Should the United States Reject MAD?

Damage Limitation and U.S. Nuclear Strategy toward China

Charles L. Glaser and Steve Fetter

China's growing investment in nuclear forces, combined with increasing strains in the U.S.-China relationship, are raising concern at home and abroad about the adequacy of U.S. nuclear strategy and forces.[1] The key strategic nuclear choice facing the United States is whether to attempt to preserve and enhance its damage-limitation capability—that is, the ability to reduce meaningfully the costs that China can inflict against the U.S. homeland in an all-out nuclear retaliatory attack. The most recent U.S. Nuclear Posture Review, which was completed in 2010, did not present a clear position on whether the United States would accept growing vulnerability to massive Chinese nuclear retaliation or instead attempt to preserve the U.S. ability to destroy most of China's nuclear force.[2] Chinese experts reacted distrustfully: "If the United States cannot answer so simple a question as 'do you accept mutual vulnerability or not?' then something must be seriously wrong in the relationship."[3] With a few exceptions,[4] this critical choice has generated little public attention. Nevertheless, because it lies at the heart of U.S. nuclear strategy, the question of whether the United States should preserve and enhance its damage-limitation capability against China deserves thorough analysis.

Damage limitation differs fundamentally from deterrence, which is the most

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1. William J. Broad and David E. Sanger, "Race for Latest Class of Nuclear Arms Threatens to Revive Cold War," *New York Times*, April 17, 2016.
2. U.S. Department of Defense, "Nuclear Posture Review Report" (Washington, D.C.: U.S. Department of Defense, April 2010).
3. Brad Roberts, *The Case for Nuclear Weapons in the 21st Century* (Stanford, Calif.: Stanford University Press, 2016), p. 153. See also Thomas Fingar, "Worrying about Washington: China's Views on the U.S. Nuclear Posture Review," *Nonproliferation Review*, Vol. 18, No. 1 (February 2011), pp. 51–68.
4. See, for example, Keir A. Lieber and Daryl G. Press, "The Nukes We Need: Preserving the American Deterrent," *Foreign Affairs*, Vol. 88, No. 6 (November/December 2009), pp. 39–51.

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frequently discussed mission for U.S. nuclear forces. A deterrent strategy is designed to influence an adversary's behavior: the United States attempts to convince China not to attack by threatening sufficiently credible and costly retaliation. In contrast, a damage-limitation strategy is designed to protect against an adversary's nuclear attack: the United States attempts to destroy China's nuclear forces before they reach the United States. To achieve damage limitation, the United States would attack China's nuclear forces on land and at sea, as well as the command and control capabilities that China relies on to launch these forces. It would also employ ballistic missile defenses (BMD) to intercept the warheads that China would launch after they have survived the U.S. attack.

Reevaluation of U.S. nuclear strategy toward China, and of damage limitation in particular, is necessary for four reasons.[5] First, the increasingly competitive U.S.-China relationship makes more likely a serious crisis that could escalate to conventional war and then to nuclear war. Although such a crisis remains extremely unlikely, the potential dangers are too large to ignore. Second, China's expansion and modernization of its nuclear forces are reducing the damage-limitation capability of the United States, an advantage it has enjoyed for decades. Third, the United States might need a damage-limitation capability more than it did in the past, because China's improving conventional forces are reducing the U.S. ability to project power in Northeast Asia. This reduction in U.S. power-projection capability is beginning to generate doubts among the United States' Northeast Asian allies about the credibility of its extended deterrent commitments. Maintaining a damage-limitation capability is one approach for slowing the decline of U.S. credibility for meeting these regional commitments. Fourth, a thorough evaluation of U.S. nuclear strategy is required to ensure that the United States avoids some of the errors it made during the Cold War, when its nuclear strategy was overly competitive, diverging significantly from the policies implied by the powerful logic of the nuclear revolution. This logic explains how the massive destructive potential of nuclear weapons can largely eliminate traditional rationales for targeting an adversary's forces.[6] Contrary to this logic, the United States devoted tremendous resources to being able to destroy Soviet nuclear forces

5. For an earlier analysis of U.S. nuclear strategy toward China, see Elbridge A. Colby and Abraham M. Denmark, *Nuclear Weapons and U.S.-China Relations: A Way Forward* (Washington, D.C.: Center for Strategic and International Studies, March 2013).

6. Robert Jervis, *The Illogic of American Nuclear Strategy* (Ithaca, N.Y.: Cornell University Press, 1985); and Charles L. Glaser, *Analyzing Strategic Nuclear Policy* (Princeton, N.J.: Princeton University Press, 1990).

long after there was a realistic possibility of acquiring a meaningful damage-limitation capability.

We appreciate that evaluating a U.S. damage-limitation strategy against China may strike some readers as an unnecessary return to the Cold War, when discussing nuclear war scenarios in which Soviet attacks killed tens of millions of American citizens was standard fare. Evaluation of U.S. nuclear strategy is necessary, however, precisely because the consequences of a nuclear war would be so horrific. Virtually any other danger that was so unlikely could reasonably be put aside. Nuclear war is the exception because the outcomes could be wholly catastrophic. We also appreciate that some of our analysis may appear arcane. This is the nature of nuclear logic. The thinkers who developed the basics of nuclear strategy in the early Cold War were labeled "wizards" largely due to the intricacies of their arguments.[7] The subject demands this type of strategic analysis, in which what actor A believes that actor B believes about what actor A will do can be the key to designing an effective deterrence policy. Evaluation of nuclear strategy must also employ at least a basic knowledge of the technical features of nuclear weapons, including how much damage they can inflict and how difficult they are to find, track, and destroy.

The U.S. decision about whether to preserve and enhance its damage-limitation capability will determine the overall character of the United States' nuclear strategy. A damage-limitation strategy is inherently competitive, requiring the United States to undermine China's efforts to make its nuclear forces survivable. In contrast, if the United States forgoes efforts to maintain and enhance its damage-limitation capability, U.S. and Chinese force requirements would be largely compatible; both states would simultaneously be able to satisfy their deterrence requirements, and competition between them should taper off. Related, a damage-limitation strategy will require much greater innovation and investment in U.S. nuclear capabilities; in contrast, current U.S. forces are adequate to support a purer deterrent strategy.[8] Finally, a U.S. damage-limitation strategy creates incentives for both the United States and China to act quickly in a crisis; in contrast, forgoing a damage-limitation capability would reduce these time pressures.

