Aircraft have to be flown into the theater of operations, posing challenges of overflight and in-flight refueling. If they are to be forward based, basing rights must be secured and such bases will inevitably be less secure than bases in the United States. Navy ships are relatively secure, although they eventually must put into port where, as underscored by the attack on the U.S.S. Cole, they can become vulnerable. Moreover, we should not assume that in all future military operations our Navy will be able to operate without threat from anti-ship missiles, submarines or even a bomb aboard a Zodiac or dhow.

Assured Delivery

Ballistic missiles also meet another criterion, that of relatively assured delivery of payload to target. ICBM-class RVs approach their targets at a high velocity, measured in kilometers per second. These speeds make traditional air defenses, and most potential theater missile defense deployments, useless for opposing ballistic missile strikes. The Russian nuclear-armed A-135 Anti-Ballistic Missile (ABM) system around Moscow is the only defensive arrangement currently deployed to deal with such systems. This means that the only existing impediments to a ballistic RV striking its target are its own accuracy and reliability.

Cruise missiles and manned-aircraft can also offer effective penetration, particularly when considering the current U.S. advantages over existing air defenses. However, those advantages are not static over time, nor are they uniform within the ebb and flow of a complex military campaign—perhaps one that necessitates making due with limited defense suppression or degraded performance of forward-based assets due to WMD strikes.

The Context: Comparative Utility in Effects-Based Operations

Although it is tempting to make comparative judgments on the relative merit of various weapons platforms based on easily understood criteria like range and payload, the real value of a weapons system is its utility to the warfighter in his construction of an efficient, effects-based plan. (See Figure 3) As described by the division chief at Air Combat Command and the plans director for Strategy, Concepts and Doctrine:

> Instead of a traditional attritional approach in terms of listing a bunch of targets and then go bombing targets, or finding where the enemy is and killing all the enemy, we really determined that what we wanted to do was in fact to achieve some sort of policy objective, and that you could, in fact, craft military operations to better achieve those policy operations in a more efficient and effective manner….
>
> …But the point here is, is that we don't have to attack everything, nor do you have to destroy everything. If we understood what the effect we desired on the battlefield, we could then figure out ways of creating that effect more efficiently, more effectively, striking less targets, using less weapons and, quite frankly, mitigating or easing potential concerns for collateral damage and civilian casualties.[97]

Precision and stealth are regularly touted as the primary enablers of this revolution in military planning. They provide commanders with the ability to strike at an enemy viewed *as a system*; for example using a stealth fighter to attack air defense command and control early in the war, thus bringing down the whole air defense grid rather than linearly “rolling up” the enemy by first striking the interceptors, then the radars, and so forth. This sort of “parallel warfare” may be the hallmark of a 21st Century transformed U.S. military.

Like stealth and precision, the ballistic missile's unique attributes like promptness and assured delivery could make similarly enabling contributions because they give the warfighter increased flexibility and range of military options in constructing his war plan—and responding to an adversary's inevitable attempts to adapt and prevail. For example, planners are increasingly dependent on single platforms to deliver strikes against multiple targets. Should an opponent be unexpectedly able to limit the effectiveness of U.S. strike aircraft, a commander's resources would decrease exponentially. Having the ability to shift direction and assign some strike missions to long-range ballistic missiles might provide sufficient freedom to keep a modern, effects-based systemic attack on an adversary in train.

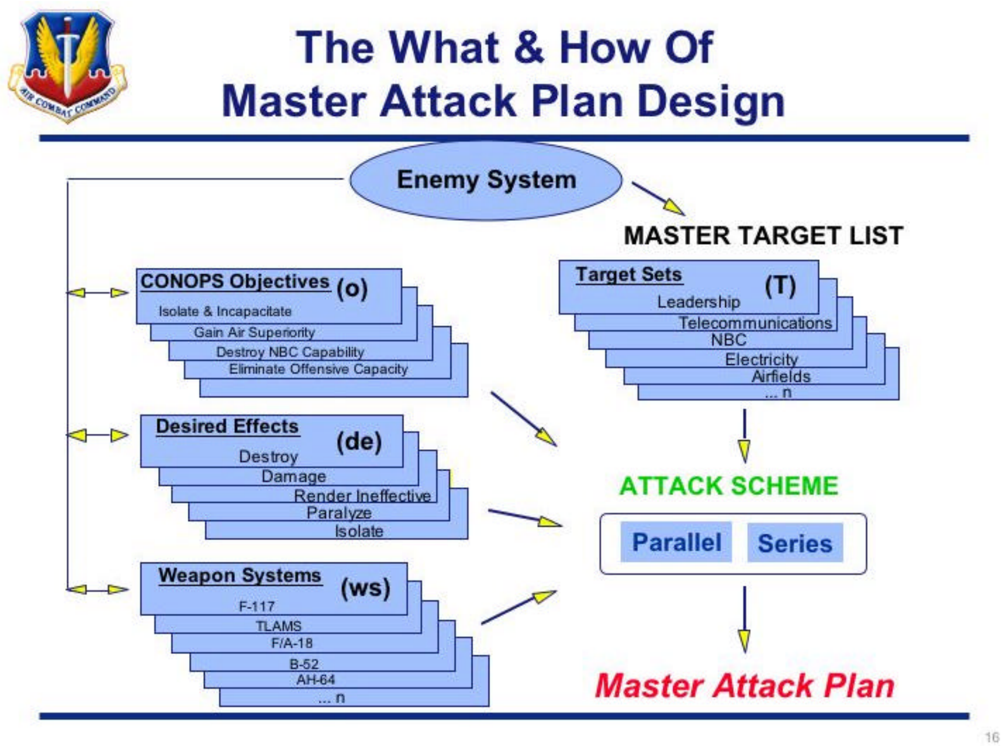


Figure 3. Effects Based Planning

Table 8 summarizes the analysis of criteria by which the potential contribution of ballistic missiles to a warfighter's plan might be assessed. It should be noted that the table is not based on quantified measures, but rather it illustrates a judgment of how the basic characteristics of the capabilities compare to one another. The full color squares represent a high capability. For instance, ballistic missiles are most prompt, whereas manned bombers can deliver the greatest payload. The partial shaded squares represent some capability. In this regard, manned bombers and cruise missiles can be prompt *when* forces are forward deployed, and they can pose little risk to U.S. personnel *if* air defenses are non-existent or severely degraded. These, however, are not givens, and are conditioned on certain circumstances.

Table 8. Comparing Capabilities for Long-Range Precision Strike
(Assuming Ballistic Missile Accuracy Improvements)

	Ballistic Missiles	Manned Bombers	Cruise Missiles
Promptness			
Payload			
Range			
Low Risk to Personnel			
Accuracy			
Assured Control			
Assured Delivery			

Based on our analysis of long-range precision strike capabilities, SOF are not analogous to ballistic missiles, manned bombers, or cruise missiles, so direct comparison within this framework would be deceptive. SOF are a formidable capability that have a role to play. SOF contribute to long-range precision strike missions in a variety of ways. First, SOF may operate in countries before conflict has begun, and they have the ability to locate and track various targets critical to overall mission success. For instance, during the recent conflict with Iraq, SOF operated throughout Iraq to gather information, which was essential once conflict began. Moreover, they may supply the "exquisite intelligence" necessary for a prompt ballistic missile or air strike, especially on mobile and rapidly relocatable targets.[98] Their unique intelligence gathering capability may also enable SOF to pinpoint and potentially destroy vulnerable portions of targets, such as entry and exit points, power, communications lines, and ventilation subsystems associated with HDBTs. Thus, the utility of SOF is heavily dependent upon local conditions and circumstances and not readily comparable at the more abstract level depicted in Table 8. Nevertheless, it is important to note that SOF complement and enhance long-range precision strike missions.

It is also important to reiterate that achieving this level of effectiveness for ballistic missiles is contingent upon the development of appropriate command and control arrangements, CONOPS, doctrine, and a Joint Staff appreciation of how these assets might contribute to the warfighter's objective.

In short, the U.S. interest in long-range precision strike reflects a broadly-held consensus about the shape that future military contingencies might take. In making decisions about force structure, U.S. leaders must be cognizant not only of the capabilities they seek to acquire in the long-term, but of the technology base upon which they are building and the near term advantages that can help existing systems bridge the gap between the present and a future "transformed" U.S. military. From its Cold War arsenal, the United States retains long-range airpower and land and sea-based ballistic missiles. Cruise missiles and forward deployed multi-role tactical aircraft have also proven to contribute to U.S. dominance in today's regional conflicts.

Each of these delivery mechanisms has advantages and disadvantages in a given context. More and more often, each provides unique attributes with which a joint forces commander can construct a holistic war plan that succeeds in meeting U.S. military objectives by using combined arms to achieve new efficiencies and levels of effectiveness. Thus, stealth fighters might conduct defense suppression to pave the way for strategic bombers that are guided to high priority mobile targets by SOF on the ground while cruise missiles are impacting on known command and control nodes. In another case, a surprise offensive might require prompt U.S. ballistic missile strikes even while significant U.S. tactical airpower is enroute to the theater. Yet again, ballistic missiles might provide relatively-assured, bolt-from-the-blue time-sensitive decapitation that allows other conventional forces time to secure or disable an adversary's WMD.

In the end, the quality of each tool in this toolbox of capabilities is judged by the unique contributions it can make to such force mixes. The ballistic missile, like the strategic bomber, is a preeminent long-range strike platform. While strategic bombers may have advantages in terms of raw payload, ballistic missiles continue to be capable of delivering a sizable payload globally—in about 30-45 minutes. Ballistic missiles provide a unique mix of promptness and direct control, which allows the commander to tailor his attack for maximum strategic impact. Moreover, the commander can do so with forces based 10,000 km from the theater of operation; a fact that may be crucial in regions where the United States may not have a presence in being or in which an adversary has made significant investments in area denial capabilities. The costs (both financial and political) associated with forward basing U.S. forces sufficient to achieve similar impact in a crisis is likely to be steep, if not prohibitive.

The United States can leverage its existing investment in ballistic missiles with advances in guidance and accuracy, tailored conventional payloads, integration with other conventional employment options, and perhaps new nuclear weapons. This is clearly in the spirit of "transformation" as identified by President Bush and pursued by Secretary Rumsfeld. Given the uncertainties that characterize modern, ambitious defense programs, an enhanced ballistic missile force is the most attainable, cost-effective way to bring some of tomorrow's technology on-line to address today's strategic problems. However, these are only the technical considerations that shape the potential future utility of ballistic missiles in the U.S. force structure. Given their history, ballistic missiles are quintessentially political weapons; based in the heartland and armed with nuclear weapons as ultimate guarantors of American security. Viewing these platforms from a new perspective that appreciates their possible roles in regional conflict must be prefaced with an understanding of the delicate political and legal considerations that will inevitably surface.

Treaty and Policy Issues

The foregoing analysis indicates that new long-range precision strike roles for existing ballistic missiles—ICBMs and SLBMs—should be seriously considered. To do that in full context it is necessary to examine a number of arms control treaty and policy issues. None needs to be a "show-stopper," but they merit careful thought and, in some cases, concrete action to address them.

Treaty Issues

Minuteman II and III, Peacekeeper, Trident C-4 and D-5 will be considered existing ICBMs and SLBMs for purpose of the START Treaty.[99] None of the modifications discussed in this study will alter that. Consequently, ICBMs and SLBMs adapted to new long-range precision strike roles—whether kinetic, conventional or nuclear—will remain subject to START Treaty limitations. It should be stressed that we are speaking of limitations, not prohibitions. The United States can do the things discussed in this paper, subject to the limitations discussed below.

Warhead Count

Any Minuteman II or III, Peacekeeper, Trident C-4 or D-5 deployed in any role will count toward START central limits because they are existing ICBMs and SLBMs: 1,600 deployed ICBMs, SLBMs and heavy bombers; 6,000 warheads on deployed ICBMs, SLBMs and heavy bombers, of which 4,900 on deployed ICBMs and SLBMs.[100]

Warheads on each missile would be counted as attributed under START, and there are limitations on downloading of warheads. The United States can now only download the number of warheads on one type of missile, and can only download four warheads. So, for example, if we were to choose to download Peacekeeper, we could reduce its START warhead attribution from ten to six.[101] Although this may appear to be a significant issue, it is not. With the reductions now planned by the United States in accordance with the NPR and the Moscow Treaty, there is considerable room beneath START limits. To illustrate the point, once the Peacekeepers are removed from service, there is sufficient room under the START limits to continue counting their warheads at ten so that the Air Force can avoid the cost of destroying Peacekeeper launchers.

