# CHAPTER 11

# Deterrence, the Triad, and Dyads

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On November 15, 1960, U.S.S. *George Washington* left Charleston harbor for the first operational patrol by a nuclear-powered ballistic missile submarine (SSBN). Before then, the U.S. strategic nuclear force comprised two elements: a large fleet of long- and medium-range bombers and a small but growing number of land-based intercontinental ballistic missiles (ICBMs). In the 50 years since, the United States has maintained a mix of long-range bombers, ICBMs, and ballistic missile submarines. Today this triad is made up of 76 B-52H and 18 B-2 bombers, 450 silo-based Minuteman III ICBMs, and 14 Trident SSBNs that each can carry 24 D5 submarine-launched ballistic missiles (SLBMs). Continuation of the triad is called for by the 2010 Nuclear Posture Review, a review led by the Defense Department and approved by President Obama, that sets U.S. nuclear policy, strategy, and forces for the next five to 10 years.[1]

Though venerable, the triad is not immutable. It is not the product of a grand blueprint worked out at the start of the nuclear era, but emerged during the 1950s and 1960s from the interplay of technological developments, inter-service competition, and international events. Its size, composition, and capabilities all have changed significantly over the decades. In that time, its very necessity periodically has been called into question by proposals to dispense with one or perhaps two of the three legs. Some have argued the vulnerability of bombers to air defenses, or ICBMs to counter-silo attacks, warrants the elimination of one or both legs. Others have claimed the triad is unnecessarily redundant and could be reduced by one or two legs to achieve costs savings without diminishing the deterrence of attack. Both the 2010 Nuclear Posture Review and a similar review in 1994 considered, but ultimately rejected, options to move away from the triad.[2]

At some future point, reductions in the U.S. strategic nuclear force could make preservation of the triad difficult. The latest U.S.-Russian

Strategic Arms Reduction Treaty (New START) is unlikely to cause serious problems in this regard. The treaty sets a limit of 700 on deployed strategic delivery vehicles (SDVs)—a category that encompasses SLBMs, ICBMs, and bombers—as well as a combined limit of 800 on deployed and non-deployed SDVs.[3] The United States currently has somewhat fewer than 900 deployed delivery vehicles.[4] Under New START, it plans to retain a triad of up to 60 bombers, up to 420 ICBMs, and 14 ballistic missile submarines with a total of no more 240 missiles, all carrying an aggregate of 1,550 treaty-accountable warheads.[5] If, however, further reductions led to a force level closer to 500 SDVs, maintaining a cost-effective triad would become a greater challenge.[6]

There is, then, reason to examine again alternative strategic nuclear force configurations with fewer than three legs. Any plausible option would retain ballistic missile submarines, which offer the valuable combination of high survivability against attack (better than that of silo-based ICBMs and bombers) and the lethality to neutralize a wide variety of targets (comparable to that of ICBMs and generally better than that of bombers). Not surprisingly, Trident submarines currently carry more than half of U.S. operationally deployed strategic nuclear warheads.[7] At the same time, a force of only ballistic missile submarines would have significant limitations, including the lack of a hedge against advances in the antisubmarine warfare or ballistic missile defense capabilities of hostile powers. Consequently, a dyad composed of submarines paired with either bombers or ICBMs would be the more likely alternative to the triad.

The move from the triad to a dyad would have important implications for nuclear policy, strategy, plans, programs, and budgets. Given the chief purpose of the strategic nuclear force is to discourage major aggression against the United States and its allies, a critical question would be how the shift to a dyad might affect deterrence. Deterrence, of course, is not simply a matter of a particular military balance, force structure, or weapons system, but greatly depends on the specific political-military setting in which a confrontation occurs, the characteristics of the adversary (such as motives, beliefs, perceptions, and decision-making process), and the ways in which the adversary and the United States interact.[8] The complexity of deterrence as well as the likelihood of wild cards (miscalculation, misperception, inadvertence, and chance) preclude

sure predictions about the deterrent effect of a dyad, triad, or other force configuration. Nonetheless, the central deterrent role assigned to the strategic nuclear force would necessitate some judgments about the consequences a dyad might have for deterrence.

The following discussion looks at possible effects on deterrence of a change from the present strategic nuclear triad to a dyad of either SSBNs and bombers or SSBNs and ICBMs. First, the appropriate time frame and prospective security environment germane to such an assessment are considered. Second, force qualities conducive to deterrence are defined. Third, the triad legs and the triad as a whole are evaluated against those force qualities. Finally, the two dyad options are examined in terms of the deterrence-related force qualities and possible offsets for the loss of either the ICBM or bomber leg are suggested.

## Strategic Context

While the long view is always useful in defense planning, it is particularly important in charting the future of the U.S. strategic nuclear force. A new bomber, missile, or submarine can take 10 to 20 years to design, develop, and build, and still more years to deploy in full. The planned follow-on to the Trident submarine, for example, will not become operational until 2028 and will not completely replace the Trident fleet until 2040.[9] Like Trident submarines, other strategic nuclear weapons systems also are expected to remain in service for another 20 or 30 years. Current plans call for existing SLBMs, ICBMs, bombers, and bomber-delivered air-launched cruise missiles (ALCM-Bs) to be maintained and upgraded in the coming years, but not replaced before 2030 (for ICBMs and ALCM-Bs) or 2040 (for SLBMs and bombers).[10] Similarly, there are programs to extend the service lives of missile warheads and gravity bombs already in the strategic nuclear arsenal, but no plans—or capacity—to produce new weapons.[11] The lengthy acquisition cycles and long service lives for U.S. strategic nuclear arms mean any dyad alternative should be suited to the security challenges of 2030 or 2040, and not only those of 2010, 2015, or 2020 (the time horizon of the latest Nuclear Posture Review).

Obviously, much can change over two or three decades. Simply recall some of the major international developments that have affected U.S. and allied security in the last 30 years: the end of the Cold War; the rise of China; wars in the Balkans, Iraq, and Afghanistan; the spread of weapons of mass destruction (WMD); repeated confrontations with North Korea and Iran; and the emergence of Islamic terrorism. Few of these developments were foreseen.

The next 30 years could bring changes of similar consequence, perhaps unexpectedly. For example, efforts by Moscow to reestablish its sphere of influence over former Soviet republics and ex-satellites in Europe—most of which are now NATO members—could fuel renewed military rivalry with the United States. The reliance Russia places on its nuclear forces could give any confrontation a distinct nuclear cast. Likewise, competition between China and the United States in the Asia-Pacific region could lead to conflict, notably over the status of Taiwan. Nuclear threats or use in such a conflict are conceivable, especially in light of Chinese anti-access and area-denial capabilities that diminish U.S. conventional force advantages, and growth in the size and sophistication of Chinese nuclear forces that can strike U.S. forward deployments and the United States itself. In addition, U.S. allies in Northeast Asia and the Mideast could fall prey to future aggression by North Korea or Iran, respectively, including intimidation or attacks involving WMD. Within the next decade, both countries also could deploy nuclear-armed ballistic missiles capable of hitting the United States.[12]

In each of the foregoing cases, as well as others, the U.S. strategic nuclear force would have a deterrent role. That force, whether a triad or dyad, would need considerable flexibility to deal with the diversity of potential adversaries and conflicts. It also would require the adaptability to respond to political-military changes of the sort sketched above, as well as technical difficulties, operational challenges, and technological surprises. Flexibility, adaptability, and other force traits that aid deterrence are addressed below.

## Deterrence-Related Force Qualities

Deterrence prevents armed attack or coercion by threatening the would-be aggressor with unacceptable military counteraction.[13] The threatened counteraction could take the form of retaliation that imposes costs greater than the expected gains of aggression (deterrence by punishment) or a response that makes those gains too difficult to achieve (deterrence by denial).[14] Deterrent strategies often are a mix of both punitive and denial threats.