The choice facing the United States about whether to preserve and enhance

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7. Fred M. Kaplan, *The Wizards of Armageddon* (New York: Simon and Schuster, 1983).
8. U.S. nuclear forces would still require replacement, but primarily because they are aging, not because their capabilities need to be enhanced. On current plans, see Amy F. Wolff, "U.S. Strategic Nuclear Forces: Background, Developments, and Issues" (Washington, D.C.: Congressional Research Service, March 10, 2016).

its damage-limitation capability is less straightforward than it was during the Cold War. By the end of the 1960s, the Soviet Union had deployed a large strategic nuclear force that included more than 2,000 ballistic missiles that carried more than 10,000 warheads capable of reaching the United States. Today China deploys approximately 45 intercontinental-range ballistic missiles (ICBMs), with the number predicted to increase to slightly more than 100 by 2030. The sheer difference in scale between these two forces increases U.S. prospects for maintaining a damage-limitation capability against China. In addition, improvements in missile accuracy have increased the U.S. ability to destroy fixed targets, and U.S. ballistic missile defense technologies have continued to mature. What appeared virtually infeasible against the Soviet Union is not clearly out of reach against China.

The United States could decide to pursue a significant damage-limitation capability for four interrelated reasons: most obvious, to enable the United States to partially protect itself in an all-out nuclear war; to enhance the ability of the United States to deter attacks against its homeland; to enhance the ability of the United States to deter attacks against its allies in Northeast Asia—that is, to extend deterrence—and related, to improve its bargaining position in crises that do occur; and to reassure U.S. allies about the effectiveness of the United States' extended deterrent, thereby helping preserve the alliances and staving off any perceived need for these countries to develop their own nuclear forces.

Whether the United States should pursue a significant damage-limitation capability depends on the feasibility of being able to do so. There is little reason to engage in intense competition with China if the United States cannot achieve this objective. Assuming an interactive arms race, we need to assess how much of China's nuclear force the United States would be able to destroy in politically relevant scenarios.

U.S. pursuit of an enhanced damage-limitation capability could entail strategic, political, and economic costs. The forces the United States would deploy to preserve a damage-limitation capability could create pressures during a crisis for deliberate escalation by both sides and for miscalculations by China that would fuel unwarranted escalation. The competitive U.S. policies required to maintain a damage-limitation capability would likely strain the U.S.-China relationship, thereby making serious crises and conflict more, rather than less, likely. In addition, a damage-limitation strategy would require the United States to make larger investments in its strategic nuclear forces.

Based on our analysis, we conclude that the United States should forgo efforts to preserve and enhance whatever damage-limitation capability it now possesses. In part this assessment reflects a technical judgment: China's continuing deployment of mobile missiles has the potential to fully erode U.S.

damage-limitation capabilities, although in the medium term this outcome will depend on how China operates its forces and in the longer term will be influenced by whether the United States deploys systems that can reliably find and destroy mobile targets. More important, however, is that the value of a damage-limitation capability to the United States is small. If such a capability were necessary for protecting vital U.S. interests, then a case could be made for investing great sums in intense military competition, and in pursuit of exotic and unproven technologies,[9] to acquire one, even if the probability of limited success were low. The United States faces a much less daunting security environment, however, than it did during the Cold War. It will be able to continue to meet its extended deterrence commitments to its key East Asian allies without a damage-limitation capability. Most important, the combined conventional capabilities of the United States and these allies—especially Japan—should be sufficient to prevent China from winning a major conventional war and thereby to deter large Chinese conventional attacks. In addition, even without a U.S. damage-limitation capability, the possibility that a large conventional war could escalate to a nuclear war should contribute to deterring a large Chinese conventional attack. Consequently, the marginal deterrent value of a significant damage-limitation capability is small, and the value of a modest damage-limitation capability is even smaller.

Compared to these limited benefits, the potential costs and risks of striving to preserve and enhance the U.S. damage-limitation capability are large. Doing so could increase a variety of escalatory dangers including accidental, unauthorized, and inadvertent nuclear attacks, as well as early intentional limited nuclear escalation driven by Chinese concerns about the possibility of U.S. preemptive attacks. In addition, U.S. efforts to preserve and enhance a damage-limitation capability would fuel strategic nuclear competition and strain U.S.-China relations—for example, by reinforcing China's belief that the United States is determined to maintain its dominance in East Asia, which would increase the probability of conflict. Finally, the systems that the United States would likely deploy in pursuit of an effective damage-limitation capability, including space-based sensors designed to track mobile missiles and an extensive national ballistic missile defense system designed to protect against China's ICBMs, would be very expensive.

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9. We do not evaluate two technologies that experts have identified—stealthy unmanned aerial vehicles and networked ground sensors. See Austin Long and Brendan Rittenhouse Green, "Stalking the Secure Second Strike: Intelligence, Counterforce, and Nuclear Strategy," *Journal of Strategic Studies*, Vol. 38, Nos. 1–2 (2015), pp. 38–73.

This article proceeds as follows. The first section explores the concept of damage limitation, including the question of where the threshold for a damage-limitation capability should be drawn. The second section analyzes the feasibility of the United States achieving a significant damage-limitation capability against China: it evaluates the vulnerability of China's retaliatory capabilities both to U.S. attacks against China's nuclear forces and command and control and to U.S. missile defenses; and it examines China's ability to offset improvements in these U.S. capabilities. The third section explores the potential benefits of a U.S. damage-limitation capability, and the fourth section assesses the potential costs.

The Concept of Damage Limitation

This section begins with a brief discussion of the evolution of the concept of damage limitation from the Cold War to the present. It then contrasts the levels of damage required to achieve damage limitation and to deter an adversary. Finally, it reviews the ways in which a damage-limitation capability can enhance a state's deterrent.

WHAT COUNTS AS SIGNIFICANT DAMAGE LIMITATION?