The Moscow Treaty calls for reductions to between 1,700 and 2,200 “operationally deployed warheads,” a counting rule different from that employed in START. The United States can define any new kinetic or conventional warheads as outside the definition of “operationally deployed warheads.” In theory it could do this also for new types of nuclear warheads, although this would likely cause major policy disagreements.

In sum, it should not be difficult for new ballistic missile capabilities to exist within START or Moscow Treaty numerical limits.

Locational Limitations

The START Treaty distinguishes between existing missiles that are deployed and non-deployed, and restricts the locations of each. Non-deployed ICBMs and SLBMs with their launchers may be present only at START test ranges and START space launch facilities.[102] Neither is an option for a force of long-range precision strike ICBMs or SLBMs. The aggregate number of missile launchers permitted at space launch facilities is limited to twenty, and RVs may not be flight-tested from space launch facilities.[103] We could test RVs from START test ranges, but the aggregate number of missiles permitted at test ranges is limited to 25, and the number of fixed test launchers to twenty.[104] The United States already declares fifteen test launchers for routine use, so there is very little margin to add anything more.[105] So, as a practical matter, ICBMs or SLBMs assigned new roles will be deployed not non-deployed for START purposes.

ICBMs or SLBMs assigned new roles will be deployed for START purposes. Deployed SLBMs must be on submarines; deployed ICBMs at ICBM bases.[106] ICBM bases must be located in the United States.[107] Deployed ICBMs must be launched from silo launchers.[108] Thus, if ICBMs assigned new roles were deployed anywhere but their current bases, new silos would have to be built.[109] With this understanding, there is no impediment to deploying ICBMs in newly assigned roles anywhere in the United States, as defined by the START Treaty.[110]

Inspections

Deployed ICBMs and SLBMs are subject to a number of inspections under START. Such inspections include data update, new facilities, RVs and technical characteristics in case a variant of an existing type of ICBM or SLBM is declared.[111] These inspections have not proven onerous for the strategic nuclear force and there is no reason to believe they would be for ICBMs and SLBMs in new roles. Indeed, the presence of Russian inspectors may help ease some of the policy concerns that could arise.

Telemetry Encryption

The START Treaty bans telemetry encryption, including jamming, broadcasting on narrow directional beam or encapsulating. All telemetric information must be broadcast in the clear, and recordings of broadcast telemetry must be provided to Russia. However, limited exemptions are available. Data may be encrypted on two flight tests per year of one type of existing ICBM or SLBM. Encryption permitted under this exemption may pertain only to the front section, and only after separation. Encryption of data pertaining to functioning of the stages, or of the self-contained dispensing mechanism, or post-boost vehicle, is prohibited.[112]

Of all the START provisions that would apply to ICBMs or SLBMs converted to new long-range precision strike roles, the telemetry encryption ban deserves the closest look by technical personnel.

Launch Notification

Russia must be notified through the Nuclear Risk Reduction Centers 24 hours in advance of ICBM and SLBM flight tests.[113] There is no provision for operational launch against third parties. The Cold War assumption was that peacetime launches of ICBMs and SLBMs would be only for testing. Although diplomatic solutions to this dilemma can surely be found, this provision underlies serious policy issues and must be considered in detail. Indeed, there are a number of policy issues that loom larger than the treaty issues presented here.

Policy Issues

The idea of actually using "Cold War" ICBMs or SLBMs for post Cold War long-range precision missions will no doubt evoke the usual reflexive reactions: accusations of Cold War thinking, U.S. unilateralism, dangerous preemptive strategy, etc. We should expect Russia and China—whose underlying motive is to curtail U.S. force projection capabilities as much as possible—to play every procedural and policy card available. The United States should anticipate negative reaction from other quarters and the international community. However, there should be no illusion that all opposition will come from abroad or from the usual arms control advocates. Serious concern may also emerge from the Pentagon over such issues as the overflight of Russia. While a determined U.S. administration working with a core of dedicated support in the Congress may ultimately be able to carry the debate, the fight will be hard and not easily won.

There, are however, three important policy issues that must be addressed before proceeding with ICBMs or SLBMs in new long-range precision strike roles: terminal phase overflight, ascent phase overflight, and clarity of intent.

Terminal Phase Overflight

Most of a long-range ballistic missile's trajectory is in outer space, posing no threat to the ground below. However, the missile does travel through the atmosphere as it ascends from its launch point and as it descends toward its target. As an RV speeds toward its target, the missile's third stage will fall about 75 miles up range from the target. In areas of the world with close borders, depending on the target, this could raise both legal and safety issues.

The RV and the third stage could violate a third country's airspace. Moreover, the third stage could do some damage in that third country. We should expect this concern to be heightened because many countries, and some of our own citizens, will use it to object to what they see as yet another instrument of U.S. power projection.

The matter can only be addressed in a comprehensive targeting and concept of operations effort. For some potential targets, the geography and trajectory will combine to obviate the problem for use of an ICBM or SLBM. Knowing which potential targets present overflight problems and which do not will be an important part of developing a concept of operations. For those that present a problem, we may, under certain circumstances, be prepared to assume the risk. However, this will not always be the case, and planners should be ready with alternatives. For example, in some cases, a well-positioned submarine launching an SLBM may provide a less problematic trajectory. For still other targets, we may need to turn to other assets.

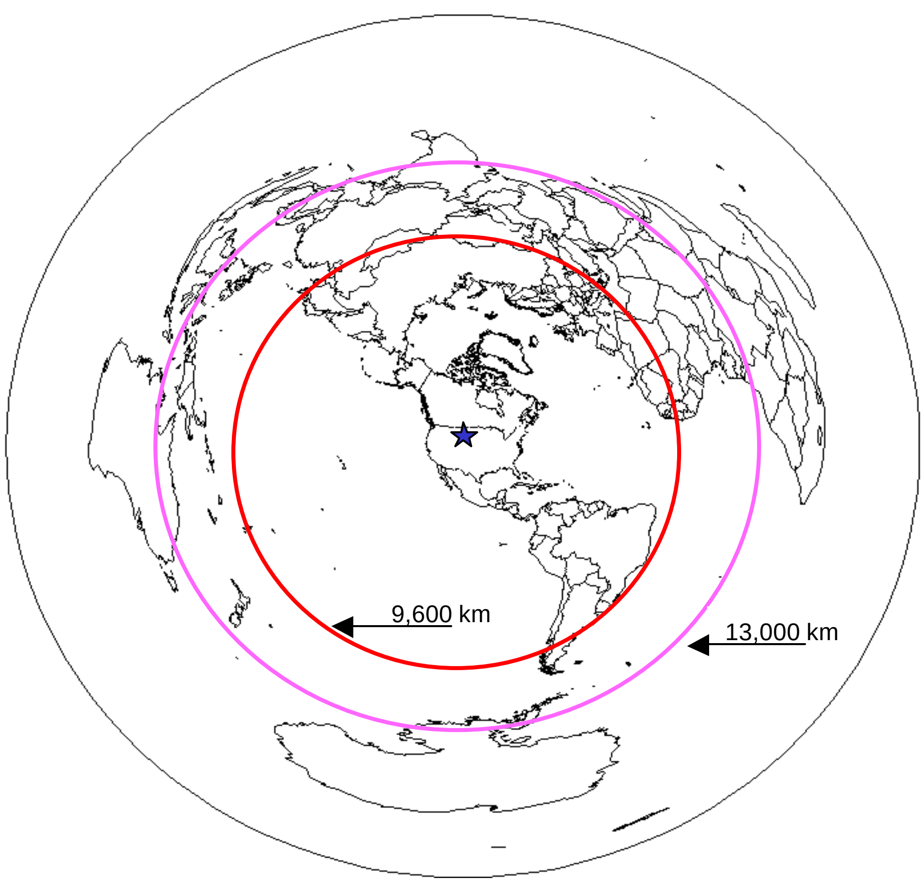
All these factors must be studied and placed into a comprehensive concept of operations. Military planners should be prepared to answer terminal overflight questions not only during a conflict, but early in the peacetime, non-crisis environment in which proceeding with the options discussed in this paper will be considered.

Ascent Phase Overflight

Submarines, of course, can be positioned to avoid any issues of overflying the United States or Canada. Where to base ICBMs is a more complex consideration.

For maximum proximity to targets in the Soviet Union, consistent with assured control, maintainability and security, U.S. ICBMs have been based in the north central United States. The cheapest and quickest basing for ICBMs assigned to new roles would, therefore, be at their traditional bases. As shown in Map 1, existing ICBMs can reach most areas of interest and perform any conceivable long-range precision strike mission from these locations. Ranges, of course, vary with missile type and payload. However, this poses a serious problem of overflight of parts of the United States and Canada. Moreover, the dropping of the first and second stages on these areas is also an important consideration.

Map 1. Great Circle Distances from F.E. Warren AFB, Cheyenne, WY



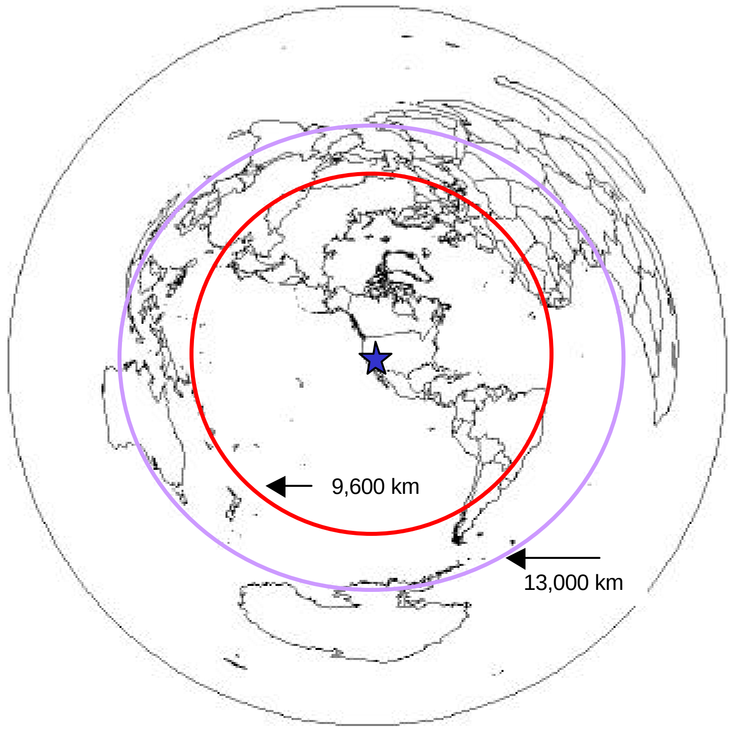
While we were willing to accept the risk of overflight in case of a war with the Soviet Union, we were unwilling to accept it for peacetime testing. Our ICBMs were traditionally tested over water from Vandenburg Air Force Base (AFB). The outlook of the American and Canadian publics, or of their governments, is unlikely to change. Consequently, we believe basing at the northern tier bases is out of the question. Moreover, it would raise serious issues with Russia, as discussed below.

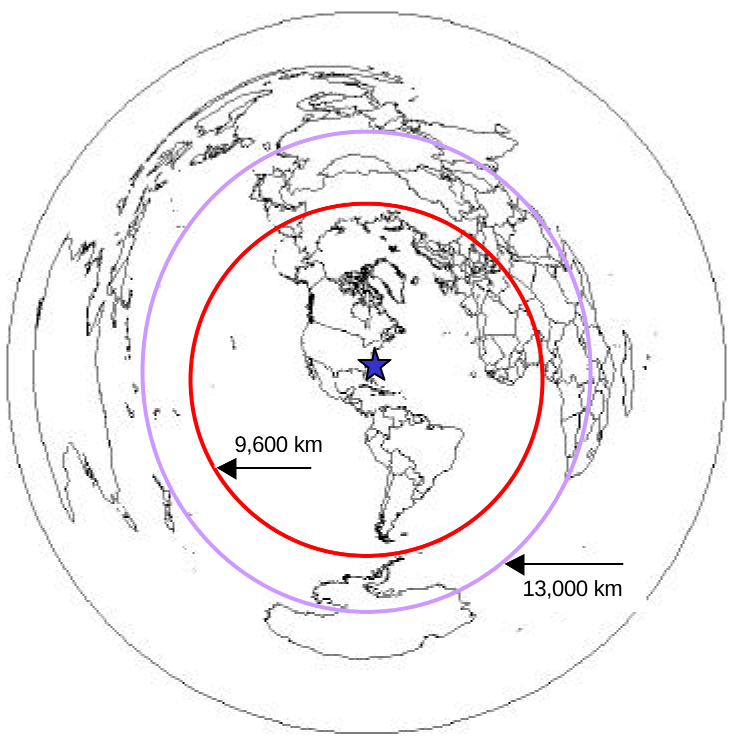
Another option would be to deploy the ICBMs assigned new roles at bases on the Atlantic and Pacific coasts of the United States. Although new silos would have to be built at any location, Cape Canaveral and Vandenburg AFB already offer considerable other launch infrastructure and, therefore, would be the logical choices. (If a suitable location on Vandenburg AFB over 100 km away from the portion of the base declared as a START space launch facility cannot be found, another west coast base would have to be chosen.) Together, Vandenburg and Cape Canaveral would afford near global coverage of potential areas of interest as outlined in Table 5, assuming the use of Minuteman III ICBMs with payloads of a weight comparable to their current one or Peacekeeper ICBMs with a payload lighter than their current one.