The deterrent value of the U.S. strategic nuclear force for a given crisis or conflict would be determined to a great extent by the beliefs of the adversary regarding whether, how, and with what consequence that force might be used. Deterrence would be weakened if enemy leaders believed they could escape unacceptable counteraction by destroying large numbers of U.S. missiles and bombers before launch or by protecting themselves and other vital elements of their state through active and passive defenses.[15]

Deterrence also would suffer if opponents calculated that counteraction by the United States would be inhibited by the fears U.S. leaders had regarding the dangers of uncontrolled nuclear escalation, the possibility of causing high enemy civilian casualties, or the prospect of nuclear retaliatory damage to the United States that outweighed the reasons for entering or continuing a conflict. To provide a credible deterrent, the U.S. strategic nuclear force overall must have qualities that would disabuse an adversary of such beliefs and promise counteraction that would be certain, effective, and appropriate to the act of aggression.

Those qualities are *survivability*, *lethality*, *flexibility*, *visibility*, and *adaptability*. The first three are needed to pose credible deterrent threats for a range of contingencies, including those in which the strategic nuclear force must withstand a first strike. Visibility refers to shows of force used to amplify deterrent threats in times of crisis. And force adaptability is the quality that maintains the effectiveness of deterrent threats under changing political, military, and technological conditions.

**Survivability**

A significant portion of the strategic nuclear force must be manifestly capable of surviving enemy attacks on operating bases and missile silos, operations against ballistic missile submarines at sea, and defenses for intercepting bombers and missiles. Force survivability helps frustrate enemy plans (deterrence by denial) and enables retaliatory strikes (deterrence by punishment). It also permits forces to be used in a deliberate, rather than a precipitate, manner, which contributes to flexibility. Were the United States to face a world of multiple nuclear competitors, the strategic nuclear force might require the capability to survive war with one antagonist and remain sufficiently intact, or able to reconstitute, to deter subsequent aggression by another.

For the foreseeable future, concerns about the survivability of the bases and silos of the U.S. strategic nuclear force are likely to be greatest with regard to possible nuclear-prone conflicts with Russia, a nuclear peer, or perhaps with China, which may aspire to that status. Ongoing improvements in Russian and Chinese air defenses and the proliferation of advanced air defense systems to other potential adversaries would make penetration of enemy airspace more difficult for U.S. bombers and cruise missiles. Improvements in the antisubmarine warfare and ballistic missile defense capabilities of opponents also would adversely affect force survivability, although such changes are harder to predict. New problems for the survivability of U.S. forces would arise if potent long-range, precision-guided *non*nuclear strike systems were to appear in the arsenal of a major nuclear-armed adversary.

In the Cold War, nearly 100 percent of ICBMs, 60 to 65 percent of SSBNs, and 33 to 50 percent of bombers were maintained on peacetime alert as insurance against the remote possibility of a Soviet surprise first strike. After the Cold War ended, U.S. bombers were taken off alert, but the alert rates for ICBMs and SLBMs stayed roughly the same.[16] In the future, some parts of the strategic nuclear force should be kept on peacetime alert, though not because the threat of surprise attack will be any less remote. Rather, forces on alert are a quiet reminder of the readiness of the United States, *in extremis*, to act in defense of its security and that of its allies. They also hedge against the possibility that those in authority might be reluctant to increase alert rates during a crisis, because

strategic warning was ambiguous, or because a higher alert level was deemed too provocative and likely to deepen the confrontation.

**Lethality**

Lethality is the ability to hold at risk and, in the event of conflict, destroy or sufficiently damage designated targets. Deterrence by threat of punishment entails holding at risk those things highly valued by adversary leaders, the individuals who would make decisions regarding peace or war. For the potential confrontations likely to involve the U.S. strategic nuclear force, adversary leaders would head authoritarian regimes. Authoritarian leaders place high value on continued rule, which requires their own survival, as well as that of supporting cadres and instruments of political control (intelligence services, secret police, and certain military units). Related targets would include command posts and wartime relocation sites for ruling elites, facilities associated with security apparatuses, and communications links used by these groups.

Threats to destroy elements of enemy military power and defeat armed aggression would serve the purpose of deterrence by denial. Among the targets here might be WMD capabilities and conventional forces and their associated facilities. The ability to strike WMD targets offers the potential for limiting the damage from enemy attacks against U.S. and allied societies, which could reduce the prospective costs the United States would incur by countering aggression, and thereby strengthen the credibility of U.S. deterrent threats. The same would be true of active and passive defenses. Threats directed against defense-industrial, transportation, communications, and electrical power targets could be a means of deterrence by punishment (promising to make the adversary pay a steep economic price for an attack) or deterrence by denial (confronting the adversary with the likelihood U.S. retaliatory strikes would impede the conduct, sustainment, and success of enemy military operations).

To hold at risk the diverse targets related to deterrence, some or all elements of the strategic nuclear force require certain characteristics. One is intercontinental range, which allows strategic delivery vehicles to reach targets throughout Eurasia, where potential opponents are located.

Another is prompt weapons delivery for striking time-sensitive targets, such as missile launchers ready to fire, command-and-control centers with responsibilities for WMD use, and forces preparing to leave their bases.

A third is high accuracy for attacking point targets, like missile silos; this means weapon delivery with a circular error probable of a few hundred feet.[17] Pending future progress in sensors, data-processing systems, and munitions, only bombers with their onboard crews are likely to have the capability for accurate weapon delivery against mobile missile launchers and other targets on the move.

A fourth attribute is weapons of suitable explosive yield. High-yield weapons (yields of a few hundred kilotons), combined with high accuracy, have the destructive potential for dealing with targets hardened against attack through the use of steel-reinforced concrete or underground construction; missile silos and underground bunkers are examples. Some types of hard and deeply buried facilities, including command bunkers for key leaders, can only be destroyed by earth-penetrating weapons.

Finally, high reliability is necessary to avoid bomber or missile aborts and ensure weapons detonate at their specified yields.

Of course, conventionally armed delivery vehicles, particularly those with precision-guided weapons, also can threaten a wide range of targets. Current nonnuclear strike capabilities, however, have limitations as substitutes for nuclear arms. Against certain targets—deeply buried facilities, for example—conventional weapons would be ineffective or less effective in comparison with the destructive power of nuclear weapons. Enemy countermeasures that impeded precision delivery of conventional munitions could render those weapons incapable of destroying or damaging assigned targets. Multiple aircraft sorties or missiles strikes conducted over some period of time might be necessary to deliver enough conventional munitions to neutralize a single target. In conflicts in which targets must be eliminated with dispatch, economy of force, and lasting effect, nuclear weapons may be preferred.

While the bombers of the nuclear triad also can deliver conventional weapons, other nonnuclear strike capabilities lack the intercontinental range of the strategic nuclear force. (This would change if planned research and development work on “a conventional, global strike capability” were to yield an operational system.)[18] Perhaps most

important, the widespread, rapid, and sure destruction promised by nuclear weapons has an intangible, but nonetheless real, deterrent effect on national leaders that threats posed by conventional bombs and missiles, no matter how lethal, cannot duplicate. The threat of nuclear use would greatly complicate the plans of would-be aggressors, making victory seem doubtful, if not impossible.[19]

**Flexibility**

The strategic nuclear force requires the flexibility to carry out strikes of varying scope, scale, and intensity, depending on the nature of the adversary and the type and level of aggression. Holding at risk certain kinds of targets might deter an adversary with one set of values, but not another with a different set. A disproportionate deterrent threat of large-scale retaliation for a lesser provocation might be discounted by an opponent. A threat to destroy enemy population centers might seem less than credible if U.S. cities were vulnerable to enemy reciprocal attacks. A threat to defeat offensive military operations might ring hollow unless backed with the requisite capabilities to strike opposing WMD-armed forces. An inability to limit damage and control escalation through constrained attacks on those forces could inhibit a U.S. military response to acts of aggression against allies, and thus weaken deterrent threats made on their behalf.