By definition, a damage-limitation capability could enable the United States to achieve a meaningfully better outcome in an all-out nuclear war than if it lacked such a capability. The feasibility of a U.S. damage-limitation capability vis-à-vis China depends on the level to which the United States would need to reduce the damage from a Chinese retaliatory attack to produce such an outcome. The lower the level of death and destruction is set, the more difficult damage limitation is to achieve.

During the Cold War, the United States set the threshold for damage limitation at a very high level. In the early 1960s, U.S. Secretary of Defense Robert McNamara defined "assured destruction" as the ability of the United States to destroy, in retaliation for a Soviet attack, 20 to 25 percent of the Soviet population and 50 percent of the Soviet industrial base. U.S. calculations estimated that the delivery of 200 1-megaton warheads could inflict this level of destruction.[10] This analysis assumed that if the Soviet Union could not reduce the effects of a U.S. retaliatory attack below this level, Soviet leaders would conclude that they could not limit damage to their homeland to any meaningful extent

10. Alain C. Enthoven and K. Wayne Smith, *How Much Is Enough? Shaping the Defense Program, 1961–1969* (Santa Monica, Calif.: RAND Corporation, 1971), p. 207.

and therefore would have virtually no incentive to launch a counterforce first strike. These judgments about the level of damage required for assured destruction largely reflected strongly diminishing marginal returns in the damage that additional U.S. warheads could inflict, not assessments of how Soviet leaders viewed various potential levels of damage to their country or how much damage they were willing to tolerate.

The same logic applied to the United States. The United States included damage limitation among its publicly stated nuclear goals in the early 1960s. But as Soviet forces became larger and more survivable, and as it became apparent that the Soviet Union could defeat any missile defense the United States could deploy, reducing the damage that the United States would suffer in a Soviet retaliatory attack to the level set by McNamara became increasingly difficult. Consequently, U.S. declaratory doctrine eschewed damage limitation as a mission for the United States' nuclear forces.[11]

The damage estimates produced during the McNamara era were based largely on the blast effects of nuclear weapons—the destruction of buildings by the explosion's shock wave—the estimates of which were in turn based on the U.S. bombings of Hiroshima and Nagasaki. But strategic nuclear weapons, which have much higher yields than did the Hiroshima and Nagasaki bombs, produce a pulse of thermal radiation that ignites fires over an area that is larger than that damaged by their blast effects; these fires can coalesce into a firestorm that would destroy everything and everyone in its path.[12] Later estimates that included fire effects indicated that the detonation of as few as 70 1-megaton weapons would kill 20 percent of the Soviet population.[13] Similar calculations for the United States indicate that only 40 1-megaton weapons could kill 20 percent of the U.S. population.[14]

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11. The United States, however, did continue to pursue a wide array of programs designed to destroy the Soviet force, and some analysts continued to offer arguments for pursuing whatever damage limitation might be feasible, even if the Soviet Union retained an assured destruction capability. These arguments for counterforce are critiqued in Glaser, *Analyzing Strategic Nuclear Policy*, pp. 211–212. On U.S. Cold War doctrine, see Desmond Ball and Jeffrey T. Richelson, eds., *Strategic Nuclear Targeting* (Ithaca, N.Y.: Cornell University Press, 1986). U.S. efforts were both more diverse and potentially more effective than is generally appreciated. See Long and Green, "Stalking the Secure Second Strike." On U.S. antisubmarine warfare efforts, see Owen R. Coté Jr., *The Third Battle: Innovation in the U.S. Navy's Silent Cold War Struggle with Soviet Submarines* (Newport, R.I.: Naval War College, 2003).
12. On why U.S. estimates did not include fire effects, see Lynn Eden, *Whole World on Fire: Organizations, Knowledge, and Nuclear Weapons Devastation* (Ithaca, N.Y.: Cornell University Press, 2006).
13. Barbara G. Levi, Frank N. von Hippel, and William H. Daugherty, "Civilian Casualties from 'Limited' Nuclear Attacks on the USSR," *International Security*, Vol. 12, No. 3 (Winter 1987/88), pp. 168–189.
14. Ibid., fig. 4. See also William Daugherty, Barbara Levi, and Frank von Hippel, "The Conse-

The military-technical challenge posed by China is very different. Whereas the Soviet Union deployed thousands of strategic warheads, with its arsenal eventually exceeding 10,000, China currently deploys only about 45 missiles capable of reaching U.S. cities.[15] In terms of destructive potential, these warheads are equivalent to roughly 45 to 90 1-megaton warheads.[16] Thus, if one adopts the Cold War criteria for assured destruction (20–25 percent of the population), the United States would have to be able to reduce a retaliatory strike to about half of the damage potential of China's current total force to deny China an assured destruction capability. Doing so is well within the capability of current U.S. forces.[17]

As the United States reevaluates its nuclear strategy toward China, the threshold for what counts as meaningful damage limitation requires a new discussion. The Cold War's analytic legacy continues to influence current thinking, but it may provide poor guidance. Today the United States faces the damage-limitation question from a somewhat different perspective than it did during the Cold War. In the 1960s, McNamara established the damage-limitation threshold and the amount of equivalent megatonnage that would produce this level of damage to demonstrate that damage limitation was infeasible. This analysis was not weakened by adopting an unnecessarily high threshold or overestimating the amount of megatonnage required to inflict this level of damage, because the analysis showed that the United States could not reduce Soviet retaliatory damage to even that high level. In other words, setting more demanding requirements—that is, lower levels of damage—would have yielded the same conclusion about the feasibility of damage limitation,

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quences of 'Limited' Nuclear Attacks on the United States," *International Security*, Vol. 10, No. 4 (Spring 1986), pp. 3–43.