Maps 2 and 3 illustrate the coverage provided considering only the range of the missiles and the launch point. However, both Cape Canaveral and Vandenburg operate under strict peacetime range safety azimuths. That is, all launches from these locations must follow a trajectory that is well clear of U.S. coastlines. Just as for testing our existing ICBMs, these range safety restrictions would pose no problem for testing ICBMs for new roles. However, for operational launch, the current peacetime range safety azimuths would restrict some targeting options.

This calls for careful planning within a comprehensive CONOPS. Since operational launches will be unusual, it may be possible to waive peacetime range safety azimuths for operational launches. Indeed, while some conceivable trajectories would fall outside these very conservative azimuths, they would nonetheless be mostly over water, posing minimal risk to coastal populations. However, pre-consideration of a waiver is likely to look at the most stressing cases.

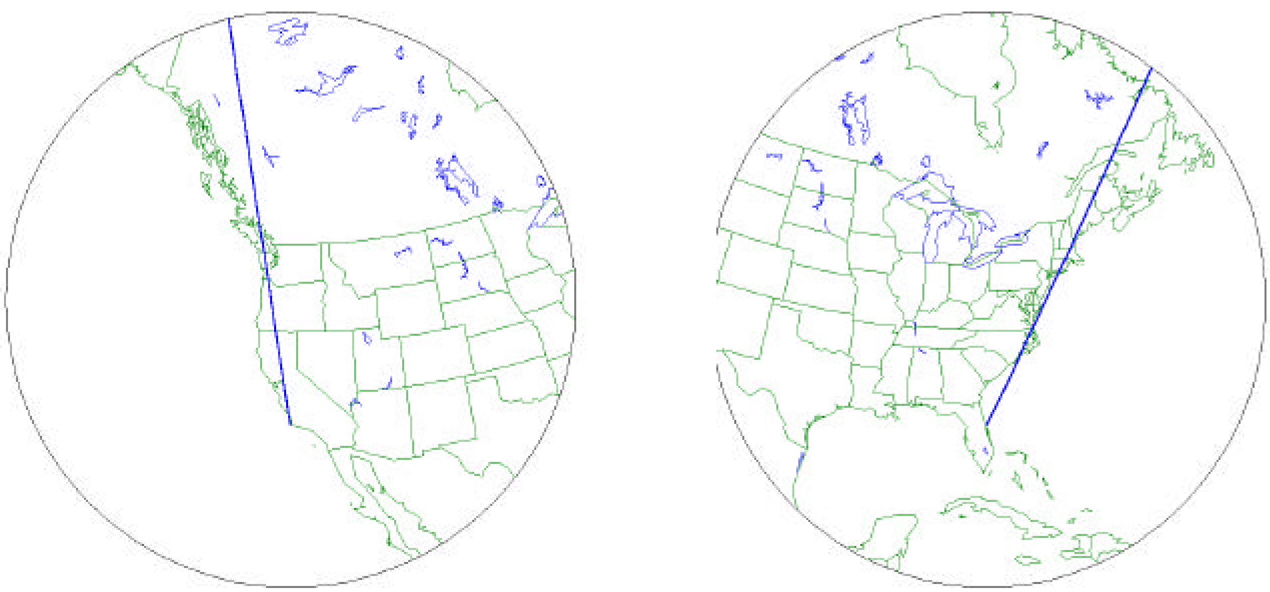
Maps 2 and 3. Great Circle Distances from Vandenberg AFB and Cape Canaveral





Targets in Central Asia present the most stressing cases for both Cape Canaveral and Vandenburg, as shown in Maps 4 and 5. Given that such launches would be unusual, and the risk, even over land, minimal, a determined U.S. administration may succeed in waiving range safety azimuths from Cape Canaveral and Vandenburg in case of operational launch. To achieve this, proponents must be ready to answer hard questions early in the peacetime environment in which they are asked.

Maps 4 and 5. Stressing Overflight Paths from Vandenburg AFB and Cape Canaveral to Targets in Central Asia

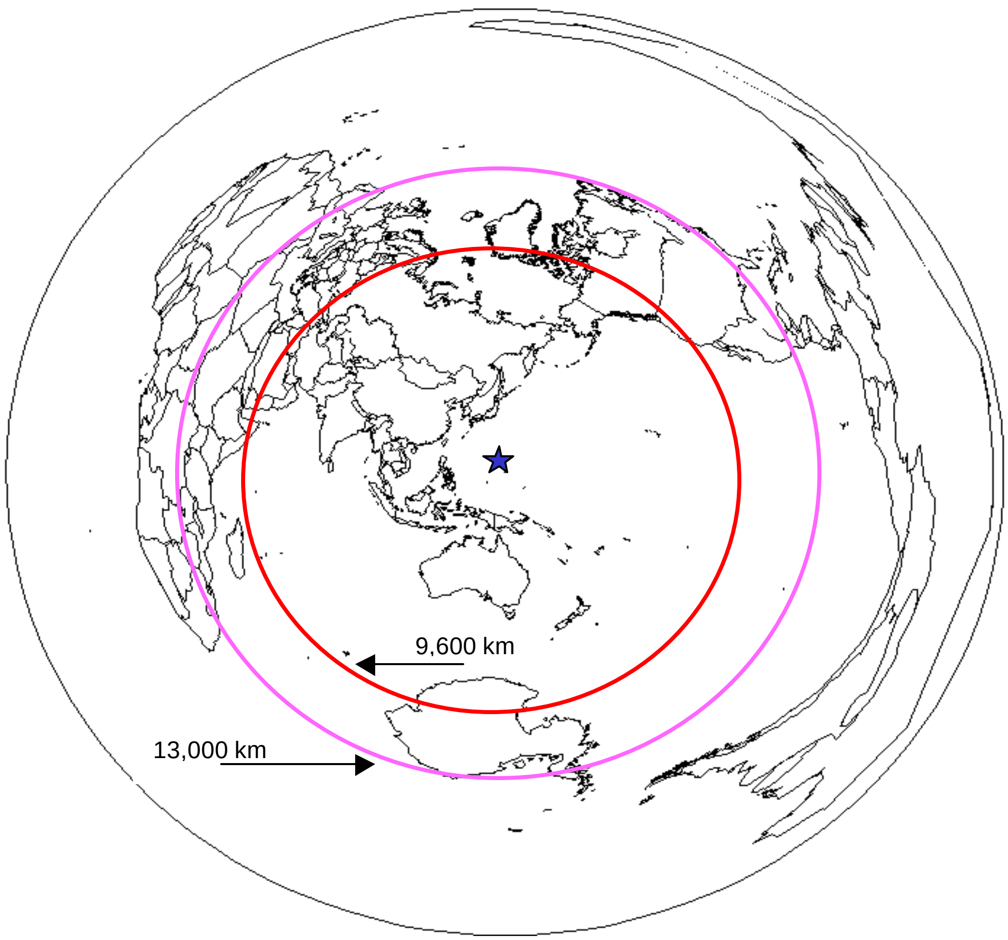


That said, Guam, defined by the START Treaty as U.S. national territory, offers another compelling alternative. As illustrated in Map 6, ICBM launch from Guam presents no ascent phase overflight problems and affords global coverage with Minuteman III ICBMs. As demonstrated in Table 5, Minuteman II and Peacekeeper ICBMs are also within range of areas of interest in the Middle East, Central Asia, and Northeast Asia from Guam. Ranges of particular missiles, of course, vary with payload.

The one wrinkle to the Guam option is that any ICBMs deployed there would be subject to Russian START inspections. Inspections must begin at a START port of entry, which require certain facilities and a full time staff.[114] Currently, U.S. START ports of entry are Washington and San Francisco, but inspections on Guam could not be mounted from the latter in the times required by the Treaty. Consequently, the United States would have to declare Agana as a START point of entry, and staff and equip it accordingly.

Of course, Guam's location will surely evoke some protest about U.S. power projection. However, it is the least problematic prospective basing option vis-àvis ascent phase overflight concerns and first and second stage debris. On the contrary, coastal basing in the United States would pose some problems for ICBM launch and limit global coverage unless bases on both coasts were employed. Thus, Guam offers the greatest global coverage from one base with the fewest ascent phase constraints.

Map 6. Great Circle Distances from Guam



Clarity of Intent

The most important policy concern that must be addressed is that Russia might misconstrue American actions upon detecting missiles rising out of the United States or the broad ocean areas. Even pro-defense circles may raise concerns over possible Russian misperceptions. The 24-hour test launch notification requirement was negotiated to avoid this kind of misunderstanding. Although the Cold War is indeed over, the U.S.-Russian relationship has not yet improved to the point that this is no longer an issue. The uncertain state of Russian early warning capabilities makes the situation even more acute.[115]

This concern adds to those of ascent phase overflight, discussed above, to argue against basing ICBMs assigned new roles at their traditional bases. These are the same locations the Soviets, and now the Russians, have traditionally monitored for ICBM launch. Missiles launched from these bases toward the Eurasian land mass would travel along the same strategic defiles projected for a nuclear war between the United States and the Soviet Union, overflying Russia for a considerable portion of their trajectory. It is unlikely such a plan would gain sufficient support in the American political system.

There are, however, a number of steps that could bolster confidence with Russia and lead to a solution.

As suggested above, to avoid overflight of the United States and Canada, ICBMs assigned new roles should be based on the two coasts and/or on Guam, which will also avoid vectors that approach or cross Russian territory. This would have the added negotiating merit of basing these missiles completely apart from our current strategic nuclear missiles.

The START Treaty could also help allay Russian concerns. START would require us to declare the new ICBM bases and make them accessible to Russian inspectors for new facilities inspections. Although the ICBMs assigned new roles would not qualify as START new type missiles, the Treaty provides for the United States to declare them a variant of existing types.[116] A variant would have some distinguishing feature so that Russian inspectors could readily tell it from the original existing type.

For example, the United States could design a new front end for the Minuteman III giving the missile some distinguishing feature observable by Russian inspectors during the technical characteristics inspection to which they would be entitled, then declare the newly equipped system "MM III variant 2." Thus, START procedures would allow Russia to confirm that only the ICBMs assigned new roles are present at particular bases. They could return to both the traditional and new ICBM bases periodically for data update and warhead inspections.

The United States could also build on START requirements with a set of confidence and security building measures (CSBMs). For example, we could provide briefings on the characteristics, missions and concept of operations of the ICBMs assigned to new roles. We could also invite continuous Russian presence at the new ICBM bases to insure that only missiles of a particular variant are there. Should one be fired operationally, a Russian officer would be present to observe and report to Moscow that what was launched was indeed the new variant ICBM. U.S.-Russian joint early warning activities could bolster START and other CSBMs.

We could also modify the Launch Notification Agreement and the corresponding START provision to give Russia some kind of launch notice. Of course, for testing, we could still provide 24 hours notice. But for operational launches the United States might not have 24 hours notice or be willing to breach operational security. Nonetheless, we could probably devise some secure way to notify Moscow of an operational launch.

In sum, we could use the START provisions, and then build upon them to assure Russia that they would always know what kind of missile would be launched from any given base.

Some of these measures could also be applied to SLBMs. The United States could declare variants, subject to Russian inspection, and could devise the same sort of notification procedures just discussed. It would be pointless, however, to try confining an SLBM variant to particular boats because boats carrying either variant could be anywhere at anytime. And any kind of continuous Russian presence would be improbable. Although SLBMs offer a number of positive aspects to new long-range precision strike missions, this drawback represents an important problem that would require a degree of Russian good faith or U.S. determination and resolve. We conclude that this obstacle to SLBMs, in this context, may be insurmountable.