For these and other reasons, the strategic nuclear force must be capable of supporting a variety of attack options suited for assorted combinations of opponents and contingencies. This includes force elements that can target the mainstays of a hostile regime and its ability to project power, execute large or limited attacks, minimize unintended civilian damage, and conduct strikes quickly (against time-sensitive targets, for example) or at a slower pace if demanded by the character of the conflict and the direction of the command authorities. As these requirements suggest, both survivability and lethality are prerequisites for flexibility.

**Visibility**

Increases in the readiness levels and changes in the deployments of military forces long have been used to deter war. These measures also can help prepare for conflict or support coercive efforts aimed at compelling an adversary to do something rather than, as in the case of deterrence, not to do something. In the pre-nuclear era, European powers often employed their forces, especially naval forces, in armed demonstrations to deter or coerce opponents.[20] During the Cold War, the United States frequently used its armed forces to affect foreign perceptions and secure political objectives in confrontations short of war.[21]

In a number of Cold War confrontations, the alert level or deployment of the U.S. strategic nuclear force was changed for deterrent purposes. These included the 1948 and 1961 Berlin crises, the 1956 Suez crisis, the 1958 Taiwan Strait and Lebanese crises, the 1962 Cuban missile crisis, and the 1973 Arab-Israeli war.[22] In the last case, the United States was intent on deterring the Soviet Union from unilaterally sending forces to the Mideast. U.S. diplomatic moves to dissuade the Soviets from intervening were deliberately reinforced by an increase in the defense readiness condition of all military commands. Strategic Air Command assumed a heightened alert for a time and had bombers and aerial tankers ready for immediate takeoff. Fifty to 60 B-52s were brought back to the United States from Guam, where they had been based for conventional bombing missions in Southeast Asia. Their return, according to then-Secretary of State Henry Kissinger, was intended to "give the Soviets another indication that we were assembling our forces for a showdown."[23] Besides the increase in bomber readiness, the ICBM force went to a somewhat higher footing and a few more ballistic missile submarines put to sea.

In future circumstances, perhaps a severe crisis in which U.S. vital interests were endangered by a major nuclear power, the United States again might find reason to underscore the deterrent threat posed by its strategic nuclear force. Taking steps to gird the force for conflict can aid deterrence by making clear to the adversary the gravity with which the United States views its stakes in a confrontation and its determination and wherewithal to defend them. To have this effect, however, the steps must

be visible to the adversary. A show of force must show force. This was true in all of the examples cited above. And in those crises, bombers put on most of the show.

In one or more cases, bombers increased ground-alert activities at air bases, conducted airborne alert missions, dispersed to alternate airfields, deployed to locations abroad, or flew close to enemy airspace. All of these actions were detectable by the opponent. Moreover, U.S. decision-makers wanted these actions to be detected. Bomber alerts and redeployments, then, exemplify the quality of visibility that contributes to deterrence.

The other two legs of the triad have inherent disadvantages in this regard. The stationary nature of silo-based ICBMs limits, without entirely excluding, displays of force. Ballistic missile submarines, part of the silent service, depend on stealth for their survivability, although they, too, might have a role in lending visibility to deterrent threats. It is also worth noting that any future bomber alert would attract more notice in foreign capitals simply because all bombers have been off alert for nearly 20 years, whereas at the same time almost all ICBMs and a large fraction of the ballistic missile submarine fleet have been maintained at a high state of alert.

**Adaptability**

Adaptability is the quality with which the strategic nuclear force can retain or regain its deterrent effectiveness despite adverse political, military, or technical developments. Unfavorable developments in the future could include a sharp deterioration in relations with Russia or China that spurred military competition with one or both countries, a serious violation of a nuclear arms agreement, a defect in a bomb or missile warhead, a significant problem (structural, mechanical, or electronic) with a delivery vehicle, or a serious decrease in the expected operational effectiveness of a force element brought about by improvement in opposing offensive or defense capabilities.

The strategic nuclear force can be adaptable in three ways. First, it can adapt through a force posture (deployed force, weapons stockpile, and readiness level) that has inherent resilience to meet new challenges without remedial changes. The diversity of delivery vehicles, weapons,

and deployment modes found in the triad, for example, affords the current force a large measure of adaptability.

Second, the adaptation can be done through modifications of the force posture that respond to the dangers and difficulties that emerge. Alert rates might be increased, additional weapons uploaded on delivery vehicles, bombers dispersed or redeployed, different tactics adopted to offset improved enemy offenses or defenses, and tasks reallocated among force elements if one leg experienced problems.

And third, the force mix can adapt through retrofits of deployed systems (with upgraded electronics, modified weapons, and other hardware fixes) or, over the longer run, the addition of next-generation missiles, aircraft, submarines, and weapons. The lack of warm production lines for strategic nuclear weapons systems, however, means the adaptability of the current triad or a future dyad would depend primarily on the resilience and modification of the force posture, and the improvement of existing capabilities, rather than the manufacture of next-generation delivery vehicles and weapons.[24]

Before examining how an SSBN-bomber or SSBN-ICBM dyad would rate when judged against the force qualities related to deterrence, some key attributes of the three strategic nuclear force elements need to be understood. Familiarity with the deterrent advantages of the triad also is useful, since this force configuration offers a standard against which dyad alternatives can be compared.

## Attributes of Strategic Nuclear Force Elements and the Triad

Outlined below are the characteristics of ballistic missile submarines, ICBMs, and bombers, as well as the triad overall, relevant to the force qualities that support deterrence.

### Ballistic Missile Submarines

The 14 Trident submarines in the fleet operate from two bases, with eight at Bangor, Washington and six at Kings Bay, Georgia.[25] A number of submarines are in port at any given time, and of those, two

usually are undergoing long-term overhauls and thus unable to leave port even in a crisis. Several submarines are on patrol. Although a typical patrol lasts 60 to 90 days, some have exceeded 100 days. Resupply could extend time at sea. The Navy conducts exercises for the resupply and repair of Trident submarines at alternative ports in the Pacific and the Atlantic.[26]

Each Trident submarine has launch tubes for 24 D5 missiles, each missile capable of delivering multiple independently targetable reentry vehicles (MIRVs). Current plans call for the number of SLBM launch tubes per submarine to be reduced to 20, with no more than 240 SLBMs deployed in the fleet at any time.[27] Each D5 SLBM can carry up to 12 Mk-4 reentry vehicles (RVs) with W76 warheads or 8 Mk-5 RVs with W88 warheads.[28] The average number of reentry vehicles per missile is likely four.[29] W76 warheads represent the majority of those carried by SLBMs.[30] Although the W88 and W76 both have high yields, the yield of the W88 is significantly greater than that of the W76. Both warheads can be delivered with high accuracy by the D5 SLBM. The D5 missile has a range that exceeds 4,000 nautical miles (nm).[31] SLBMs can reach their targets in 30 minutes or less, depending on target location, the launch position of the submarine, and the trajectory of the missile.

**ICBMs**

The Minuteman III force currently has 450 silo-based ICBMs located at Air Force bases in Wyoming, Montana, and North Dakota. Each of the three bases has 150 missiles.[32] The alert rate of the force is "near 100 percent."[33] Minuteman III ICBMs initially were deployed with three reentry vehicles each, but now carry one, two, or three RVs.[34] In the future, no more than 420 missiles will be deployed and all will be equipped with only one reentry vehicle each.[35] The two types of weapons for the ICBM are the Mk-12A RV with the W78 warhead and the Mk-21 RV with the W87 warhead.[36] Both warheads are high yield and can be delivered with relatively high accuracy. The range of the Minuteman III is over 5,000 nm.[37] Time from launch to target would be roughly 30 minutes.