15. Hans M. Kristensen and Robert S. Norris, "Chinese Nuclear Forces, 2015," *Bulletin of the Atomic Scientists*, Vol. 71, No. 4 (July 2015), p. 80, report that China has deployed 20 DF-5A ICBMs armed with either one warhead with a yield of 4–5 megatons or three warheads with a yield of 200–300 kilotons and about 25 DF-31A ICBMs armed with one warhead with a yield of 200–300 kilotons. Although the DF-4 and DF-31 missiles meet the technical U.S. definition of an ICBM (range greater than 5,500 kilometers), they are unable to reach any major U.S. city, so we do not count them as ICBMs. In its 2015 report to Congress, the Department of Defense for the first time indicated that China had equipped "some" of its DF-5A missiles with multiple independently targetable reentry vehicles (MIRVs). See Office of the Secretary of Defense, *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China 2015* (Washington, D.C.: U.S. Department of Defense, April 7, 2015), http://www.defense.gov/pubs/2015_China_Military_Power_Report.pdf. Kristensen and Norris assume that up to half of China's DF-5A missiles are MIRVed.

16. For the calculation, see our appendix at http://dx.doi.org/10.7910/DVN/SKJMLU.

17. Because the destructive potential of the Chinese nuclear force lies disproportionately in its fixed ICBM force, the United States would need to destroy the majority of these warheads and a much smaller fraction of China's mobile missiles.

because the United States was unable to meet the less demanding standard. In contrast, to determine whether meaningful damage limitation is feasible requires, first, setting a threshold above which additional damage does not result in significantly worse outcomes for the United States and below which less damage does result in better outcomes, and, then, accurately estimating the amount of damage that an attack of a specific size would actually inflict.

To achieve this second step in the analysis, damage estimates need to be based on more comprehensive and realistic technical analysis. Beyond correcting damage calculations for fire effects, an adequate assessment needs to address a fuller range of effects—including the impact of destroying critical infrastructure, comprising among other things energy systems, communication and information systems, and major ports and other transportation nodes.[18] In other words, the analysis should address the vulnerability to nuclear attack of a highly integrated and potentially fragile modern economy. Results based on a less complete analysis should be recognized as underestimating the damage, and arguments built on them should be treated with caution.

The first step in the analysis is still more challenging. Deciding what constitutes a significantly better outcome in an all-out nuclear war requires careful consideration. Damage limitation and, in turn, where to set the damage-limitation threshold, can be conceptualized in a variety of ways. Cold War analyses did little to explore the variants, but because they could support different policies, these variants require consideration as the United States faces basic choices about its nuclear strategy toward China. The variants capture different understandings of what a damage-limitation capability would provide the United States.

One variant sets the threshold at a given level of economic and population damage that reflects a subjective judgment about the overall societal costs that a specific nuclear attack would inflict on the United States: outcomes in which damage exceeds the threshold are considered not significantly or meaningfully worse than those at the threshold; whatever nuclear weapons the U.S. damage-limitation attack destroyed would be redundant; that is, they would not have significantly increased the costs that the adversary's attack would have inflicted on the United States. McNamara's damage thresh-

18. Cold War studies on the impact of large attacks include Arthur M. Katz, *Life after Nuclear War: The Economic and Social Impact of Nuclear Attacks on the United States* (Cambridge, Mass.: Ballinger, 1982); and Office of Technology Assessment, *The Effects of Nuclear War* (Washington, D.C.: Government Printing Office [GPO], 1979).

old is commonly understood in this way, even though it did not originate from this type of judgment. His flat-of-the-curve logic captured the relationship between additional megatons and additional damage, not the relationship between additional damage and additional costs to the country that was attacked. Employing this conception of damage limitation could result in a damage threshold that is lower than the one set by McNamara, or conceivably a higher one.

A second variant sets the threshold by considering a country's ability to recover from a nuclear attack: at some level, the extent of economic and infrastructure damage and population loss, and the resulting social and political collapse, might prevent a country from recovering from a nuclear war in anything resembling its current form. While this understanding raises many questions of its own—recover how quickly? recover along what dimensions?—it offers a different perspective for thinking through this difficult question. The issue becomes not only the immediate damage inflicted, but also the long-term implications of that damage, including environmental effects.[19]

A third variant conceives of the damage-limitation threshold as the level above which the United States should be unwilling to risk even a small increase in the probability of nuclear war to reduce the damage of an all-out nuclear war. This conception is more complicated than the first two because it incorporates judgments about the impact of pursuing damage-limitation capabilities on the likelihood of nuclear war. Although some analysts understand the infeasibility of damage limitation in this way, it is very difficult to determine the threshold, because the relationship between the damage-limitation efforts and the probability of war is complex and controversial.

We cannot fully explore this set of issues here, but we identified multiple possible meanings of the term "damage limitation" because well-informed decisions about U.S. strategy need to be built on a clear appreciation of what the United States would be pursuing and what it might achieve. For this analysis, we are setting a range that draws on the first two conceptions of damage limitation instead of a specific threshold: at the lower end, 10 medium-yield warheads dropped on ten cities, reflecting the possibility that such an attack could

19. The environmental impacts could be enormous; reductions in crop yields would put at risk of starvation a billion people worldwide. See Mutlu Özdoğan, Alan Robock, and Christopher J. Kucharik, "Impacts of a Nuclear War in South Asia on Soybean and Maize Production in the Midwest United States," *Climatic Change*, Vol. 116, No. 2 (January 2013), pp. 373–387; Xia Lili et al., "Decadal Reduction of Chinese Agriculture after a Regional Nuclear War," *Earth's Future*, Vol. 3, No. 2 (February 2015), pp. 37–48; and appendix.

result in damage that greatly exceeds the prompt destruction, including damage caused by the collapse of essential economic, communication, and political infrastructure;[20] and at the higher end, 40 equivalent megatons on cities, which is the Cold War/McNamara threshold for killing approximately 20 percent of the U.S. population, although the full effects would undoubtedly be much worse.[21] Analysts who disagree with our thresholds/range can adjust our findings by setting their own thresholds.

DAMAGE LIMITATION VERSUS DETERRENCE

A common reaction from many people, including experts, to the preceding type of discussion is that exploring such extremely high levels of damage resulting from a nuclear attack is ridiculous and out of touch with reality; the prospect of suffering even much lower levels of damage would certainly deter U.S. leaders from contemplating an action that could provoke such a devastating Chinese attack. The implication is that the United States should therefore not pursue a damage-limitation capability against China unless it could reduce the damage the United States would suffer in a retaliatory attack to far below the lower boundary we set above (i.e., 10 warheads on ten cities). This reaction, reasonable as it is, conflates damage limitation and deterrence. As we revisit the question of what counts as damage limitation, we need to keep in mind the distinction between the two.