Though beyond the scope of this study, there are other ballistic missile options that could be considered to address some of the issues raised in this section, including medium-range ballistic missiles (MRBM), intermediate-range ballistic missiles (IRBM), or surface ship-launched ballistic missiles. Today, the Intermediate Nuclear Force (INF) Treaty prohibits the United States from possessing ballistic missiles of ranges between 500 and 5,500 km.[117] The START Treaty prohibits surface ship launch of ballistic missiles of ranges greater than 600 km.[118] These treaties would have to be amended to pursue either of these options.

Finally, it is appropriate here to mention the issue of China. China has not traditionally had early warning systems, so the kind of misunderstanding possible with Russia is not today a factor with China. Nonetheless, we should expect Beijing to argue that the kind of developments discussed in this study are destabilizing, and China may in the future acquire some rudimentary early warning capability. This should not be a show-stopper, however, proponents of new roles for ICBMs and SLBMs should be prepared to say what we are willing or unwilling to do to allay Chinese concerns.

Policy and Treaty Issues: Summary Implications

The policy and treaty issues raised in this section are every bit as serious as the technical challenges raised elsewhere in this paper. They can, however, be addressed as follows:

- ICBMs assigned new roles must be based only at new ICBM bases on the two coasts and/or on Guam.
- Technical personnel should consider carefully whether the new front ends discussed in this paper can be designed within the telemetry encryption limitations of the START Treaty.
- Planning to use ballistic missiles for long-range precision strike must include well developed operational concepts that, among many other things, address overflight issues.
- We can use the provisions of the START Treaty, as well as CSBMs built upon them, to allay Russian concerns. Real progress on joint early warning might be both an enabler in this regard, and of significant value in its own right.

Conclusions

This paper has demonstrated that, although ballistic missiles are generally perceived of as Cold War weapons, they have much to offer 21st Century U.S. defense planners. The discussion of how ballistic missiles fit within the context of U.S. pursuit of long-range precision strike has demonstrated why the United States has moved toward a capabilities-based understanding of force structure requirements. In some circumstances, ballistic missiles might have little to offer a commander in the field. However, in other circumstances, equally as plausible (if not more so), the promptness, accuracy and range of ballistic missiles could mean the difference between victory and defeat. From this general point of departure, we can draw some specific conclusions:

- The ICBM and SLBM force identified by the NPR to be retained on active service is vital to continued traditional deterrence and to the responsive infrastructure required to meet possible geopolitical developments.
- Overcoming political hurdles will be critical for ballistic missiles to meet some of these future missions. Ballistic missiles are narrowly conceived of as Cold War systems, and many arms control advocacy groups and Congressional members will likely label new interest in ballistic missiles as internationally provocative. Serious concerns may also be raised in defense circles that Russia might misconstrue American actions upon detecting missiles rising out of the United States or broad ocean areas. Overcoming international concerns of U.S. allies, Russia, and perhaps even China (particularly if a Chinese early warning capability begins to emerge), will require attention and dedicated effort both in the administration and on Capitol Hill.

- Effective long-range precision strike is highly dependent upon improving U.S. intelligence capabilities. Thus, enhanced intelligence is a prerequisite for effective long-range precision strike, no matter the delivery mechanism. This constraint applies to all forms of long-range precision strike—including ballistic missiles.

- Developing a concept of operations that retains ballistic missile attributes like promptness and assured control will be crucial for making these systems relevant to the warfighter's planning process.

- Using available test assets to field a near-term conventional ballistic missile capability may be a cost effective initial step if sufficient political resolve is present and other policy and legal issues are addressed. This step might make it easier to seek support for follow-on programs. Leveraging existing capabilities may be the responsive infrastructure's only recourse if political and budgetary considerations are allowed to trump development of new strategic capabilities.

- Treaty requirements dictate that ICBMs be launched from in-ground silos only.

- Joint early warning activities may be an important confidence building measure that could work in conjunction with START inspections, etc. to lessen Russian anxiety about U.S. non-traditional ICBM deployments and launches. Joint Early Warning discussions were held during the early 1990s and could be productively resumed, given appropriate leadership support.

- A ballistic missile's mix of promptness and range make it uniquely suited for some types of missions e.g., WMD neutralization, strategic decapitation, and offensive counterforce.

- For ballistic missiles to play a larger role in long-range precision strike, they will require improvements in terms of: new payloads and specialized payloads (conventional and perhaps nuclear); accuracy; and in-flight retargeting.

- Moving a non-traditional ballistic missile force to basing on the east and west U.S. coasts and/or Guam will likely be necessary to address the policy concerns raised by "adapting" the Cold War forces to new missions. Basing in Guam provides the greatest global coverage with the fewest ascent phase constraints from a single location. Basing in Guam plus one coastal site affords the most comprehensive coverage. When ascent phase overflight and clarity of intent are considered, Cape Canaveral emerges as the better U.S. coastal site to complement Guam.

- Since range is dependent on the type of missile and payload, further technical work is required to determine precise coverage and, therefore, ideal basing.

- Additional CSBMs for Russia will by necessity be on the agenda. Effective CSBMs for ICBMs could be achievable, but would be very difficult for SLBMs.

- Ballistic missiles, especially the decommissioned Peacekeeper ICBMs, can provide a capability for quick response space launch. While the Missile Defense Agency currently does not have plans to use existing ICBMs for the ground-based midcourse defense system, these assets may be used as interceptor boosters or to launch BMD components, to meet the September 2004 deployment date outlined by the Bush administration, or for later developments in the BMDS.

- Legal and treaty considerations—warning and notification requirements, overflight concerns, and START inspection protocol—are serious issues, and could prove to be "show stoppers" unless the right measures are presented and implemented in a timely and understandable manner. For example, facilitating Russian inspections of silos or facilities, modifying the Launch Notification

Agreement to provide Russia with some kind of launch notification, and inviting continuous Russian presence at the new ICBM facilities.

Appendix: Ballistic Missile Background

The relatively inaccurate German V-2 was developed and used during the Second World War. More than 2,500 V-2 missiles launched by Nazi Germany caused several thousand civilian deaths and considerable anxiety among Allied civilian populations.[119] General Dwight D. Eisenhower also estimated that missiles might have had a broader strategic impact. Eisenhower remarked that had Germany perfected the V-2 earlier in the war and targeted certain ports, the Allied D-Day invasion of Europe would have been jeopardized.[120] After the war, the German scientists and engineers who developed the V-2 formed the nucleus of missile design teams in both the United States and the Soviet Union.

The United States has developed and deployed a variety of ballistic missiles. The Atlas, the first ICBM developed and tested by the United States, went on alert in October 1959. It used liquid fuel and had to be fueled immediately before launch.[121]

The Titan was the second ICBM developed by the United States. In April 1962, the first squadron of Titan I missiles was declared operational. The Titan II, a significantly more accurate missile capable of lifting much heavier payloads, was developed and placed on combat alert in April 1963. The Titan II used storable liquid propellant and carried a nine Megaton nuclear warhead.[122] Because of their reliability, Titans are still a standard Air Force SLV for placing heavy payloads into orbit.

The Minuteman was the first solid-fueled ICBM fielded by the United States.[123] Solid fuel use meant that the missile could be stored for longer periods of time and did not require a time-consuming and potentially dangerous fueling process. The first Minuteman was deployed in April 1963 and quickly replaced the Atlas and Titan I missiles, which were phased out by April 1965. The Minuteman II, which became operational in August 1965, featured many improvements over Minuteman I. It had a redesigned engine, which increased range by 1,600 km, and its guidance unit could store up to eight sets of target coordinates. Minuteman III deployment began in April 1970 and improved upon the previous Minuteman II. The most important change was a radically new warhead section which carried three MIRVs. In the 1970s, upgrades to the Minuteman III included an updated guidance system and a higher-yield warhead. According to some estimates, the improved accuracy and higher-yield warhead gave the Minuteman III a hard target kill capability against Soviet ICBM sites—that is, the ability to destroy a "hardened" site constructed to withstand a nuclear attack.

The larger "MX" Peacekeeper ICBM, with 10 RVs, became operational in December 1986. The Peacekeeper had an advanced guidance system, which made it more accurate than the Minuteman III.[124] In accordance with the 2001 NPR, Peacekeeper ICBMs will be deactivated over a three-year period beginning in October 2002, and Minuteman III ICBMs will be retained in the active force structure, although some of the newer Peacekeeper warheads will be modified to replace the oldest warheads on Minuteman III ICBMs.[125]

U.S. SLBMs went through a similar evolution. In November 1960 the Polaris A-1 was the first SLBM deployed by the U.S. Navy. An improved Polaris A-2, deployed in June 1962, increased range and utilized newer electronic components that provided for higher reliability. The Polaris A-3, which became operational in September 1964, was a significantly enhanced missile. The A-3 saved weight by using fiberglass casings for both stages, and had a 60 percent lighter guidance section, thus, almost doubling the range of the A-2. It also had a new warhead section with three 200 kiloton warheads, and an inertial navigation system which increased accuracy by a third over the A-2.[126] The Poseidon G3, declared operational in March 1971, used essentially the same guidance system as the Polaris A-3 and was a direct development of the Polaris.[127]

The next generation of SLBM, the Trident C-4, derived from the Poseidon C-3, was first deployed in October 1979.[128] The Trident C-4 increased range over the C-3 by over 2,000 km through several new technologies. A new propulsion system was developed, and an "aero-spike," which projects from the nose after launch, creates a shock cone, reducing frontal drag by about 50 percent. The payload of the Trident C-4 consists of eight 100 kiloton MIRVs, and accuracy was increased by about 30 percent over the C-3. The Trident D-5, first deployed by the U.S. Navy in 1990, improved upon the accuracy, range, and payload of the Trident C-4, introducing a hard target kill capability to the SLBM. The D-5 is equipped with eight 100 kiloton or 475 kiloton MIRVs, and it will remain as the Navy's principal ballistic missile, as the C-4 is gradually phased out.

In the intermediate-range class, the Thor was the first IRBM deployed by the United States. The first successful flight test occurred in September 1957, and all operational Thor IRBMs were stationed in Great Britain beginning in September 1958. The Thor could deliver a 1.45 megaton warhead 2,400 km, and the inertial guidance unit achieved an accuracy of approximately 300 m. By September 1963, all Thors had been deactivated and moved back to the United States. At the same time, the United States was developing the Jupiter IRBM. In October 1957 the first successful Jupiter launch occurred, and in June and November 1961 the first Jupiter squadrons became fully operational in Italy and Turkey. Much like Thor, Jupiter had a short operational life, and by July 1963 the missiles were removed from Italy and Turkey.[129]

The Pershing was the first and only MRBM deployed by the U.S. Army. The Pershing I and Pershing Ia were fielded during the 1960s and 1970s. Improvements to the original Pershings led to the Pershing II, a more accurate and longer-range variant. The enhanced accuracy of the Pershing II increased lethality and enabled a 50 kiloton warhead to replace its original 400 kiloton payload.[130] The Pershing II was also equipped with a highly accurate maneuvering RV that incorporated guidance in the terminal phase of the missile's flight. In December 1983, the first Pershing II battery became operational, and by December 1985 all 108 Pershing Ia missiles in West Germany were replaced by Pershing II. However, the deployment was short-lived. In December 1987, the United States and Soviet Union signed the INF Treaty which abolished all land-based nuclear-armed ballistic missiles with ranges from 500 to 5,500 km.[131] All Pershing IIs were subsequently destroyed in accordance with the treaty.

Among short-range ballistic missiles (SRBM), Corporal was the first operational guided missile of the U.S. Army approved for nuclear armament. In April 1954 the first Army units began training with the missile, which was equipped with a 20 kiloton warhead and capable of traveling between 48 and 130 km.[132] Honest John was deployed in Europe in spring 1954, with a range between 25 and 50 km, capable of delivering nuclear and conventional payloads.[133] In July 1962 the U.S. Army deployed the first Sergeant, a solid fuel surface-to-surface missile with a maximum range of 140 km.[134] The Sergeant delivered a 200 kiloton warhead, and its solid fuel rocket motor was safer and more reliable than the liquid fueled Corporal. The Lance replaced both the Sergeant and Honest John in U.S. Army service.[135] The first operational Lance battalion was deployed in Europe in 1973. In contrast to earlier designs, the missile could be fired on short notice (less than 15 minutes reaction time), and due to its compact size, more missiles could be moved by a single unit.