**Bombers**

Unlike SSBNs and ICBMs, bombers are dual-capable, with the ability carry out conventional as well as nuclear missions. Over the last two decades, bombers have been used extensively in the Kosovo, Iraq, and Afghanistan conflicts.[38] Of the 76 nuclear-capable B-52Hs, 44 are combat-coded, with the other bombers used for training, test, backup, and attrition reserve. Sixteen of the 18 nuclear-capable B-2s are combat-coded.[39] Under current plans, some B-52Hs will be converted to a conventional-only role and a smaller nuclear-capable fleet of up to 60 bombers will be retained, including all nuclear-capable B-2s.[40] The B-1B bomber, originally dual-capable, was removed from its nuclear role following the 1994 Nuclear Posture Review.[41]

The B-52Hs are split between two Air Force bases, Barksdale in Louisiana and Minot in North Dakota. The B-2s are located at a single base, Whiteman in Missouri.[42] The bomber force has not maintained a day-to-day alert status since 1991, but, if necessary, a portion of the force could placed on ground alert in a matter of days.[43]

The low-observable (stealth) features of the B-2 bomber aid it in penetrating opposing air defenses. This enables the aircraft to close on targets and deliver nuclear gravity bombs. The older B-52H bomber is more readily detected and thus is armed with long-range (1,300 nm) cruise missiles that can be launched from outside enemy air defense coverage.[44] The B-2 can carry up to 16 B61-7, B61-11, or B83 bombs. The B61-11 bomb, it should be noted, is the only earth-penetrating nuclear weapon in the U.S. inventory and is specifically designed for use against hard and deeply buried facilities.[45] The B-52H can be armed with up to 20 ALCM-Bs,[46] each cruise missile with a W80-1 warhead.[47] Bomber weapons provide a variety of explosive yields "from megaton to subkiloton."[48] Indeed, some of the weapon types can be employed with more than one yield. Gravity bombs can be delivered with high accuracy, while the guided ALCM-B can strike targets with even better "pinpoint accuracy."[49]

Bombers have longer intercontinental ranges than ballistic missiles—6,000 nm for the B-2 and 7,500 nm for the B-52H[50]—but their flight times are measured in hours rather than minutes.

## The Triad

In combination, SSBNs, ICBMs, and bombers make for a strategic nuclear force with diverse, advantageously redundant, and mutually reinforcing capabilities. While there are shared characteristics among the three force elements, each leg of the triad has a unique and useful set of attributes. Weaknesses in one leg are offset by strengths in others. Adjustments can be made within and among the legs as conditions change. The legs together make an enemy attack especially difficult. In the event of crisis or war, the three legs offer a range of possible military responses. Though elements of the strategic nuclear force in many ways could be improved, they nonetheless have important strengths with regard to survivability, lethality, flexibility, visibility, and adaptability.

### *Survivability*

Small in number and soft, SSBN and bomber bases are vulnerable to attack. Submarines in port and bombers not on alert would be easily destroyed by nuclear strikes and could suffer severe damage even in nonnuclear attacks. The harder and more numerous silos for ICBMs can be damaged or destroyed by high-accuracy, high-yield ballistic missile warheads, like those currently found in the Russian strategic nuclear force, but the need to expend two warheads per silo to ensure a high kill probability could make the price of such an attack prohibitive. The attack could be unprofitable as well, since many of the silos currently house Minuteman III missiles with only a single warhead, and all missiles will be single-warhead in the future.

Ballistic missile submarines on patrol are virtually undetectable, barring breakthroughs in antisubmarine warfare. In the aftermath of a nuclear conflict, surviving SSBNs could serve as a deterrent to opportunistic aggression as the United States sought to recover from the catastrophe.

SLBMs launched from submarines on patrol and ICBMs fired from silos that survived an attack would face, at worst, limited missile defenses. Because of the wide-ranging mobility of SSBNs, SLBMs could be launched from many different azimuths, complicating enemy plans.

The air defense threat confronting bombers would be greater, although the stealth of B-2s and the standoff missiles of B-52Hs would mitigate the danger. Bombers and cruise missiles also could be flown so as to attack an enemy from multiple directions, thereby stressing the opposing defenses, and to skirt parts of the defensive system. The combination of penetrating bombers and standoff bombers with cruise missiles can compel an adversary to develop and deploy not only perimeter air defenses, but also close-in defenses of high-value targets. This can complicate the attack planning of a would-be aggressor, impose costs on the adversary, dilute opposing defense efforts, and divert resources from enemy offensive forces.

Looking at the strategic nuclear force as a whole, the ballistic missile submarines on alert and the daunting number of aim points presented by silo-based ICBMs offset, at least partially, the vulnerability of submarine and bomber operating bases, individual missile silos, and unalerted bombers. Submarines and ICBMs on alert offer insurance against surprise due to lack of sufficient warning or lack of timely response. In the absence of effective enemy missile defenses, U.S. ballistic missiles once launched are likely to reach their targets, even if defense penetration by bombers and cruise missiles is more problematic. Any enemy seeking to eliminate U.S. retaliatory capabilities would be burdened within an exceedingly complex military challenge.

### *Lethality*

SLBMs, ICBMs, and bombers all have the intercontinental range to reach targets within the territory of any hostile power in Eurasia. Ballistic missiles could strike time-sensitive targets minutes after launch. Ballistic missiles, bombers, and cruise missiles all can deliver their nuclear weapons with high accuracy. Ballistic missiles have the accuracy/yield combinations to hold at risk most types of hard targets, including missile sites and command centers that would have to be struck quickly. High-confidence neutralization of many of these targets would require the use of more than one weapon. Bombers, with the necessary targeting updates, could attack mobile targets. The B-2 could deliver the B61-11 earth-

penetrating bomb against underground targets, although some hard and deeply buried facilities would be resistant even to its effects.[51]

Though not as great as in the past, the variety of delivery vehicles (D5, Minuteman III, B-52H, B-2, ALCM-B) and weapons (W76, W78, W80-1,W87, W88, B61, B83) is a hedge against problems with a vehicle or weapon type that could compromise operational effectiveness. Force diversity also allows high-priority targets to be covered by weapons from different triad legs (cross-targeting) in order to ensure their destruction. Thus, if a command bunker were slated to be hit by both a bomber-delivered weapon and an ICBM warhead, the loss of the ICBM warhead to an enemy counter-silo attack would not prevent the bunker from being hit.

This collection of capabilities within the triad gives the overall strategic nuclear force the ability to threaten a wide array of military, regime, and economic targets.

### *Flexibility*

Force elements of the triad have a number of characteristics suited for selective nuclear attacks. Bombers could be used for limited attacks, including the delivery of just one weapon against a single target. The low-yield options for bomber weapons would be useful in limiting unintended damage. Bombers could be routed to avoid overflight of sensitive areas, redirected in flight, or recalled from their missions. Bomber aircrews could assess damage inflicted by earlier attacks and carry out or refrain from follow-on strikes. Of course, bombers and cruise missiles would have to penetrate any air defenses protecting their designated targets, a task that might be especially difficult in a small attack, where, with advance warning, the enemy could concentrate defenses (airborne sensors, fighter-interceptors, and mobile surface-to-air missiles) to shield likely targets. Long flight times could limit the utility of bombers for selective strikes against time-sensitive targets.

Another force feature that offers flexibility is the single-warhead payload of many, and eventually all, Minuteman III ICBMs. While a ballistic missile with a MIRVed payload would have to deliver all of its warheads against multiple targets located within a certain elliptical area (or “footprint”), each single-warhead Minuteman III could be employed to hit just one target located at any point within a much larger area. Single-

warhead ICBMs could be used, for example, in limited attacks against a small number of targets, attack options put together quickly, or strikes against time-sensitive targets suddenly discovered by U.S. intelligence-gathering systems. Single-warhead ICBMs probably would be up against less effective defenses than those that bombers would confront in a limited attack. But their warheads would lack the low-yield options of bomber weapons. In some cases, overflight restrictions might exclude the use of ICBMs, though not the employment of bombers or SLBMs.