The level of retaliation required to deter a nuclear attack is almost certainly much lower than the level required to achieve damage limitation.[22] Deterrence of an action requires that the expected costs of retaliation exceed the benefits that an actor expects to receive. There are very few, if any, actions that U.S. leaders would pursue if they believed that such an action would result in the destruction of even one U.S. city. This basic position was articulated in an often-quoted statement by McGeorge Bundy, who served as the national security adviser to Presidents John F. Kennedy and Lyndon Johnson: "Think-tank analysts can set levels of 'acceptable' damage well up in the tens of millions of lives. They can assume that the loss of dozens of great cities is somehow a real

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20. Ten 200-kiloton warheads targeted on the centers of the ten largest U.S. cities would effectively eliminate economic activity in metropolitan areas that are responsible for more than one-third of total U.S. gross domestic product.

21. In equating the number of surviving and penetrating Chinese warheads with these levels of damage, we are assuming that China's force is optimally targeted against the U.S. population.

22. To simplify our discussion, this claim glosses over the fact that the state would need to threaten greater damage when its deterrent threat is not fully credible than when it is fully credible; nevertheless, our basic point stands.

choice for sane men. They are in an unreal world. In the real world of real political leaders—whether here or in the Soviet Union—a decision that would bring even one hydrogen bomb on one city of one's own country would be recognized in advance as a catastrophic blunder; ten bombs on ten cities would be a disaster beyond history; and a hundred bombs on a hundred cities are unthinkable."[23]

Bundy's position, however, is largely consistent with the belief that a nuclear attack that reduced damage to the U.S. homeland but nevertheless allowed the destruction of ten or more U.S. cities could qualify as meaningful damage limitation. Whether the threat of nuclear damage would deter a leader from pursuing a specific action and whether that leader would judge the outcome of two nuclear attacks on her country to have inflicted meaningfully different costs are entirely distinct questions. The deterrence question arises when the leader is comparing pursuing the action and risking retaliation to not pursuing the action. In sharp contrast, the damage-limitation question arises when a country is already in a severe crisis or war and the leader believes that the adversary may launch a massive nuclear attack against her country. The choice at this point is between possibly suffering a first strike and definitely suffering a second strike.

This critical distinction between damage limitation and deterrence is often blurred. Consider, for example, an official document in which the U.S. secretary of defense stated that, if the United States could reduce the number of Americans killed from 120 million to 10 million to 40 million through a combination of a first strike and missile defenses, the Soviets would "lose their deterrent."[24] This claim is likely wrong: although this capability would deny the Soviet Union an assured destruction capability, what action would a U.S. leader take that would risk losing 10 million to 40 million Americans, but would not take if 120 million were at risk? What seems clearer is that a nuclear war that killed 120 million Americans would be significantly worse that one with a total death toll of 10 million to 40 million.

Because the logics of damage limitation and deterrence are distinct, an all-out nuclear war could occur even though both the United States and China prefer to avoid it. Consequently, the United States should place special weight

23. McGeorge Bundy, "To Cap the Volcano," *Foreign Affairs*, Vol. 48, No. 1 (October 1969), pp. 1–20, at p. 10.
24. Memorandum from Secretary of Defense Clifford to President Johnson, *Foreign Relations of the United States (FRUS), 1964–1968*, Vol. 10: *National Security Policy* (Washington, D.C.: GPO, 2002), doc. 210, https://history.state.gov/historicaldocuments/frus1964-68v10/d210.

on ensuring that its nuclear policy encompasses the full range of possibilities for avoiding preemptive escalation. These possibilities could include reducing incentives and pressures for China to escalate to nuclear use and to take actions that the United States might mistakenly believe indicated that China was preparing to escalate; being prepared to back down in certain crises; and improving crisis communications both to avoid misunderstandings and to be able to demonstrate restraint.

DAMAGE LIMITATION, DETERRENCE, AND ESCALATION

Although deterrence and damage limitation are fundamentally different concepts, possession of a damage-limitation capability can increase a country's ability to deter. A damage-limitation capability could also create pressures for escalation. Here we summarize the basic logics, foreshadowing our application of these arguments in later sections.

A state's damage-limitation capability could increase its adversary's assessment of the probability that the state would carry out its deterrent threat, thereby enhancing the credibility of the state's deterrent. An adversary might doubt that a state would retaliate because the adversary could then escalate further, inflicting massive damage on the state. By reducing or even eliminating this counter-deterrent threat, a damage-limitation capability would enhance the state's ability to deter.

The contribution of a damage-limitation capability to a state's deterrent is likely to be greater for attacks against a state's allies than against the state's homeland. Retaliatory threats tend to be more credible when designed to protect interests that a state values more. Because states value their own territory more than their allies' territory, credibility is harder to achieve when protecting allies, which makes the potential contribution of a damage-limitation capability greater.

The contribution of a damage-limitation capability to a state's deterrent depends on the effectiveness of that capability. If the damage the United States expects to suffer would remain so high that it dwarfs the interests at stake, then its damage-limitation capability would do little to enhance the credibility of U.S. threats to escalate.

A damage-limitation capability could create pressures for escalation in a crisis or war. If a state's ability to limit damage decreases as its adversary raises the alert level of its nuclear force, the state might attack early instead of letting this damage-limitation opportunity slip away. On the flip side, the adversary might feel pressure to escalate early, if it wants to use some of its nuclear

weapons—possibly to signal its resolve—before the state destroys them. In addition, a damage-limitation capability could increase the probability of unintended escalation, for example, by pressuring the adversary to make a quick decision to launch nuclear weapons before having acquired fully reliable information.

Feasibility of a U.S. Damage-Limitation Capability

The United States was until recently capable of destroying the vast majority of China's relatively small strategic nuclear force, although it did not acquire this capability as the result of a dedicated effort.[25] China's nuclear modernization, especially its deployment of mobile ICBMs, is changing this nuclear equation. How the United States should respond depends partly on the feasibility of the United States maintaining a meaningful damage-limitation capability as China invests in making its forces larger and more survivable.