In the 1980s and 1990s, the United States developed the short-range tactical ballistic missile system, known as the Army Tactical Missile System (ATACMS). These SRBMs have a range of approximately 300 km, and are useful against a variety of threats, including surface-to-surface missile sites, air defense sites, and C^3 complexes. Newer ATACMS designs entered into service in 1998 and were equipped with GPS-aided guidance to increase accuracy. ATACMS variants can deliver small bomblet submunition, Brilliant Anti-Tank guided submunition, and a 500-pound unitary high explosive warhead.[136]

Notes

[1]Interviews for this study were conducted on the condition of anonymity. Most interview material was integrated into the overall prose of the study and not specifically attributed to interviewees.

[2]Eric Schmitt, "U.S. Considers Conventional Warheads on Nuclear Missiles," *New York Times*, February 24, 2003.

[3]J.D. Crouch, Assistant Secretary of Defense for International Security Policy, "Special Briefing on the Nuclear Posture Review," January 9, 2002, available at <http://www.defenselink.mil/news/Jan2002/t01092002_t0109npr.html> (transcript) and <http://www.defenselink.mil/news/Jan2002/g020109-D-6570C.html> (slides).

[4]The White House, *National Strategy to Combat Weapons of Mass Destruction*, December 2002, p.1, available at <http://www.whitehouse.gov/news/releases/2002/12/WMDStrategy.pdf>; and The White House, *The National Security Strategy of the United States of America*, September 2002, p. 16, available at <http://www.whitehouse.gov/nsc/nss.pdf>.

[5]"President Bush Delivers Graduation Speech at West Point," June 1, 2002, p. 3, available at <http://www.whitehouse.gov/news/releases/2002/06/20020601-3.html>.

[6]This is not to suggest that these are the only countries of concern. According to the NPR, "North Korea, Iraq, Iran, Syria, and Libya are among the countries that could be involved in immediate, potential, or unexpected contingencies…North Korea and Iraq in particular have been chronic military concerns. All sponsor or harbor terrorists, and all have active WMD and missile programs." See "Nuclear Posture Review Excerpts," January 8, 2002, available at <http://www.globalsecurity.org/wmd/library/policy/dod/npr.htm, p. 6.

[7]As Undersecretary of State John R. Bolton stated, "North Korea is the world's foremost peddler of ballistic missile-related equipment, components, materials, and technical expertise." Martin Nesirky, "U.S. Official Calls North Korea 'Peddler' of Missile Technology," *Washington Post*, August 30, 2002, p. A17; and Doug Struck and Glenn Kessler, "Foes Giving in to North Korea's Nuclear Aims," *Washington Post*, March 5, 2003, p. A1.

[8]Peter Slevin and Joby Warrick, "U.S. Wary of Iranian Nuclear Aims," *Washington Post*, February 11, 2003, p. A12. In the case of Iran, not only is Russia finishing construction of an $800 million nuclear reactor in Bushehr, where it is feared that Tehran will be able to generate weapons-grade fissionable materials, but also plans already exist for another five reactors for $10 billion. For more on the implications of Iran going nuclear see, Kori N. Schake and Judith S. Yaphe, *The Strategic Implications of a Nuclear-Armed Iran*, McNair Paper no. 64 (Washington, D.C.: Institute for National Strategic Studies, National Defense University, 2001); and Michael Eisenstadt, "Living with a Nuclear Iran?" *Survival* 41, no. 3 (autumn 1999), pp. 124-48.

[9]For a recent assessment of the worldwide threat environment to the United States see, George Tenet, Director of the Central Intelligence Agency, prepared statement before the Senate Select Committee on Intelligence, February 11, 2003, available at <http://intelligence.senate.gov/0302hrg/030211/tenet.pdf>; and Vice Admiral Lowell E. Jacoby, Director of the Defense Intelligence Agency, prepared statement before the Senate Select Committee on Intelligence, February 11, 2003, available at <http://intelligence.senate.gov/0302hrg/030211/jacoby.pdf>.

[10]See, for example, Sanjeev Khagram, James V. Riker, and Kathryn Sikkink, ed., *Restructuring World Politics: Transnational Social Movements, Networks, and Norms* (Minneapolis: University of Minnesota Press, 2002); Paul J. Smith, "Transnational Terrorism and the al Qaeda Model: Confronting New Realities," *Parameters* 32, no. 2 (summer 2002), pp. 33-46; P. W. Singer, "Corporate Warriors: The Rise of the Privatized Military Industry and Its Ramifications for International Security," *International Security* 26, no. 3 (winter 2001/02), pp. 186-220; Alison Jamieson, "Transnational Organized Crime: A European Perspective," *Studies in Conflict and Terrorism* 24, no. 5 (September/October 2001), pp. 377-88; Paul J. Smith, "Transnational Security Threats and State Survival: A Role for the Military?" *Parameters* 30, no. 3 (autumn 2000), pp. 77-91; and Thomas Risse-Kappen, ed., *Bringing Transnational Relations Back In: Non-State Actors, Domestic Structures, and International Institutions* (Cambridge: Cambridge University Press, 1995).

[11]This point was clearly articulated in the 2001 QDR: "Although the United States will not face a peer competitor in the near future, the potential exists for regional powers to develop sufficient capabilities to threaten stability in regions critical to U.S. interests. In particular, Asia is gradually emerging as a region susceptible to large-scale military competition. Along a broad arc of instability that stretches from the Middle East to Northeast Asia, the region contains a volatile mix of rising and declining regional powers." Department of Defense, *Quadrennial Defense Review Report*, hereafter referred to as QDR (Washington, D.C.: DoD, September 30, 2001), available at <http://www.defenselink.mil/pubs/qdr2001.pdf>, p. 4.

[12]*The National Security Strategy of the United States of America*, pp. 16, 29. In successive conflicts, the use of precision guided munitions has proved critical to achieving U.S. objective at all levels. For example, as Defense Secretary Donald Rumsfeld noted, precision guided munitions accounted for only 7 percent of the munitions dropped in the Gulf War, 30 percent in Kosovo and 70 percent in Afghanistan. See Donald H. Rumsfeld, Secretary of Defense, prepared statement on the Crusader Recommendation before the Senate Armed Services Committee, May 16, 2002, p. 9, available at <http://www.senate.gov/~armed_services/statemnt/2002/May/Rumsfeld.pdf>. Over 35,000 nonnuclear, precision-guided munitions have been expended in diverse U.S. military operations during the last 10 years. *Gulf War Air Power Survey, Vol. V, Pt. I* (Washington, DC: U.S. Government Printing Office, 1993), pp. 553-54; Lt. Col. Richard L. Sargent, USAF, "Weapons Used in Deliberate Force," in *Deliberate Force: A Case*

Study in Effective Air Campaigning, ed. Col. Robert C. Owen, USAF (Maxwell Air Force Base, AL: Air University Press, January 2000), pp. 258, 267, available at <http://www.maxwell.af.mil/au/aul/aupress/Owen/Owen.pdf>; Benjamin S. Lambeth, *NATO's Air War for Kosovo: A Strategic and Operational Assessment*, MR-1365-AF (Santa Monica, CA: RAND, 2001), p. 88, available at <http://www.rand.org/publications/MR/MR1365; Gen. Tommy R. Franks, USA, Commander in Chief, Central Command, prepared statement before the House Armed Services Committee, February 27, 2002, available at <http://www.house.gov/hasc/ openingstatementsand pressreleases/107thcongress/02-02-27franks.html>; William Arkin, "Weapons Total from Afghanistan Includes Large Amount of Cannon Fire," *Defense Daily*, March 5, 2002, p. 12; and Eric Schmitt, "Improved U.S. Accuracy Claimed in Afghan Air War," *New York Times*, April 9, 2002, p. A14.

[13]Information on the NPR for this study is drawn from the following sources: "Nuclear Posture Review Excerpts"; Crouch, "Special Briefing on the Nuclear Posture Review"; Donald H. Rumsfeld, Secretary of Defense, unclassified cover letter for Nuclear Posture Review report to Congress, January 9, 2002, available at <http://www.defenselink.mil/news/Jan2002/d20020109npr.pdf>; Office of Public Affairs, Office of the Secretary of Defense, "Pentagon Briefing: 2002 Nuclear Posture Review," fact sheet, January 10, 2002; Douglas J. Feith, Under Secretary of Defense for Policy, John A. Gordon, Administrator of the National Nuclear Security Administration, and Admiral James O. Ellis, Commander of U.S. Strategic Command, prepared statements before the Senate Armed Services Committee, February 14, 2002, available at <http://www.senate.gov/~armed_services>.

[14]*QDR*, pp. iv, 13-14; and Crouch, "Special Briefing on the Nuclear Posture Review."

[15]The NPR pointed out that "U.S. nuclear forces, alone are unsuited to most of the contingencies for which the United States prepares. The United States and its allied interests may not require nuclear strikes. A 'new mix' of nuclear, non-nuclear, and defensive capabilities is required for the diverse set of political adversaries and unexpected threats the United States may confront in the coming decade." "Nuclear Posture Review Excerpts," p. 3. One senior defense official suggested, "a capabilities-based approach . . . is intended to give is . . . a 'portfolio of capability.' What you really want is a variety of means which, in combination, give you an optimum solution to a problem you're facing." See "Background Briefing on the Defense Planning Guidance," May 10, 2002, p. 14, available at <http://www.defenselink.mil/news/May2002/t05102002_t0510dpg.html>.

[16]*QDR*, pp. iii-iv, 11-13.

[17]*QDR*, p. 30.

[18]"Special DoD News Briefing—Conventional Forces Study," June 22, 2001, pp. 4-5, available at <http://www.defenselink.mil/ news/Jun2001/t06232001_t622gomp.html>.

[19]Secretary of Defense Donald H. Rumsfeld, *Annual Report to the President and Congress*, 2002, chap. 2, p. 4, available at <http://www.defenselink.mil/execsec/adr2002/html>_files/chap2.htm. (emphasis added)

[20]One of the six operational goals underlying transformation the QDR identified was the goal of "projecting and ensuring the security of U.S. forces in challenging environments." *QDR*, p. 30.

[21]*Annual Report to the President and Congress*, chap. 6, p. 3, available at <http://www.defenselink.mil/ execsec/adr2002/html>_files/chap6.htm.

[22]Ibid., chap. 2, p. 3.

[23]As the NPR notes: "Terrorists or rogue states armed with WMD will likely test America's security commitments to its allies and friends. In response, we will need a range of capabilities to assure friend and foe alike of U.S. resolve. A broader array of capability is needed to dissuade states from undertaking political, military, or technical courses of action that would threaten U.S. and allied security. U.S. forces must pose a credible deterrent to potential adversaries who have access to modern military technology, including nuclear, biological, and chemical weapons and the means to deliver them over long distances. Finally, U.S. strategic forces need to provide the President with a range of options to defeat any aggressor. To meet the nation's defense goals in the 21st century, [offensive nuclear forces] will be just part of the first leg of the New Triad, integrated with non-nuclear strategic capabilities that strengthen the credibility of our offensive deterrence." "Nuclear Posture Review Excerpts," p. 2.

[24]Admiral James O. Ellis, Commander of U.S. Strategic Command, prepared statement before the Senate Armed Services Committee Strategic Subcommittee, April 8, 2003, pp. 34, available at <http://www.senate.gov/~armed_services/statemnt/ 2003/April/Ellis2.pdf>; and Gail Kaufman, "USAF To Speed Long-Range Strike by 2012," *Defense News*, April 7, 2003, p. 20.

[25]Ellis, prepared statement before the Senate Armed Services Committee Strategic Subcommittee, April 8, 2003, pp. 9-10. See also "USAF to Study Conventional ICBMs," *Jane's Missiles and Rockets* 6, no. 10 (October 2002), p. 6; William B. Scott, "Milspace Will Be a Major Player in 'Gulf War 2'," *Aviation Week & Space Technology*, January 13, 2003, p. 398; and Schmitt, "U.S. Considers Conventional Warheads on Nuclear Missiles." Similar arguments for submarines have been put forth. See Elaine M. Grossman, "Pentagon Eyes Bunker-Busting Conventional Ballistic Missile for Subs," *Inside the Pentagon*, June 27, 2002, p. 1; and Ken Perry, "Broaden the SSBN's Punch," U.S. Naval Institute's *Proceedings* (June 2002), pp. 34-36. The conventional ICBM concept has been discussed in earlier studies. See, for example, C. H. Builder, D. C. Kephart, and A. Laupa, *The U.S. ICBM Force: Current Issues and Future Options*, U.S. Air Force Project RAND, R-1754-PR, October 1975, pp. 82-84, available at <http://www.gwu.edu/~nsarchiv/NSAEBB/NSAEBB43/doc19.pdf>.