D5 SLBMs have the valuable ability to strike a wide range of targets, but their MIRVed payloads and high-yield W88 warheads could be disadvantageous for certain limited attack options. The high survivability of Trident submarines on patrol is one of the most important force characteristics that would enable the United States to respond in a deliberate and flexible manner to a large-scale nuclear attack on the homeland.

For flexibility, then, bombers offer low-yield weapon options and man-in-the-loop control, attributes ballistic missiles lack. A significant number of ballistic missiles, like bombers, can deliver a single weapon, but with greater speed. More survivable than bombers at their bases or ICBMs in silos, SSBNs on patrol would have greater flexibility for conducting strikes of different sorts (or withholding attacks) as a conflict evolved and the command authorities made changes in the strategic direction of U.S. operations.

***Visibility***

As the earlier discussion of this force quality suggests, bombers constitute the triad leg most likely to be used for shows of force to back deterrent threats. Any display now, however, would be less impressive, probably less intimidating, and perhaps less deterring than those of the past. In all but the last of the aforementioned crises in which the alert level or deployment of the strategic nuclear force was changed, bombers made up all or most of the force. In each of those dangerous episodes, the United States had hundreds of bombers, not the tens of aircraft in the inventory today. During the Cuban missile crisis, for example, more than 1,000 bombers were on alert, some 180 bombers were dispersed to roughly 30 civilian and military airfields, and the number of bombers just

on airborne alert—65—was larger than the total number of combat-coded aircraft in the current nuclear-capable bomber force.[52]

In addition, the effectiveness of a future nuclear show of force by bombers could be adversely affected by lack of alert experience during the last two decades. An Air Force report in 2008 found that "[w]ithin the next few years, the USAF will no longer have a pool of bomber wing commanders who have performed extended alert duty" and "due to limited aircraft nuclear generations, aircrews have little experience interacting with operational issues involved with bringing aircraft to nuclear alert status."[53]

It also should be noted that the training program to prepare for an airborne alert was canceled in 1993 because it had, in the words of an official history, "become anachronistic and, in [U.S. Strategic Command's] view, served little purpose."[54] Changes instituted by Air Force Global Strike Command could improve the preparedness of the bomber force for alert duty. This command, which is responsible for all ICBMs and nuclear-capable bombers, was established in 2009 to provide greater attention to the nuclear mission.[55]

### *Adaptability*

In the past, the triad has demonstrated considerable ability to adapt to unfavorable military and technical developments. For example, from the 1960s through the 1980s, the overall resilience of the triad allowed the United States to pursue a long series of remedies for deficiencies in the bomber leg caused by improvements in Soviet air defenses. During the 1970s and 1980s, the triad also afforded time to deal with the vulnerability of the ICBM force that arose from Soviet deployment of silo-busting missiles, although no fix was implemented before the Soviet Union disintegrated. And when significant problems with Polaris and Poseidon SLBM warheads emerged, the insurance provided by the ICBM and bomber legs permitted the required retrofits to be made without undue haste.[56]

Similar adjustments in the strategic nuclear force might be necessary in the future. If, for example, bomber vulnerability increases because of air defense advances, more reliance might be placed on

ballistic missiles, with additional warheads loaded on SLBMs. Some number of SLBM warheads also might be allocated for the suppression of enemy air defenses. If the W88 warhead were to experience a serious technical problem, additional W76 warheads might be deployed as replacements (despite their lesser capability against some classes of hard targets) until the problem was solved.

If, for various reasons, the strategic force required greater lethality, the guidance systems for ballistic missiles, bombers, and their weapons might be improved to increase delivery accuracies. And were the United States to find itself in a stepped-up nuclear arms competition with Russia or China, part of the bomber force again might be placed on ground alert and the number of ballistic missile submarines on alert might be increased.

In addition, warheads could be uploaded on bombers and missiles. Under the planned reductions in the strategic nuclear force, bombers, ICBMs, and SLBMs all will retain the capacity to carry more warheads than the number in their standard operational payloads. Some number of non-deployed warheads that could be uploaded will be kept in the nuclear weapons stockpile as a hedge against adverse technical, military, or international developments.[57] The bomber force could be uploaded in weeks, the SLBM force in months, and the ICBM force at a rate of one squadron (50 missiles) per missile wing (150 missiles) per year.[58] Note the availability of upload options could help in deterring opponents from breaking out of nuclear arms agreements or engaging in competitive nuclear buildups with the United States.

## Dyad Alternatives

For the reasons cited at the beginning of this discussion, the force qualities of survivability, lethality, flexibility, visibility, and adaptability support—but do not guarantee—the deterrence of major aggression. As detailed in the previous section, the assorted attributes of ballistic missile submarines, ICBMs, and bombers invest the current strategic nuclear triad with all of these deterrence-related qualities, although below ideal levels. If one triad leg and its capabilities were removed from the current strategic nuclear force, it is reasonable to assume the expected deterrent effectiveness of the force might diminish, unless adequate offsetting

measures were adopted. In comparison to the triad, what capabilities that support deterrence would be lost or reduced? The brief assessments below look at the deterrent effectiveness of SSBN-bomber and SSBN-ICBM dyads from this perspective. Given no new strategic nuclear weapons system is likely to be deployed for 20 years or more, next-generation bombers, missiles, and submarines are not among the offsetting measures considered here.

For the submarine-bomber dyad, it is assumed the current ICBM force would be eliminated entirely. This assumption is consistent with dyad proposals that claim the ICBM leg is superfluous, vulnerable, "destabilizing," and too costly to maintain and modernize. For the submarine-ICBM dyad, however, it is assumed bombers are removed from their nuclear role, but retained for nonnuclear missions. This assumption reflects both the significant utility bombers have demonstrated in conventional conflicts and the past precedent of removing the B-1B bomber from its nuclear role, but keeping it as a conventional strike aircraft.

## SSBN-Bomber Dyad (No ICBMs)

### *Survivability*

The absence of hundreds of silo-based ICBMs would make it less difficult for an adversary to plan an attack on the U.S. strategic nuclear force. All bombers not on alert and SSBNs not on patrol could be eliminated by an attack on just five main operating bases. SSBNs at sea would represent the main deterrent to a first strike. This deterrent could be strengthened by increasing the alert rate for the Trident submarine fleet. At the same time, if ballistic missile submarines on patrol were the only survivable element of the strategic nuclear force, hostile nuclear peers might devote greater effort to antisubmarine warfare. Maintaining part of the bomber force on alert and probably dispersed, at least during crises, would reduce prelaunch vulnerability, demonstrate that bombers could not be eliminated simply through attacks on their air bases, take some of the burden off the submarine force, and vex opponents with the problem of defending against air, as well as ballistic missile, attack.

### *Lethality*

Without ICBMs, the strategic nuclear force would lose a large fraction of its capability for prompt, accurate, and deadly strikes against various types of targets, including those that are hardened. If required, this loss might be partially offset by uploading W88 warheads on SLBMs, assuming sufficient non-deployed warheads of this type were available.

### *Flexibility*

Removing the ICBM force from the triad would eliminate single-warhead Minuteman III missiles. To retain the flexibility offered by a single-warhead ballistic missile, some D5 SLBMs might be converted to carry single-warhead payloads. Concurrent with this change, other D5 missiles might be uploaded in order to maintain the total number of warheads carried by SSBNs. In comparison to single-warhead Minuteman III ICBMs, single-warhead D5 SLBMs would have the added advantages of greater prelaunch survivability and more flight profiles consistent with possible overflight restrictions.