To reduce China's ability to inflict retaliatory damage, the United States could rely on a mix of systems to destroy China's nuclear forces. It could employ nuclear missiles against China's ICBMs and antisubmarine warfare (ASW) forces against China's ballistic missile submarines (SSBNs), as well as engage in nuclear or conventional attacks against China's command and control (C2) assets. In addition, the United States could employ ballistic missile defense to intercept any warheads China was able to launch.[26]

TARGETING SILO-BASED ICBMS

China's first ICBM, the DF-5, began operations in 1981, but full deployment of the approximately 20 silo-based upgraded DF-5A missiles was not completed until 1995. China has attempted to conceal the silos using camouflage, both during construction and in operation. Using widely available commercial satellite photography, however, nongovernmental analysts have identified several likely DF-5A silos.[27] It is highly likely that U.S. intelligence has identified the locations of all of China's DF-5A operational silos, either through the use of multispectral imagery (which can distinguish camouflage from surroundings)

25. China did, however, have mobile nuclear systems capable of hitting Japan, Taiwan, and Guam that would have been much harder for the United States to destroy, and which therefore provided China with a significant retaliatory capability. The authors thank Christopher Twomey for highlighting this point.
26. In addition, a country can, at least in principle, try to limit damage through civil defense, protecting its population from nuclear weapons that explode on its territory.
27. Personal communications from Jeffrey Lewis and Hans Kristensen.

or as a result of the occasional removal of camouflage (e.g., during missile loading or training exercises). If all of the operational silos have been identified, there is a 55 percent to 95 percent chance that no DF-5A missiles would survive a U.S. first strike; a 90 percent or greater chance that no more than one missile would survive; and virtual certainty that no more than 2 missiles would survive.[28] Such an attack could be carried out with 10 Trident-II or 40 Minuteman-III missiles, representing only a small percentage of the currently deployed U.S. strategic force. If it is possible to detect missile failures and to rapidly reprogram and launch replacement Trident or Minuteman missiles, the probability of no survivable and deliverable DF-5A missiles would be 90 percent or greater, and the probability of no more than one missile would be more than 99 percent.[29]

Nongovernmental sources report that China has constructed decoy silos to complicate U.S. targeting.[30] U.S. intelligence may be able to distinguish decoys from operational silos based on observations during and after construction; if not, additional warheads could be used to destroy the decoys. Some of these sources also report that many or all of the DF-5 missiles are not ready to launch in peacetime, either because they are not fueled or because they are not armed with warheads.[31] If so, operations to fuel and arm missiles in a crisis would give the United States additional opportunities to identify and destroy operational silos before China could use them. Although there may be some residual uncertainty, reasonable Chinese planners would have to assume that all operational silos have been or will be identified by the United States, and that its silo-based ICBMs are vulnerable to preemptive attacks.

TARGETING MOBILE ICBMS

Given the vulnerability of China's silo-based ICBMs, the survivability of its ICBM force to a U.S. nuclear strike would depend on its mobile missiles. Although China would face challenges ensuring the survivability of these systems, our analysis indicates that it could win this competition against U.S. counterforce systems.

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28. See appendix. See also Lieber and Press, "The Nukes We Need."
29. On reprogramming counterforce strikes, see, for example, Lynn E. Davis and Warner R. Schilling, "All You Ever Wanted to Know about MIRV and ICBM Calculations but Were Not Cleared to Ask," *Journal of Conflict Resolution*, Vol. 17, No. 2 (June 1973), p. 218. See appendix for estimates.
30. Hans M. Kristensen, Robert S. Norris, and Matthew G. McKinzie, *Chinese Nuclear Forces and U.S. Nuclear War Planning* (Washington, D.C.: Federation of American Scientists and Natural Resources Defense Council, November 2006), pp. 72, 185.
31. Jeffrey G. Lewis, "Chinese Nuclear Posture and Force Modernization," *Nonproliferation Review*, Vol. 16, No. 2 (July 2009), p. 204.

China deployed its first road-mobile ICBM, the three-stage DF-31, in 2006; a total of 5 to 10 are currently deployed. Because the range of the DF-31 is estimated at 7,000 kilometers, which is insufficient to reach U.S. cities, the DF-31 is probably intended for Russia or U.S. bases in East Asia. China has deployed an extended-range version of the DF-31, the DF-31A. The DF-31A is believed to have a range of 11,000 kilometers—sufficient to target the west coast but not the east coast of the United States. Both the DF-31 and the DF-31A are believed to carry a single warhead with a yield of 200–300 kilotons.[32] About 25 DF-31A missiles had been deployed as of 2015. There are reports that China is developing and has tested a larger road-mobile ICBM capable of delivering multiple warheads (the DF-41).[33] The Chinese mobile ICBM force is predicted to approach 100 missiles by 2030.[34]

The survivability of mobile ICBMs depends largely on operational practices. A survivable mobile capability requires that a significant number of mobile ICBMs be armed with nuclear weapons and deployed in the field over a large area, away from bases or other fixed sites known to be associated with the missiles. In addition, these mobile missiles must be able to avoid being tracked or detected once in the field.

According to various reports in the open literature, in peacetime Chinese missiles and their transporter-erector-launchers (TELs) are stored together in garrison, leaving base only for the occasional training mission. Nuclear warheads are stored separately at a central storage facility or one of six base-level storage facilities.[35] In a crisis, warheads would be transported by road or rail from central to base-level storage facilities, and from there to the garrisons, where they would be mated with missiles before being deployed. Alternatively, warheads may be dispersed from base-level storage, rendezvousing with and being loaded onto mobile ICBMs in the field. Warhead shipments reportedly use specialized rail cars and vehicles on designated rail lines and roads, with armed escorts for the transfer of warheads to garrisons or mobile missiles in the field. These operations likely have distinctive signatures that