[26]"Nuclear Posture Review Excerpts," p. 17.

[27]For a discussion of traditional deterrence during and after the Cold War see, Alexander George and Richard Smoke, *Deterrence in American Foreign Policy: Theory and Practice* (New York: Columbia University Press, 1974); Richard Ned Lebow, *Between Peace and War* (Baltimore, MD: Johns Hopkins University Press, 1981); Peter Karsten, Peter D. Howell, and Artis Frances Allen, *Military Threats: A Systematic Historical Analysis of the Determinants of Success* (Westport, CT: Greenwood Press, 1984); Colin S. Gray, *Nuclear Strategy ad Strategic Planning* (Philadelphia: Foreign Policy Research Institute, 1984); Robert Jervis, Richard Ned Lebow, and Janice Stein, *Psychology and Deterrence* (Baltimore, MD: Johns Hopkins University Press, 1985); Lawrence Freedman, *The Evolution of Nuclear Strategy*, 2nd ed. (New York: St. Martin's Press, 1989); McGeorge Bundy, *Danger and Survival: Choices About the Bomb in the First Fifty Years* (New York: Vintage Books, 1988); Alex Hybel, *Power Over Rationality* (Albany, NY: State University of New York, 1993); Keith B. Payne, *Deterrence in the Second Nuclear Age* (Lexington, KY: University Press of America, 1996); and Keith B. Payne, *The Fallacies of Cold War Deterrence and a New Direction* (Lexington, KY: University Press of Kentucky, 2001).

[28]*QDR*, pp. iii-iv, 11-13; and "Nuclear Posture Review Excerpts," pp. 4-5.

[29]"Nuclear Posture Review Excerpts," p. 3.

[30]On May 24, 2002 U.S. President George W. Bush and Russian President Vladimir Putin signed the Strategic Offensive Reductions Treaty—the Moscow Treaty—under which both countries committed to reduce operationally deployed strategic offensive warheads to a level between 1,700 and 2,200.

[31]The third leg of the New Triad is a revitalized defense infrastructure that will provide new capabilities in a timely fashion to meet emerging threats. Since the end of the Cold War, the U.S. defense infrastructure has contracted, especially the nuclear infrastructure, which includes testing and production. New approaches to development and procurement of capabilities are necessary so that innovations can be more quickly integrated into the force structure. For more on this see, National Institute for Public Policy, *Strategic Offensive Forces and the Nuclear Posture Review's "New Triad,"* (Fairfax, VA: National Institute for Public Policy, March 2003), p. 17, available at <http://www.nipp.org/Adobe/Strategic%20Offensive.pdf>. Secretary of Defense Rumsfeld also noted: "The reality is [that] we live in the world, there is a security environment, Russia exists and has capabilities to be sure, but so does the People's Republic of China, and they are increasing their defense budget. And they are increasing their nuclear capabilities purposefully." Donald H. Rumsfeld, Secretary of Defense, testimony before the Senate Foreign Relations Committee, July 17, 2002, available at <http://www.defenselink.mil/speeches/2002/s20020717-secdef1.html>. For more on Chinese military modernization see, Yihong Zhang, "China's Rising," *Jane's International Defense Review* (August 2002), pp. 36-39; Thomas J. Christensen, "Posing Problems without Catching Up: China's Rise and Challenges for U.S. Security Policy," *International Security* 25, no. 4 (spring 2001), pp. 5-40; David J. Smith, "Sun Tzu and the Modern Art of Countering Missile Defense," *Jane's Intelligence Review* 12, no. 1 (January 2001), pp. 35-39; David Shambaugh, "A Matter of Time: Taiwan's Eroding Military Advantage," *Washington Quarterly* 23, no. 2 (spring 2000), pp. 119-133; Mark A. Stokes, *China's Strategic Modernization: Implications for the United States* (Carlisle, PA: Strategic Studies Institute, September 1999); and Jim Garamone, "Chinese Military Power Secret, but Growing," American Forces Press Service, July 19, 2002, available at <http://www.defenselink.mil/news/Jul2002/n07192002_200207191.html>.

[32]As the NPR notes: "The responsive force is intended to provide a capability to augment the operationally deployed force to meet potential contingencies…The responsive force…retains the option for leadership to increase the number of operationally delayed forces in proportion to the severity of an evolving crisis. A responsive force need not be available in a matter of days, but in weeks, months, or even years." "Nuclear Posture Review Excerpts," p. 7.

[33]"Nuclear Posture Review Excerpts," p. 14; and Crouch, "Special Briefing on the Nuclear Posture Review."

[34]Interview with senior Air Force Staff. See also "Nuclear Posture Review Excerpts," p. 15.

[35]Rear Admiral Charles B. Young, Director of Strategic Systems Programs, Department of the Navy, prepared statement before the Senate Armed Services Committee Strategic Subcommittee, April 8, 2003, pp. 3-5, available at <http://www.senate.gov/~armed_services/ statemnt/2003/April/YoungCharles.pdf>; and "Nuclear Posture Review Excerpts," p. 15.

[36]Under the NPR, 76 B-52 and 21 B-2 bombers will be retained in the force structure, while the B-1 bomber will no longer serve a nuclear role. Admiral James O. Ellis, Commander in Chief, U.S. Strategic Command, prepared statement before the Senate Armed Services Committee Strategic Subcommittee, March 20, 2002, p. 6, available at <http://www.senate.gov/~armed_services/statemnt/2002/March/Ellis.pdf>.

[37]Colonel John A. Warden III, one of the principal architects of the Desert Storm air campaign, is the theorist most closely associated with decapitation. He identifies leadership as the most critical element in determining a nation's will to fight: "The command structure . . . is the only element of the enemy—whether a civilian at the seat of government or a general directing a fleet—that can make concessions. In fact, wars through history have been fought to change (or change the mind of) the command structure—to overthrow the prince literally or figuratively or to induce the command structure to make concessions. Capturing or killing the state's leader has frequently been decisive. In modern times, however, it has become more difficult—if not impossible—to capture or kill the command element. At the same time, command communications have been more important than ever, and these are vulnerable to attack. When command communications suffer extreme damage . . . the leadership has great difficulty in directing war efforts. In the case of an unpopular regime, the lack of communications not only inhibits the bolstering of national morale but also facilitates rebellion on the part of dissident elements." John A. Warden III, "Employing Air Power in the Twenty-first Century," in *The Future of Air Power in the Aftermath of the Gulf War*, ed. Richard H. Schultz Jr. and Robert L. Pfaltzgraff Jr. (Maxwell Air Force

Base, AL: Air University Press, 1992), p. 65. See also Bruce A. Ross, "The Case for Targeting Leadership in War," *Naval War College Review* 46 (winter 1993), pp. 73-93; and Robert A. Pape, *Bombing to Win: Air Power and Coercion in War* (Ithaca, NY: Cornell University Press, 1996), pp. 79-86.

[38]There were 50 leadership strikes in the war with Iraq out of a total of 156 time sensitive target missions. Vernon Loeb, "Air Force Drops Some Numbers," *Washington Post*, July 7, 2003, p. A15.

[39]Sir Michael Howard, "Lessons of the Cold War," *Survival* 36, no. 4 (winter 1994-95), p. 166.

[40]*Report of the Commission to Assess United States National Security Space Management and Organization*, January 11, 2002, p. 9, available at <http://www.defenselink.mil/pubs/space20010111.html>.

[41]This was made clear in Jacoby, prepared statement before the Senate Select Committee on Intelligence, February 11, 2003, p. 17. See also Michael Krepon with Christopher Clary, *Space Assurance or Space Dominance? The Case Against Weaponizing Space* (Washington, D.C.: Henry L. Stimson Center, 2003); James Clay Moltz, "Reigning in the Space Cowboys," *Bulletin of the Atomic Scientists* 59, no. 1 (January/February 2003), pp. 61-66; and Nader Elhefnawy, "Four Myths about Space Power," *Parameters* 33, no. 1 (spring 2003), pp. 124-32. For an alternative assessment see, Jeremy Singer, "Pentagon in No Rush to Deploy Space-Based Weapons," *Space News*, December 16, 2002, p. 22.

[42]In March 2003, AFSPC began a year long Operationally Responsive Spacelift (ORS) Analysis of Alternatives focused on putting payloads into space on short notice. According to Colonel Pamela L. Stewart, the director of the study, "the key element is responsiveness. The goal [of ORS] is hours-to-days versus weeks-to-months in order to have an asset on-orbit. That requires responsive payloads, because just launching something, then taking three months to initialize it, does not make for responsive space." The study team will examine the following payloads: CAV, a munition than can be delivered from or through space; a navigation payload that could supplement or replenish the GPS constellation; a representative electro-optical payload, like the low-cost visible-light imager; a counterspace device, something in orbit that could protect friendly force satellites or disable an adversary's; and a payload that would augment a space-based radar equipped with a ground moving target indicator. See William B. Scott, "Rapid Response," *Aviation Week & Space Technology*, April 7, 2003, p. 67; Michael A. Dornheim, "Quick, Cheap Launch," *Aviation Week & Space Technology*, April 7, 2003, pp. 70-71; and Jeremy Singer, "Pentagon Renews Interest in Small Launchers," *Space News*, March 3, 2003, p. 3.

[43]Those in Detachment 12 of the Space and Missile Systems Center have identified this potential application. As one of its major responsibilities, Detachment 12 manages retired ICBMs under the Rocket Systems Launch Program. Air Force Colonel James Neumeister, commander of the detachment, recently stated, "Think of everything and anything to be done with retired ICBM assets. We are in the process of source selection for our follow-on orbital/suborbital program contract. This is to pick a couple of contractors who will have responsibility for working with us to take those Minuteman assets, and now Peacekeeper assets, and build those up into both target launch vehicles as well as SLVs." Ray Nelson, "ICBMs Useful in Retirement," *Space & Missile Defense Report*, November 7, 2002, p. 2.

[44]"Nuclear Posture Review Excerpts," p. 17.

[45]Department of Defense and Department of Energy, *Report to Congress on the Defeat of Hard and Deeply Buried Targets*, October 2001, p. 8; and "Nuclear Posture Review Excerpts," p. 17.

[46]To build a "cut and cover" facility, earth is removed, a concrete bunker is built in the open hole, and rock or dirt is then used to backfill the remaining space. The reinforced concrete walls are usually less than 5 m thick. According to the joint Department of Energy and Department of Defense report on HDBTs, such facilities make up the majority of the world's HDBTs. They can extend over hundreds of square meters and tend to be buried at depths less than 30 m. These facilities usually serve a tactical function, like support to artillery or missile launchers, and most can be held at risk with current conventional weapons, assuming that precise target information is available. The second class of HDBTs are tunneled into rock or earth but not located far beneath the surface. The Libyan Tarhunah chemical production facility, reported to be tunneled 18 m below the earth, is a typical example of such a facility. The differences between these facilities and the first class is that because they are tunneled rather than built in the open and then covered, they are harder and more difficult to find. They can be constructed through the use of traditional drilling and blasting techniques, more modern tunneling equipment, or one can make use of natural geography, such as al Qaeda's use of caves in Afghanistan. The third class of facilities are characterized by their depth, since these underground complexes are tunneled deep into rock. Given their depth, earth-penetrating weapons cannot breach many of these facilities, since depths range from 20 m to more than 1 km. As the joint Department of Energy and Department of Defense report on HDBTs noted, these facilities often have "a concrete overburden equivalent of 70 to 300 feet," making them much stronger and secure. Deep tunnels in this class, unlike the second class, are often dug sideways into the base of a mountain, which further complicates targeting. As one former Iraqi colonel stated, hardened bunkers were built for Saddam Hussein in Iraq to resist a direct hit of a 20 kiloton atomic bomb and keep those inside independent of the outside world for six months. See *Report to Congress on the Defeat of Hard and Deeply Buried Targets*, p. 9; Michael A. Levi, *Fire in the Hole: Nuclear and Non-Nuclear Options for Counter-proliferation*, Carnegie Endowment for International Peace, Working Paper no. 31 (November 2002), p. 8; and Nedim Dervisbegovic, "Saddam's Bunkers Said 'Impossible' to Destroy," *Reuters*, March 25, 2003.