### *Visibility*

The lack of ICBMs would not affect the ability of the bomber leg to be used for shows of force that signaled U.S. resolve.

### *Adaptability*

Retiring all ICBMs would remove an entire force element that could hedge against technical problems, operational challenges, or technological surprises that might impair bombers or ballistic missile submarines. One of the options for uploading a significant number of hard target-capable warheads for prompt strikes would be lost. The diversity of the weapons stockpile would be diminished with the elimination of two

(the W78 and W87) of the seven warhead types. The decrease in adaptability would be worse if the bomber force, because of its dual capability and conventional commitments, were only a "half leg" in a submarine-bomber dyad.

## SSBN-ICBM Dyad (No Bombers)

### *Survivability*

With a submarine-ICBM dyad, improvements in opposing missile defenses would have the potential to weaken the entire strategic nuclear force. If adversaries no longer were threatened by nuclear-armed B-52Hs and B-2s, they might reallocate resources from air defenses to missile defenses, as well as to antisubmarine warfare aimed at SSBNs. But the fact they still faced threats from B-52Hs, B-2s, and B-1Bs with conventional payloads, not to mention from shorter-range nonnuclear strike aircraft, would likely militate against such a shift.

### *Lethality*

Ending the nuclear role for bombers would mean the loss of the only nuclear earth-penetrating weapon (the B61-11), another high-yield weapon (the B83), and the only guided strategic nuclear weapon (the ALCM-B). The delivery vehicle currently best suited for attacking mobile targets no longer would have a nuclear mission.

With regard to offsetting measures, an earth-penetrating ballistic missile warhead might be developed and deployed to replace the B61-11. Here it is worth noting that three decades ago, engineering development of an earth-penetrating warhead for the Pershing II intermediate-range ballistic missile was completed and the design then put on the shelf.[59] In the case of the B83, the current stockpile may not include a ballistic missile warhead with the yield and other characteristics that would make it a suitable substitute. To gain delivery accuracy comparable to that of the ALCM-B, Trident Mk-4 reentry vehicles might be retrofitted with global positioning system (GPS) guidance; some work along this line already has been done.[60] At some future point, it might be possible to equip intercontinental-range ballistic missiles with small, powered unmanned

combat aerial vehicles (UCAVs) that, like bombers, could be used to attack mobile targets.[61]

### *Flexibility*

Relieving bombers of nuclear duty would deprive the strategic nuclear force of the flexibility that comes from their readily changeable payloads, weapons with low-yield options, and man-in-the-loop control. As noted, these traits are valuable for conducting limited attacks and responding to rapid changes in conflict conditions.

In the absence of bombers, the remaining strategic force still would, or could, offer some flexibility. Single-warhead ICBMs would be available for selective strikes. SLBMs would have some ability to avoid overflight of specified areas. Some ballistic missile warheads might be modified for reduced yields. Improvements in $C^4ISR$[62] capabilities could facilitate the shoot-look-shoot employment of ballistic missiles. Small UCAVs delivered by future ballistic missiles might have some of the same advantages as the bomber with its man-in-the-loop control. And to give a submarine-ICBM dyad something akin to the recall option for bombers, a command destruct system might be installed on some or all ballistic missiles. It should be emphasized, however, that this last measure also would create a serious vulnerability that adversaries could exploit.[63]

### *Visibility*

If bombers were withdrawn from the strategic nuclear force, the best means for a nuclear show of force would be lost. In theory, test launches of ICBMs and SLBMs might be used to demonstrate the might and determination of the United States to stand against aggression. Given their own use of missile tests for political-military purposes, this type of signal is one potential opponents likely would understand. North Korea and Iran have test-launched ballistic missiles as part of their strategies to counter international pressure aimed at halting their nuclear programs. China has used ballistic missile tests to intimidate the leadership and populace of Taiwan and to discourage the United States from interfering with any Chinese forcible attempts to reclaim the island. And Russia

conducts ICBM and SLBM tests in exercises intended to put its strategic nuclear power on display. Yet a U.S. ballistic missile test in the context of an intense crisis could be misperceived as an attack, making it a more dangerous move than alerting and dispersing the bomber force. As an alternative, the crisis deployment of additional ballistic missile submarines to patrols at sea might be announced, or made known to an adversary through diplomatic channels, but this could compromise operations security.

### *Adaptability*

As with the submarine-bomber dyad, the hedge offered by an entire force element would be eliminated with the removal of bombers from a nuclear role. In the absence of bombers, the two remaining legs of the strategic nuclear force both would be vulnerable to improved, expanded, or proliferated ballistic missile defenses. To respond to this danger, tactics for suppressing defensive systems might be devised, tailored penetration aids might be added to ICBM and SLBM payloads, and ballistic missiles might be uploaded with more warheads for saturating opposing defenses.

The stockpile of strategic nuclear weapons would be less diverse without the bomber-delivered B61-7, B61-11, B83, and W80-1. The stockpile would retain some redundancy, however, with two ICBM warheads (the W78 and W87) and two SLBM warheads (the W76 and W88). On the other hand, if the W76 warhead, the most numerous strategic weapon, were to suffer a major technical problem that afflicted the entire type, much of the strategic nuclear force would be rendered ineffective, since there are too few W88 warheads to be used as replacements.

Without bombers, the strategic nuclear force would lose its capacity for the rapid upload of a substantial number of nuclear weapons. Bombers are armed with no weapons today, because no aircraft are on alert, but several hundred bombs and cruise missiles could be uploaded in a matter of weeks.[64] This option would be unavailable with a submarine-ICBM dyad.

## Conclusions

The move from the existing triad to a dyad could be detrimental to force survivability, lethality, flexibility, visibility, and adaptability—the qualities that support deterrence. For a submarine-bomber dyad, the quality of visibility would be unaffected because bombers would remain for shows of force. Survivability, however, would be diminished because adversaries would not confront the attack problem presented by a large force of silo-based ICBMs. The submarine-ICBM dyad would lack real options for shows of force. The entire dyad also would be vulnerable to improvements in opposing missile defenses. Both dyad alternatives would be less adaptable than the triad. With regard to lethality and flexibility, adjustments in the submarine-bomber dyad could be made to offset some of the capabilities lost by the elimination of ICBMs. For the submarine-ICBM dyad, the offsets might involve development and deployment of new systems.

## Notes

[1] Department of Defense (DoD), *Nuclear Posture Review Report* (Washington, D.C.: Department of Defense, April 2010), 21-24; and Statement by President Barack Obama on the Release of Nuclear Posture Review, Office of the White House Press Secretary (April 6, 2010).

[2] DoD, *Nuclear Posture Review Report*, op. cit., 21; and Janne E. Nolan, *An Elusive Consensus: Nuclear Weapons and American Security After the Cold War* (Washington, D.C.: Brookings Institution, 1999), 52-55.

[3] Treaty Between the United States of America and the Russian Federation on Measures for the Future Reduction and Limitation of Strategic Offensive Arms (signed April 8, 2010), Article II.

[4] Amy F. Woolf, *The New START Treaty: Central Limits and Key Provisions*, R41219 (Washington, D.C.: Congressional Research Service, June 18, 2010), 19.

[5] Unclassified fact sheet on the *New START Treaty Framework and Nuclear Force Structure Plans* report, submitted by the President to the Congress in response to section 1251 of the National Defense Authorization Act for Fiscal Year 2010 (May 13, 2010); and DoD, *Nuclear Posture Review Report*, op. cit., 21.

[6] See, for example, Gen. James E. Cartwright, vice chairman of the Joint Chiefs of Staff, testimony before the Senate Armed Services Committee (July 9, 2009), committee transcript, 22.

[7] "1,000 Trident Patrols: SSBNs the Cornerstone of Strategic Deterrence," Navy News Service (Feb. 24, 2009).