32. Kristensen and Norris, "Chinese Nuclear Forces, 2015."
33. Office of the Secretary of Defense, *Annual Report to Congress*, p. 8; and Kristensen and Norris, "Chinese Nuclear Forces, 2015," p. 80.
34. U.S. Air Force, *Ballistic and Cruise Missile Threat*, NASIC-1031-0985-13 (Dayton, Ohio: National Air and Space Intelligence Center, 2013), pp. 18–19. The document states that "the number of Chinese ICBMs capable of threatening the United States is expected to grow to well over 100 in the next 15 years"; given the deployment of about 20 silo-based ICBMs capable of reaching the United States, this implies approximately 100 mobile ICBMs.
35. Mark A. Stokes, "China's Nuclear Warhead Storage and Handling System" (Arlington, Va.: Project 2049 Institute, March 12, 2010).

could be identified. This likelihood raises the possibility that the United States would have warning that China is placing its nuclear forces on alert, moving from a vulnerable to a more survivable posture. Such warning would provide opportunities for U.S. counterforce attacks that could destroy warhead storage facilities or missile garrisons, or the roads and rail lines linking them. There may be choke points in China, such as rail or road tunnels, bridges, or narrow passages that, if destroyed, would prevent Chinese warheads from being delivered to missiles or prevent missiles from leaving their garrisons. Such attacks could be carried out with low-yield nuclear weapons, and possibly with precision conventional weapons, if available.[36]

China could deploy some fraction of its mobile ICBMs in the field during peacetime to reduce the vulnerability of these forces to a preemptive U.S. attack; this is the standard Russian procedure. Chinese leaders may have chosen not to do so because they believe that the safety and security risks associated with routine deployment of China's nuclear-armed mobile missiles in the field outweigh the risks of preemptive attack during peacetime. So long as this remains the case, a key question is how early in a crisis China would move to put its mobile missiles on alert. Moving quickly to place missiles on alert could escalate a crisis by signaling that China believes that the United States is preparing to launch a nuclear attack; waiting until a crisis is so severe that war appears likely increases the risk of a U.S. damage-limitation attack.

China's mobile ICBMs would be more survivable once they were deployed in the field together with their nuclear warheads, but the degree of survivability would depend on other operational details that are not publicly known. The TEL for the DF-31A is the largest vehicle found on Chinese roads, and would be accompanied by command and control and other vehicles, which give this combination of vehicles a distinctive signature. To escape detection, movements could occur at night or when no U.S. photoreconnaissance satellites were known to be overhead. TELs might, for example, move into hidden tunnels to wait out an attack and then move to prepared sites to launch a retaliatory attack. Interestingly, nongovernmental analysts in the United States using commercial satellite photographs have identified many likely Chinese

36. On U.S. prompt conventional strike programs, see James M. Acton, *Silver Bullet? Asking the Right Questions about Conventional Prompt Global Strike* (Washington, D.C.: Carnegie Endowment for International Peace, 2013); Bruce M. Sugden, "Speed Kills: Analyzing the Deployment of Conventional Ballistic Missiles," *International Security*, Vol. 34, No. 1 (Summer 2009), pp. 113–146; and Austin Long, Dinshaw Mistry, and Bruce M. Sugden, "Correspondence: Going Nowhere Fast: Assessing Concerns about Long-Range Conventional Ballistic Missiles," *International Security*, Vol. 34, No. 4 (Spring 2010), pp. 166–184.

mobile missile launch sites.[37] The launch sites have a distinctive turnaround loop for a TEL; in a few cases, a TEL is present.

Chinese crews train to launch the DF-31A from these prepared sites, presumably to reduce launch time and minimize exposure to attack.[38] If, as seems likely, U.S. intelligence has identified many of these prepared launch sites, the United States could preemptively destroy the sites by using nuclear or even long-range precision conventional weapons (if they are available). Therefore, for its DF-31As to survive, China must be able to launch them from unprepared sites. With the widespread availability of the Global Positioning System and other modern positioning and navigation services, it is highly likely that China can launch the DF-31A from arbitrary and unprepared positions, albeit with a somewhat longer preparation time.

If the United Sates can locate a Chinese TEL, and if the TEL is stationary for more than thirty minutes after being located, the United States could easily destroy it. If a TEL is located while it is moving, barrage attacks are possible with nuclear weapons. The DF-31A TEL almost certainly is confined to moving on paved roads at modest speeds, and the large turning radius limits opportunities to change direction. If a TEL was spotted moving down a highway, it might be destroyed with high probability by a few to a dozen U.S. nuclear warheads.[39] Thus, if the DF-31A TELs could be reliably detected, China's current force of 25 missiles might be destroyed with as few as 25 nuclear or long-range precision conventional weapons if the TELs are stationary, or by 100–300 nuclear weapons if they are moving in predictable directions along a road.[40]

The survivability of China's DF-31A therefore depends on the missile's ability to escape detection or to launch quickly after detection. The U.S. experience in the 1991 Gulf War suggests that this may not be difficult. With total air superiority over Iraq and the use of the joint surveillance and target attack radar system (JSTARS) aircraft to detect and track moving targets throughout Iraq, the United States conducted roughly 1,000 sorties to search for Iraqi Scud missiles over a six-week period without the confirmed destruction of any of Iraq's 30 or so mobile launchers, even though Iraq launched a total of 88 Scud missiles.[41] Iraq evaded detection by reducing prelaunch setup times, avoiding

37. Personal communications from Jeffrey Lewis and Hans Kristensen, 2015.
38. Launch preparation times of less than thirty minutes have been reported. See Li Bin, "Tracking Chinese Strategic Mobile Missiles," *Science and Global Security*, Vol. 15 (2007), pp. 10–11.
39. See appendix.
40. Much larger numbers of weapons would be required for barrage attacks if the TEL could drive in any direction after being spotted, but this would require off-road capability or deployment in an area with a dense network of suitable roads, both of which seem unlikely. The required number could be somewhat increased by forks in the road.
41. Barry D. Watts and Thomas A. Keaney, "Effects and Effectiveness," in Eliot A. Cohen et al.,

radio and other electromagnetic emissions, and deploying decoy vehicles around the launch areas. This experience has led many observers to conclude that it would be impossible to find and destroy mobile missiles in China—a vastly larger country with far more effective air defenses.[42]

There are differences between Iraq and China that cut in the other direction, however. The United States had not attempted to identify Scud launch sites and hiding places prior to the start of the Gulf War. It is likely, however, that U.S. intelligence has devoted considerable attention to locating Chinese mobile missiles. The Scud TEL is relatively small; its radar and infrared signatures were similar to those of ordinary trucks; and it could hide in culverts and highway overpasses. By comparison, the DF-31A missile alone is ten times heavier and has a cross section nearly four times larger than the Scud, and it would be accompanied by numerous support vehicles, further increasing the signature of the unit. Finally, on many occasions U.S. forces located Scud launchers in Iraq, but without enough precision to allow a successful attack with the conventional weapons available. Nuclear weapons have a much larger radius of destruction against mobile missiles, which would make relatively unimportant any lack of precision in U.S. ICBMs and sea-launched ballistic missiles (SLBMs).