[47]John Diamond, "N. Korea keeps U.S. Intelligence Guessing," *USA Today*, March 10, 2003. The use of buried targets has long been central to North Korean strategy. As Kim Il-Song noted in 1963, "the entire nation must be made into a fortress. We do not have an atomic bomb. Therefore, we must dig ourselves into the ground to protect against the threats of atomic bombs." Quotation

provided by Joseph S. Bermudez, Jr, October 4, 2002. See also his *Shield of the Great Leader: The Armed Forces of North Korea* (St. Leonards, Australia: Allen & Unwin, 2001).

[48]"Nuclear Posture Review Excerpts," p. 18.

[49]Ibid., p. 18.

[50]During the war, 42 Scuds were fired at Israel and 45 at Saudi Arabia; 1 landed in Qatar. *Gulf War Air Power Survey, Vol. IV, Pt. I*, p. 278, n. 78.

[51]*Gulf War Air Power Survey, Vol. II, Pt. II*, pp. 331-32, 337, 340; and National Institute for Public Policy, *Rationale and Requirements for U.S. Nuclear Forces and Arms Control, Vol. II* (Fairfax, VA: National Institute for Public Policy, 2001), pp. 64-65.

[52]In August 1990 during contingency planning for an Iraqi invasion of Saudi Arabia, the Commander-in-Chief of Central Command expressed concern over the prospect of "chemical and perhaps biological warheads threatening cities, airfields, ports, and troops" and emphasized the importance of suppressing Scud attacks quickly once hostilities began. *Gulf War Air Power Survey, Vol. IV, Pt. I*, p. 278.

[53]One concept the Defense Threat Reduction Agency, the Office of Naval Research, and Lockheed Martin are pursuing involves a high-temperature incendiary to be spread and ignited before, rather than after, the weapon's blast. When the facility temperature reaches 230 degrees Celsius, submunitions rupture the storage tanks, exposing the agents to the neutralizing heat. In addition, as a by-product of the heating reaction, chlorine and fluorine gases and hydrochloric and hydrofluoric acids are created, further aiding in the neutralization of remaining biological agents. Andrew Koch, "USA Expedites Chem-Bio Bunker-Buster Project," *Jane's Defence Weekly*, September 18, 2002, p. 3. See also "Nuclear Posture Review Excerpts," p. 19; William M. Arkin, "'Sci-Fi' Weapons Going to War," *Los Angeles Times*, December 8, 2002, p. M1; Robert Wall, "UAVs, Counter-Terror Top Pentagon Demos," *Aviation Week & Space Technology*, March 11, 2002, pp. 28-29; and Levi, *Fire in the Hole*, pp. 24-25.

[54]For good introductions to ballistic missiles see, Willis Stanley, Bernie Victory, and Keith Payne, *Defense Against Ballistic Missile Threats: Questions & Answers* (Fairfax, VA: National Institute for Public Policy, 2000); and "Ballistic Missile Basics", available at <http://www.fas.org/nuke/intro/missile/basics.htm>.

[55]These definitions are taken from National Air Intelligence Center, *Ballistic and Cruise Missile Threat*, NAIC-1031-0985-03 (Dayton, OH: Wright-Patterson Air Force Base, February 2003), p. 3.

[56]Ballistic missiles could also be launched from surface sea platforms or even from aircraft.

[57]Some SRBMs may not rise out of the atmosphere.

[58]For more on this point see, Richard L. Russell, "Swords and Shields: Ballistic Missiles and Defenses in the Middle East and South Asia," *Orbis* 46, no. 3 (summer 2002), pp. 483-98; Aaron Karp, "The Spread of Ballistic Missiles and the Transformation of Global Security," *The Nonproliferation Review* 7, no. 3 (fall/winter 2000), pp. 106-22; and *Report of the Commission to Access the Ballistic Missile Threat to the United States* (Washington D.C.: U.S. GPO, July 15, 1998), available at <http://www.access.gpo.gov/su_docs/newnote.html>.

[59]Scott, "Milspace Will Be a Major Player in 'Gulf War 2'," p. 399.

[60]In December 1987, the United States and Soviet Union signed the INF Treaty, which abolished all shorter, medium and intermediate-range nuclear-armed ballistic missiles, that is, ballistic missiles with ranges from 500 to 5,500 km.

[61]"Nuclear Posture Review Excerpts," pp. 14-15. The details of how the force transitions from the interim size of 3,800 in 2007 to 1,700-2,200 in 2012 have been explicitly relegated to a process of periodic reviews (beginning in 2003). See "Nuclear Posture Review Excerpts," p. 7; and also "Text of U.S.-Russian Strategic Offensive Reductions Treaty," May 24, 2002, available at <http://www.whitehouse.gov/news/releases/2002/05/20020524-3.html>.

[62]The three-year schedule for Peacekeeper deactivation will see 17 missiles drawn out in each of the first two years and 16 in the last year.

[63]Duncan Lennox, ed., *Jane's Strategic Weapons Systems*, no. 36 (January 2002), pp. 211-17. Minuteman II range drawn from "USAF Almanac," *Air Force Magazine* 74, no. 5 (May 1991), pp. 175-76. Minuteman II throw weight and CEP drawn from International Institute for Strategic Studies, *The Military Balance, 1991-1992* (London: IISS, 1991), p. 221.

[64]The throw weight of a ballistic missile is the total weight of components above the third stage including the payload, any payload support wafers, or post-boost vehicle.

[65]Accuracy is described in terms of a missile's CEP. This is the radius of a circle within which an RV would land 50 percent of the time.

[66]Interview with senior Air Force official.

[67]Interview with senior Navy official.

[68]Interview with engineers.

[69]Using ballistic missiles to deliver kinetic energy weapons echoes the thinking of Air Force Chief of Staff General John Jumper, who noted that "the future of countering deeply buried targets lies in speed" rather than size. According to General Jumper, a weapon could be dropped from very high altitude to reach speeds of Mach 10—so fast they may not need to carry explosive warheads

because the energy created by impact would cause significant destruction. Andrew Koch, "USAF Takes New Look at 'Big BLU'-Style Bomb," *Jane's Defence Weekly*, October 30, 2002, p. 6.

[70]The Air Force is also exploring whether it should add a booster to penetrator bombs to increase their impact velocity. Robert Wall, "Emerging Weapons Aim to Foil Hardest Targets," *Aviation Week & Space Technology*, October 21, 2002, p. 28.

[71]The NPR describes the B61-11 as a "single-yield" weapon, but other sources suggest that the bomb has a variable yield between 0.3 and 300 kilotons. See "Nuclear Posture Review Excerpts," p. 18; Robert W. Nelson, "Low-Yield Earth-Penetrating Nuclear Weapons," *Journal of the Federation of American Scientists* 54, no. 1 (January/February 2001), p. 3; Levi, *Fire in the Hole*, pp. 5-6; and Robert W. Nelson, "Low-Yield Earth-Penetrating Nuclear Weapons," *Science and Global Security* 10 (2002), p. 4.

[72]Adam Stump, "B-2 Successfully Drops Improved Bunker Buster Bomb," available at <http://www.fas.org/nuke/guide/usa/bomber/n19980326_980417.html>; and Robert W. Nelson, "Low-Yield Earth-Penetrating Nuclear Weapons," *Science and Global Security*, p. 4.

[73]"Nuclear Posture Review Excerpts," p. 18.

[74]See David J. Smith, "Keep Nuclear Options Open," *Los Angeles Times*, February 20, 2003, p. A11; Ellen Sorokin, "Administration Won't Bar Use of Nuclear Weapons," *Washington Times*, January 27, 2003, p. A1; and Brad Knickerbocker, "In an Age of Biowarfare, US Sees New Role for Nukes," *Christian Science Monitor*, November 26, 2002.

[75]Eric Miller, "Bunker-Busting Nuke Expands U.S. Options," *Defense News*, September 16-22, 2002, p. 21; James Dao, "Nuclear Study, Given Go-Ahead, Rouses Fears About a New 'Bunker Buster' Weapon," *New York Times*, November 17, 2002; Richard T. Cooper, "Making Nuclear Bombs 'Usable'," *Los Angeles Times*, February 3, 2003, p. A1; Walter Pincus, "U.S. Explores Developing Low-Yield Nuclear Weapons," *Washington Post*, February 20, 2003, p. A9; and Walter Pincus, "Pentagon Pursues Nuclear Earth Penetrator," *Washington Post*, March 7, 2003, p. A25.

[76]Los Alamos National Laboratory will modify the B61, and Lawrence Livermore National Laboratory will work with the B83. See Linton F. Brooks, Acting Administrator of the National Nuclear Security Administration, prepared statement before the Senate Armed Services Committee Strategic Subcommittee, April 8, 2003, p. 7, available at <http://www.senate.gov/~armed_services/statemnt/2003/April/Brooks.pdf>; Everet H. Beckner, Deputy Administrator for Defense Programs at the National Nuclear Security Administration, prepared statement before the Senate Armed Services Committee Strategic Subcommittee, April 8, 2003, pp. 3-4, available at <http://www.senate.gov/~armed_services/statemnt/2003/April/Beckner.pdf>; National Resources Defense Council Nuclear Notebook, "The B61 Family of Bombs," *Bulletin of the Atomic Scientists* (January/February 2003), pp. 74-76; and "Nuclear Posture Review Excerpts," p. 18.

[77]Stephen Younger suggested the utility of new nuclear weapons in that "a lower-yield nuclear weapon would have greater deterrence value for those leaders who believe the United States would not use larger strategic nuclear weapons." Andrew Koch, "USA Examines Options for 'Nuclear Package'," *Jane's Defence Weekly*, March 27, 2002, p. 3.

[78]Koch, "USA Examines Options for 'Nuclear Package'," p. 3. See also Stephen M. Younger, "Nuclear Weapons in the Twenty-First Century," Technical Report LAUR-00-2850, Los Alamos National Laboratory (June 2000).

[79]Interview with engineers.

[80]Interview with senior Air Force official.

[81]Robert Wall, "Improving ICBMs," *Aviation Week & Space Technology*, May 5, 2003, p. 41.

[82]Interview with engineers.

[83]Brig. Gen. Simon P. Worden and Lt. Col. Martin E. B. France, "Towards an Evolving Deterrence Strategy: Space and Information Dominance," *Comparative Strategy* 20, no. 5 (2001), pp. 453-66; and William M. Arkin, "The Last Word: One to Watch," *Bulletin of the Atomic Scientists* 55, no. 5 (September/October 1999), p. 72.

[84]Interview with senior Air Force official.

[85]The NPR noted: "Today's satellite constellation is not optimized for the current and developing mobile target challenge. Planned improvements to this constellation would provide the capability to rapidly and accurately locate and track mobile targets from the time they deploy from garrison until they return. Sensors with rapid revisit or dwell capability over deployment areas combined with automated exploitation sides are required to provide this capability." See "Nuclear Posture Review Excerpts," p. 18.

[86]Ellis, prepared statement before the Strategic Subcommittee of the Senate Armed Services Committee, March 20, 2002, p. 13. As Rear Admiral James M. Zortman, commander of the Naval Air Force Atlantic fleet, noted, "The thing we're lacking is the ability to generate the target [information] we need to employ precision." Quoted in Robert Wall, "Emerging Weapons Aim to Foil Hardest Targets," *Aviation Week & Space Technology*, October 21, 2002, p. 29.

[87]Bradley Graham, "Series of Breaks Speeded Air Force Attacks on Hussein Bunker," *Washington Post*, March 25, 2003, p. A12; and David A. Fulghum, "Opening Night in Baghdad," *Aviation Week & Space Technology*, April 7, 2003, pp. 24-25.

[88]Tony Capaccio, "U.S. Launched More than 50 'Time Sensitive' Strikes in Iraq," *Bloomberg.com*, April 14, 2003.

[89]Bombers values drawn from Keith B. Payne and John J. Kohout, III, ed., *The B-2 Bomber: Air Power for the 21st Century* (Lanham: University Press of America, 1995), p. 180. Ballistic missiles values drawn from Lennox, *Jane's Strategic Weapons Systems*, pp. 211-17; and John R. Harvey, "Regional Ballistic Missiles and Advanced Strike Aircraft: Comparing Military Effectiveness,"

International Security 17, no. 2 (1992), p. 44. Minuteman II value drawn from IISS, *The Military Balance, 1991-1992*, p. 221. Cruise missile value drawn from Dennis M. Gormley, *Dealing with the Threat of Cruise Missiles*, Adelphi Paper no. 339 (London: International Institute for Strategic Studies, 2001), p. 100; “Tomahawk Cruise Missile,” available at <http://www.chinfo.navy.mil/navpalib/factfile/missiles/wep-toma.html>; and “AGM-86C/D Conventional Air Launched Cruise Missile,” available at <http://www.fas.org/man/dod-101/sys/smart/agm-86c.htm>.