[8] See Department of Defense, *Deterrence Operations Joint Operating Concept*, Version 2.0 (Washington, D.C.: Department of Defense, Dec. 2006).

[9] Ronald O'Rourke, *Navy SSBN(X) Ballistic Missile Submarine Program: Background and Issues for Congress*, R41129 (Washington, D.C.: Congressional Research Service, July 27, 2010), 4, 8-9.

[10] James N. Miller, principal deputy under secretary of defense for policy, testimony before the Senate Armed Services Committee (July 20, 2010), prepared statement, 3 and committee transcript, 21; and Vice Adm. John T. Blake, deputy chief of naval operations for integration of capabilities and resources, testimony before the Senate Armed Services Committee (May 6, 2010), committee transcript, 27. According to Dr. Miller, DoD plans to sustain the B-52H through 2035 and the B-2 through 2050.

[11] On the life extension programs for warheads and bombs, see Government Accountability Office, *NNSA and DOD Need to More Effectively Manage the Stockpile Life Extension Program*, GAO-09-385 (Washington, D.C.: Government Accountability Office, March 2009). Because of deficiencies in the nuclear weapons infrastructure (labs, plants and workforce), "the United States is now the *only* nuclear weapons state party to the [Non-Proliferation Treaty] that does not have the capacity to produce a new nuclear warhead." Moreover, "[t]he United States has not designed a new nuclear warhead since the 1980s and has not built a new nuclear warhead since the early 1990s." Department of Energy and Department of Defense, *National Security and Nuclear Weapons in the 21st Century* (Washington, D.C.: Department of Energy and Department of Defense, Sept. 2008), 19 (emphasis in original).

[12] National Air and Space Intelligence Center, *Ballistic and Cruise Missile Threat*, NASIC-1031-0985-09 (Wright-Patterson Air Force Base, Ohio: National Air and Space Intelligence Center, April 2009), 19.

[13] The Defense Department formally defines deterrence as, "The prevention from action by fear of the consequences. Deterrence is a state of mind brought about by the existence of a credible threat of unacceptable counteraction." *Department of Defense Dictionary of Military and Associated Terms*, Joint Publication 1-02 (Washington, D.C.: Joint Chiefs of Staff, April 12, 2001—as amended through April 2010), 139.

[14] For an early discussion of the distinction between deterrence by threat of punishment and deterrence by denial, see Glenn H. Snyder, *Deterrence and Defense: Toward a Theory of National Security* (Princeton, N.J.: Princeton Univ. Press, 1961), 14-16.

[15] Active defenses are military systems designed for intercepting aircraft and missiles in flight. Examples of passive defenses include command posts that are underground or mobile, redundant (duplicate) military and industrial facilities, and plans for crisis dispersal of civilian populations, all of which are intended to mitigate the consequences of an attack.

[16] Robert Standish Norris and Thomas B. Cochran, *US-USSR Strategic Offensive Nuclear Forces, 1946-1990*, NWD 90-2 (Washington, D.C.: Natural Resources Defense Council, May 15, 1990), 2; J.C. Hopkins and Sheldon A. Goldberg, *The Development of Strategic Air Command, 1946-1986 (The Fortieth Anniversary History)* (Offutt Air Force Base, Neb.: Office of the Historian, Headquarters Strategic Air Command, Sept. 1, 1986), 65, 98, 147; Dick Cheney, *Department of Defense Annual Report to the President and the Congress* (Washington, D.C.: GPO, Feb. 1992), 59; U.S. Air Force, "LGM-30G Minuteman III," fact sheet (July 26, 2010); and Hans M. Kristensen, "U.S.

Strategic Submarine Patrols Continue at Near Cold War Tempo," FAS [Federation of American Scientists] Strategic Security Blog (March 16, 2009), http://www.fas.org/blog/ssp.

[17] Circular error probable is the radius of the circle within which half the weapons are expected to fall.

[18] Secretary of Defense Robert M. Gates, DoD News Briefing with Secretary Gates and [JCS Chairman] Adm. [Michael] Mullen from the Pentagon (Feb. 1, 2010), transcript, DoD release; and Department of Defense, *Quadrennial Defense Review Report* (Washington, D.C.: Department of Defense, Feb. 2010), 33.

[19] On the limitations of deterrent threats backed by conventional forces, see Edward Rhodes, "Conventional Deterrence," *Comparative Strategy*, Vol. 19, No. 3 (July-Sept. 2000), 221-253.

[20] Alfred Vagts, *Defense and Diplomacy: The Soldier and the Conduct of Foreign Relations* (New York: King's Crown Press, 1956), 232-261.

[21] Barry M. Blechman and Stephen S. Kaplan, *Force Without War: U.S. Armed Forces as a Political Instrument* (Washington, D.C.: Brookings Institution, 1978).

[22] Hopkins and Goldberg, *The Development of Strategic Air Command*, op. cit., 14, 59, 73, 108-109; Samuel R. Williamson, Jr., with the collaboration of Steven L. Rearden, *The View from Above: High-Level Decisions and the Soviet-American Strategic Arms Competition, 1945-1950* (Washington, D.C.: Office of the OSD [Office of the Secretary of Defense] Historian, Oct. 1975), (Top Secret/Restricted Data; declassified in part), 104, 106, 111, http://www.dod.mil/pubs/foi/rdroom.html; Richard K. Betts, *Nuclear Blackmail and Nuclear Balance* (Washington, D.C.: Brookings Institution, 1987), 103, 105; Robert J. Watson, *History of the Office of the Secretary of Defense, Vol. IV: Into the Missile Age, 1956-1960* (Washington, D.C.: GPO, 1997), 65, 66-67; Dwight D. Eisenhower, *The White House Years, Vol. II: Waging Peace, 1956-1961* (Garden City, N.Y.: Doubleday, 1965), Chapter 11, "Landing in Lebanon," esp. p. 59; Michael Dobbs, *One Minute to Midnight: Kennedy, Khrushchev, and Castro on the Brink of Nuclear War* (New York: Alfred A. Knopf, 2008), esp. 49-52, 94-96; Robert Kipp, Lynn Peake, and Herman Wolk, *Strategic Air Command Operations in the Cuban Crisis of 1962, Historical Study No. 90, Vol. I* (Offutt Air Force Base, Neb.: Strategic Air Command, 1963), (Top Secret/Formerly Restricted Data/ No Foreign Dissemination; declassified in part, 2008), 33-78, http://www.gwu/~nsarchiv/; and Barry M. Blechman and Douglas M. Hart, "The Political Utility of Nuclear Weapons: The 1973 Middle East Crisis," *International Security*, Vol. 7, No. 1 (Summer 1982), 132-156.

[23] Henry Kissinger, *Years of Upheaval* (Boston: Little, Brown & Co., 1982), 591.

[24] At present, only the D5 SLBM line remains open. Department of the Navy, *Fiscal Year (FY) 2011 Budget Estimates: Justification of Estimates—Weapons Procurement* (Washington, D.C.: Department of the Navy, Feb. 2010).

[25] U.S. Navy, "Fleet Ballistic Missile Submarines," fact sheet, Navy Fact File (May 11, 2009).

[26] Kristensen, "U.S. Strategic Submarine Patrols Continue at Near Cold War Tempo," op. cit.

[27] Unclassified fact sheet on the *New START Treaty Framework and Nuclear Force Structure Plans* report, op. cit.

[28] Congressional Budget Office, *Rethinking the Trident Force* (Washington, D.C.: Congressional Budget Office, July 1993), 10. Special fittings would be required for the D5 to carry 12 Mk-4 RVs.

[29] Amy F. Woolf, *U.S. Strategic Nuclear Forces: Background, Developments, and Issues*, RL33640 (Washington, D.C.: Congressional Research Service, Jan. 20, 2010), 17.