[90]Payne and Kohout, *The B-2 Bomber*, p. 180.

[91]Bomber ranges drawn from “Air Force Facts Sheets,” available at <http://www.af.mil/news/indexpages/fs_index.shtml> and <http://www.cnn.com/interactive/us/0109/deployment/content3.html>. Tactical aircraft ranges drawn from “USAF Almanac,” *Air Force Magazine* 86, no. 5 (March 2003), pp. 163-64; and “Navy Fact Sheets,” available at <http://www.chinfo.navy.mil/navpalib/factfile/aircraft/air-fa18.html>. Ballistic missile ranges drawn from Lennox, *Jane’s Strategic Weapons Systems*, pp. 211-17. Minuteman II range drawn from “USAF Almanac,” *Air Force Magazine*, pp. 175-76. Cruise missile ranges drawn from Timothy M. Laur and Steven L. Llanso, *Encyclopedia of Modern U.S. Military Weapons* (New York: Berkeley Books, 1995), p. 284; and “Cruise Missile,” *The Columbia Encyclopedia*, 6th ed. (New York: Columbia University Press, 2001), available at <http://www.bartleby.com/65/cr/cruisemi.html>.

[92]JDAM accuracy drawn from “Joint Direct Attack Munitions GBU 31/32,” available at <http://www.af.mil/factsheets/factsheet.asp?fsID=108. During operational testing in 1998 and 1999, 450 JDAMs were dropped with a 95 percent system reliability achieving an accuracy of 9.6 m. Ballistic missile accuracy drawn from Duncan Lennox, ed., *Jane’s Strategic Weapons Systems*, no. 36 (January 2002), pp. 211-17. CALCM accuracy drawn from “AGM-86C/D Conventional Air Launched Cruise Missile,” available at <http://www.fas.org/man/dod-101/sys/smart/agm-86c.htm>.

[93]For more information about the characteristics of cruise missiles see, Gormley, *Dealing with the Threat of Cruise Missiles*; National Air Intelligence Center, *Ballistic and Cruise Missile Threat*; “Tomahawk Cruise Missile,” available at <http://www.chinfo.navy.mil/navpalib/factfile/missiles/wep-toma.html>; and “BGM-109 Tomahawk,” available at <http://www.fas.org/man/dod101/sys/smart/bgm-109.htm>.

[94]The Guidance Control Unit provides accurate guidance in both GPS-aided Inertial Navigation Systems (INS) modes of operation to 13 m CEP, and the INS-only modes of operation to 30 m. CEP. See “Joint Direct Attack Munitions GBU-31/32,” available at <http://www.af.mil/factsheets/factsheet.asp?fsID=108>.

[95]In one Scud hunting episode during Iraqi Freedom, the Scud was not at the coordinates provided, but the crew was able to locate it visually nearby and subsequently destroy it. David A. Fulghum, “Scud Busting a Success,” *Aviation Week & Space Technology*, April 7, 2003, p. 27.

[96]However, as seen during the Scud Hunts of the Gulf War, operational countermeasures can degrade air power’s effectiveness. For instance, 81 percent or seventy-one of all Scuds launches were done in darkness. *Gulf War Air Power Survey, Vol. IV, Pt. I*, pp. 279, 283, 292.

[97]Col. Gary L. Crowder, “Briefing Effects based Operations,” March 19, 2003, available at <http://www.defenselink.mil/news/Mar2003/t03202003_t0319effects.html>.

[98]See Ellis, prepared statement before the Senate Armed Services Committee Strategic Subcommittee, April 8, 2003, p. 8; Rowan Scarborough, “Special Ops Steal Show As Successes Mount in Iraq,” *Washington Times*, April 7, 2003, p. A1; and Thom Shanker and Eric Schmitt, “Covert Units Conduct an Invisible Campaign,” *New York Times*, April 6, 2003.

[99]*Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Reduction and Limitation of Strategic Offensive Arms*, hereafter referred to as START, available at <http://www.state.gov/t/ac/trt/10423.htm>.

[100]Although the Air Force has removed the Minuteman II from service, it has not fulfilled START requirements to “retire” it. Consequently, Minuteman IIs are now non-deployed ICBMs which could be deployed as START existing ICBMs. START Article II(1).

[101]START Article III(5).

[102]START Article IV.

[103]START Articles IV(4)(b) and V(14).

[104]START Articles IV(1)(d) and IV(4).

[105]START Articles IV(1)(d) and IV(2)(d). U.S. declaration of fifteen confirmed with DoD.

[106]START Article V(8) and *Annex, Terms and Definitions,* hereafter referred to as *Definitions*, Definition #109. It is possible to convert SLBMs into ICBMs, thereby launching deployed SLBMs from land. However, this would be very complicated, the resultant SL/ICBMs would likely be double counted for START purposes and new silo launchers would have to be designed for these missiles.

[107]START Article V(28). The authoritative *Article-by-Article Analysis* of the START Treaty defines U.S. national territory as including “Guam, Puerto Rico, American Samoa and the Virgin Islands, in addition to the territory of the fifty states and the District of Columbia.”

[108]START Articles V(3) and V(9).

[109]The construction of such silos could leverage existing plans and forego the cost of new designs. However, new conventional ICBM silos may not require the same level of hardness, and new less hardened designs could be relatively cheaper.

[110]If it were decided to deploy ICBMs at Vandenburg AFB, CA, a logical choice, there is one complication to consider. The United States has declared parts of Vandenburg as START space launch facilities (see definition #104). START Article IV(11)(c) requires ICBM bases to be located no less than 100 km from space launch facilities. If this option is of interest, it would have to be determined if suitable parts of Vandenburg AFB are more than 100 km from the declared space launch facility.

[111]START Article XI.

[112]START Article X and *Protocol on Telemetric Information Relating to the Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Reduction of Strategic Offensive Arms,* Article III.

[113]START Article VIII(3)(f), *Protocol on Notifications Relating to the Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Reduction and Limitation of Strategic Offensive Arms*, Article VI(1); and *Agreement Between the United States of America and the Union of Soviet Socialist Republics on Notifications of Launches of Intercontinental Ballistic Missiles and Submarine-Launched Ballistic Missiles*, Article I. See also the authoritative *Article-by-Article Analysis* of the Notifications Protocol submitted to the U.S. Senate at the time of ratification, which underscores that "all launches of START accountable ICBMs and SLBMs, regardless of the purpose or intent of the launch, must be notified."

[114]START *Definitions* #121.

[115]For a discussion see David E. Mosher, et al., *Beyond the Nuclear Shadow: A Phased Approach for Improving Nuclear Safety and U.S-Russian Relations,* RAND, 2003, available at <http://www.rand.org/publications/MR/MR1666/. Although many of the authors' recommendations are of doubtful value (in some case potentially counterproductive), the idea of joint early warning was broached during the early 1990s in bilateral discussions and could be productively rejoined with sufficient executive support from both Presidents.

[116]START, *Protocol on Inspections and Continuous Monitoring Activities Relating to the Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Reduction and Limitation of Strategic Offensive Arms,* Article VII(5).

[117]*Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Elimination of Their Intermediate-Range and Shorter-Range Missiles,* Articles I and II, available at <http://www.state.gov/t/np/trty/18432.htm>.

[118]START Article V(18)(a).

[119]Wesley Frank Craven and James Lea Cate, eds., *The Army Air Forces in World War II, Vol. III* (Chicago, IL: University of Chicago Press, 1951, new imprint by the Office of Air Force History, 1983), pp. 84-106, 525-46; and Adam L. Gruen, *Preemptive Defense: Allied Air Power Versus Hitler's V-Weapons, 1943-1945* (Washington, D.C.: Air Force History and Museums Program, 1998).

[120]Stanley, Victory, and Payne, *Defense Against Ballistic Missile Threats*, p. 13.

[121]"Atlas II Launch Vehicle," available at <http://www.au.af.mil/au/awc/awcgate/afspc-fs/atlas2.htm>; and "SM-65 Atlas," available at <http://www.fas.org/nuke/guide/usa/icbm/sm-65.htm>.

[122]"Titan II," available at <http://www.au.af.mil/au/awc/awcgate/afspc-fs/titan2.htm>; and "SM-68B Titan II," available at <http://www.fas.org/nuke/guide/usa/icbm/sm-68b.htm>.

[123]"LGM-30 Minuteman III," available at <http://www.af.mil/factsheets/factsheet.asp?fsID=113; and LGM-30 Minuteman III," available at <http://www.fas.org/nuke/guide/usa/icbm/lgm-30_3.htm>.

[124]"LG-118A Peacekeeper," available at <http://www.af.mil/factsheets/factsheet.asp?fsID=112>.

[125]"Nuclear Posture Review Excerpts," p. 14; and Ellis, prepared statement before the Senate Armed Services Committee Strategic Subcommittee, March 20, 2002, p. 5.

[126]"Polaris A-3," available at <http://www.fas.org/nuke/guide/usa/slbm/a-3.htm>; and "Lockheed UGM-27 Polaris," available at <http://www.designation-systems.net/dusrm/m-27.html>.

[127]"Poseidon C-3," available at <http://www.fas.org/nuke/guide/usa/slbm/c-3.htm>.

[128]"Trident Fleet Ballistic Missile," available at <http://www.chinfo.navy.mil/navpalib/factfile/missiles/wep-d5.html>.

[129]"History of the Jupiter Missile System," available at <http://www.redstone.army.mil/history/systems/jupiter/chapter1.html>.

[130]"The Pershing Weapon System and its Elimination," available at <http://www.redstone.army.mil/history/systems/pershing/welcome.html>; and "Pershing II Fact Sheet," available at <http://spaceline.org/rocketsum/pershing-II.html>.

[131]Freedman, *The Evolution of Nuclear Strategy*, p. 416; and Seyom Brown, *The Faces of Power: United States Foreign Policy from Truman to Clinton*, 2nd. ed. (New York: Columbia University Press, 1994), pp. 496-98.

[132]"Corporal," available at <http://www.redstone.army.mil/history/systems/corporal/welcome.html>.

[133]"Honest John," available at <http://www.redstone.army.mil/history/systems/HONEST_JOHN.html>.

[134]"Sergeant," available at <http://www.redstone.army.mil/history/systems/sergeant.html>.

[135]"Lance," available at <http://www.redstone.army.mil/history/lance/welcome.html>.

[136]"Army TACMS," available at <http://www.redstone.army.mil/history/systems/ARMYTACMS.html>.

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Payne, Keith B. (study director) et al., *Rationale and Requirements for U.S. Nuclear Forces, Vol. I, Executive Report,* (Fairfax, VA: National Institute for Public Policy, January 2001).

Payne, Keith B. (study director) et al., *Rationale and Requirements for U.S. Nuclear Forces, Vol. II, Foundation Report* (Fairfax, VA: National Institute for Public Policy, January 2001).

Bailey, Kathleen C., *Comprehensive Test Ban: The Worst Arms Control Treaty Ever* (Fairfax, VA: National Institute for Public Policy, September 1999).

Thatcher, Lady Margaret, et. al., *Conference Proceedings, Ballistic Missile Defense: New Requirements for a New Century* (Fairfax, VA: National Institute for Public Policy, December 1998).

Payne, Keith B., *Post-Cold War Requirements for U.S. Nuclear Deterrence Policy* (Fairfax, VA: National Institute for Public Policy, March 1998).

Payne, Keith B., *The Case Against Nuclear Abolition And For Nuclear Deterrence* (Fairfax, VA: National Institute for Public Policy, December 1997).

Odom, LTG William E., *Modernizing Intelligence: Structure and Change for the 21st Century* (Fairfax, VA: National Institute for Public Policy, September 1997).

Kortunov, Andrei and Keith B. Payne et. al., *"Cold Peace" or Cooperation? The Potential for U.S.-Russian Accommodation on Missile Defense and the ABM Treaty* (Fairfax, VA: National Institute for Public Policy, 1997).

Guthe, Kurt, *A Precisely Guided Analytic Bomb: The Defense Department's Heavy Bomber Force Study* (Fairfax, VA: National Institute for Public Policy, September 1996).

Ranger, Robin, *Theater Missile Defenses: Lessons from British Experiences with Air and Missile Defenses* (Fairfax, VA: National Institute for Public Policy, March 1994).

Abrahamson, James A., and Henry F. Cooper, *What Did We Get For Our $30-Billion Investment in SDI/BMD?* (Fairfax, VA: National Institute for Public Policy, September 1993).