[30] Loc. cit. There are, in fact, more W76 warheads in the strategic force as a whole than warheads of any other type. See Thomas Scheber, *Reliable Replacement Warheads: Perspectives and Issues*, United States Nuclear Strategy Forum Publication No. 0005 (Fairfax, Va.: National Institute Press, August 2007), 9.

[31] U.S. Navy, "Trident Fleet Ballistic Missile," fact sheet, Navy Fact File (Jan. 17, 2009).

[32] Woolf, *U.S. Strategic Nuclear Forces*, op. cit., 9.

[33] U.S. Air Force, "LGM-30G Minuteman III," op. cit.

[34] Woolf, *U.S. Strategic Nuclear Forces*, op. cit., 10-11.

[35] Unclassified fact sheet on the *New START Treaty Framework and Nuclear Force Structure Plans* report, op. cit.

[36] Department of Energy, *FY 2012 Congressional Budget Request, Vol. 1: National Nuclear Security Administration*, DOE/CF-0057 (Washington, D.C.: Department of Energy, Feb. 2011), 67, 69.

[37] U.S. Air Force, "LGM-30G Minuteman III," op. cit.

[38] Rebecca Grant, *Return of the Bomber: The Future of Long Range Strike* (Arlington, Va.: Air Force Association, Feb. 2007), 10-15.

[39] U.S. Air Force, *Long Range Strike Aircraft White Paper* (Washington, D.C.: U.S. Air Force, Nov. 2001), 2; Secretary of Defense Task Force on DoD Nuclear Weapons Management, *Phase I Report: The Air Force's Nuclear*

*Mission* (Washington, D.C.: Department of Defense, Sept. 2008), D-1; Robert S. Norris and Hans M. Kristensen, "U.S. Nuclear Forces, 2010," *Bulletin of the Atomic Scientists*, Vol. 66, No. 3 (May-June 2010), 58, 65; and Woolf, *U.S. Strategic Nuclear Forces*, op. cit., 20, 21-23.

[40] DoD, *Nuclear Posture Review Report*, op. cit., 24; and Secretary of Defense Robert M. Gates, testimony before the Senate Armed Services Committee (June 17, 2010), committee transcript, 8.

[41] Kurt Guthe, *Assessments of the Bomber Force: Lessons from the Past, Directions for the Future* (Fairfax, Va.: National Institute for Public Policy, Dec. 1998), 19. The option to "re-role" the B-1 for nuclear missions was eliminated as a result of the 2001 Nuclear Posture Review. See Adm. James O. Ellis, commander in chief, U.S. Strategic Command, in Senate Armed Services Committee, *Department of Defense Authorization for Appropriations for Fiscal Year 2003*, Part 7, 107th Cong., 2d sess. (Washington, D.C.: GPO, 2003), 169.

[42] "Air Force Global Strike Command Gains Three Bomber Bases," Air Force News Service (Feb. 2, 2010).

[43] Secretary of Defense Dick Cheney and Gen. Colin Powell, JCS chairman, news briefing (Sept. 28, 1991), transcript, DoD release; and William S. Cohen, *Department of Defense Annual Report to the President and the Congress* (Washington, D.C.: GPO, 2001), 92.

[44] U.S. Air Force, "AGM-86B/C/D Missiles," fact sheet (May 24, 2010).

[45] William B. Scott, "Test Drops of B61-11 Penetrator Weapon Continue," *Aviation Week & Space Technology* (June 9, 1997), 75-76.

[46] U.S. Air Force, *Long Range Strike Aircraft White Paper*, op. cit., 20.

[47] Office of the Deputy Assistant to the Secretary of Defense for Nuclear Matters, *Nuclear Matters: A Practical Guide* (Washington, D.C.: Office of the Deputy Assistant to the Secretary of Defense for Nuclear Matters, 2008), 37.

[48] Ibid., 39.

[49] U.S. Air Force, "AGM-86B/C/D Missiles," op. cit.

[50] U.S. Air Force, "B-52 Stratofortress," fact sheet (April 23, 2010); and U.S. Air Force, "B-2 Spirit," fact sheet (April 23, 2010). In-flight refueling can extend these ranges.

[51] U.S. Air Force, *Long Range Strike Aircraft White Paper*, op. cit., 20; and National Research Council of the National Academies, *Effects of Nuclear Earth Penetrator and Other Weapons* (Washington, D.C.: National Academies Press, 2005), 3, 13-17, 26-27, 30-51, 110-112.

[52] Kipp et al., *Strategic Air Command Operations in the Cuban Crisis of 1962*, op. cit., 33-59.

[53] Maj. Gen. Polly Peyer, chair, *Air Force Blue Ribbon Review of Nuclear Weapons Policies and Procedures* (Washington, D.C.: Headquarters U.S. Air Force, February 8, 2008), 16, 17, http://www.fas.org/blog/ssp.

[54] Command Historian's Office, U.S. Strategic Command, *History of the United States Strategic Command, June 1, 1992—October 1, 2002* (Offutt Air Force Base, Neb.: U.S. Strategic Command, Jan. 2004), 30.

[55] Lt. Gen. Frank G. Klotz, commander, Air Force Global Strike Command, prepared statement before the House Armed Services Committee (Jan. 21, 2010); and Woolf, *U.S. Strategic Nuclear Forces*, op. cit., 22-23.

[56] A Department of Energy-sponsored study done in the early 1980s reported "at times in the past, the warheads for a large part of the U.S. [fleet ballistic missile submarine] force have been found to be badly deteriorated. At different times, a large fraction of the warheads either obviously or potentially would not work; they were obvious or potential duds." Jack W. Rosengren, *Some Little-Publicized Difficulties With a Nuclear Freeze*, RDA-TR-122116-001 (Marina del Rey, Calif.: R&D Associates, Oct. 1983), 13-20 (the quote is from p. 13). See also Walter Pincus, "Scientists Bare Warhead Duds on '60s Polaris," *Washington Post* (Dec. 2, 1978).

[57] DoD, *Nuclear Posture Review Report*, op. cit., 22, 25, 38.

[58] J.D. Crouch II, assistant secretary of defense for international security policy, "Challenges of a New Capability-Based Defense Strategy: 'Transforming US Strategic Forces,'" briefing to the National Defense Industrial Association 2003 Science & Engineering Technology Conference (March 5, 2003), briefing slide 21, "Nuclear Forces and Contingencies."

[59] National Research Council, *Effects of Nuclear Earth Penetrator and Other Weapons*, op. cit., 20.

[60] Amy F. Woolf, *Conventional Warheads for Long-Range Ballistic Missiles: Background and Issues for Congress*, RL33067 (Washington, D.C.: Congressional Research Service, Jan. 26, 2009), 7-8.

[61] Defense Science Board Task Force on Future Strategic Strike Forces, *Final Report* (Washington, D.C.: Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics, February 2004), 7-8, 7-18—7-19.

[62] $C^4$ISR refers to command, control, communications, computers, intelligence, surveillance, and reconnaissance.

[63] Thomas Scheber, "Whither the Triad: Considerations for a Triad, Dyad, or Monad," in Taylor Bolz, ed., *In the Eyes of the Experts: Analysis and Comments on America's Strategic Posture* (Washington, D.C.: United States Institute of Peace Press, 2009), 73.

[64] DoD, *Nuclear Posture Review Report*, op. cit., 24; U.S. Air Force, *Long Range Strike Aircraft White Paper*, op. cit., 2, 20; Secretary of Defense Task Force on DoD Nuclear Weapons Management, *Phase I Report*, op. cit., D-1; Norris and Kristensen, "U.S. Nuclear Forces, 2010," op. cit., 58, 65; Secretary of Defense Gates, testimony before the Senate Armed Services Committee (June 17, 2010), op. cit., 8; and Crouch, "Challenges of a New Capability-Based Defense Strategy," op. cit.