The U.S. government has given considerable thought since 1991 to developing ways to improve its capability to counter mobile missiles.[43] The 2002 Nuclear Posture Review identified locating and tracking mobile targets as one of the greatest challenges: "[C]ollection systems and techniques that defeat adversary relocation capabilities must be developed. . . . 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."[44]

The 2006 Quadrennial Defense Review called for "[i]nvestments in moving

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Gulf War Air Power Survey, Vol. 2: *Operations and Effects and Effectiveness* (Washington, D.C.: GPO, 1993), part 2, pp. 330–340, http://www.afhso.af.mil/shared/media/document/AFD-100927-067.pdf.

42. On differences between Iraq and China, see, for example, James M. Acton, "Bombs Away? Being Realistic about Deep Reductions," *Washington Quarterly*, Vol. 35, No. 2 (Spring 2012), pp. 37–53; and James M. Acton, *Deterrence during Disarmament: Deep Nuclear Reductions and International Security*, Adelphi Paper No. 417 (New York: Routledge, 2011), chap. 2.

43. See, for example, Alan J. Vick et al., *Aerospace Operations against Elusive Ground Targets* (Santa Monica, Calif.: RAND Corporation, 2001), chap. 4, http://www.rand.org/content/dam/rand/pubs/monograph_reports/MR1398/MR1398.ch4.pdf.

44. U.S. Department of Defense, "Nuclear Posture Review" [excerpts], January 8, 2002, http://imi-

target indicator and synthetic aperture radar capabilities, including Space Radar . . . to provide a highly persistent capability to identify and track moving ground targets in denied areas."[45] The advantage of space-based radar (SBR) is that it provides an ability to track targets—particularly moving targets in the air or on the ground—during the day or night and in almost any weather conditions. Unlike airborne radar platforms, such as JSTARS or Global Hawk, SBR can track targets deep in the interior of large countries with good air defenses. But because of the long distances from space to ground and corresponding high radar power requirements, together with the high cost of building and placing equipment in space, SBR is very expensive. Providing SBR coverage of mobile missile deployment in China would cost at least $100 billion, and likely much more.[46] In 2005 the U.S. Congress concluded that the acquisition of a useful SBR capability would be prohibitively expensive.[47] The technologies involved are mature, and significant reductions in cost are unlikely.

Even if the United States were to decide to deploy a large, very expensive SBR system, China could pursue a variety of countermeasures that would degrade and quite possibly undermine the SBR's capability. Among the possibilities are deploying mobile decoys; deploying mobile missiles in mountainous terrain that blocks the radar signals; and employing stealth technology to reduce the TELs' radar cross section, thereby generating a requirement for a still-larger U.S. SBR constellation.[48] China reportedly has constructed a substantial network of underground facilities, which might be used to protect mobile missiles from surveillance. In addition, China could use electronic warfare and antisatellite weapons to jam or destroy SBR and other U.S. intelligence, surveillance, and reconnaissance capabilities.[49] Although there is always the possibility that China would fail to effectively pursue countermeasures, the competition between survivable mobility and SBR detection appears to favor survivability.

Instead of investing in the SBR system described above, the United States

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online.de/download/Nuclear_Posture_Review.pdf. This document was leaked to the press; neither author has had access to the "Nuclear Posture Review" beyond these leaked excerpts.

45. U.S. Department of Defense, "Quadrennial Defense Review Report" (Washington, D.C.: U.S. Department of Defense, February 6, 2006), p. 57; and Li, "Tracking Chinese Strategic Mobile Missiles."

46. See Joseph A. Post and Michael J. Bennett, "Alternatives for Military Space Radar" (Washington, D.C.: Congressional Budget Office, January 2007); and appendix.

47. House Committee on Appropriations, *Report of the Committee on Appropriations*, Department of Defense Appropriations Bill, 2005, House Report 108-553, pp. 312–314.

48. Li, "Tracking Chinese Strategic Mobile Missiles," pp. 15–25.

49. Office of the Secretary of Defense, *Annual Report to Congress*, pp. 43–59.

could use small and inexpensive imaging satellites. The capabilities of the high-resolution satellites used by the U.S. intelligence community are legendary, but these cost billions of dollars each and have a narrow field of view, which renders them useful only if one knows precisely where to look. Commercial imaging satellites, such as DigitalGlobe's WorldView, have a resolution of about 0.3 meters and a wider field of view. This resolution is more than sufficient to identify large vehicles such as the DF-31A TEL. Commercial imaging satellites, however, cost several hundred million dollars each and have a revisit time of about one day.[50] Recently, several satellite imaging start-up companies have emerged that are building small, highly capable imaging satellites at a fraction of the previous costs. Some of these satellites are constructed from off-the-shelf technologies, and can be built and launched for approximately $100,000 each.[51]

These developments suggest that the United States may soon be able to provide near-continuous imagery of the entire Earth at a resolution sufficient to identify and track large objects, such as mobile missiles and the trains and trucks that transport warheads, at a cost that is readily affordable by the U.S. Department of Defense.[52] Imaging techniques would work only during the daytime, and even then only during clear weather, but a need to avoid daytime operations could impose serious constraints on China's operations of mobile missiles in a crisis.

As with SBR, China could pursue a variety of approaches for defeating these imaging satellites, including proliferating decoys, hiding missiles in tunnel networks, and increasing the size of its mobile missile force. The lower cost of the mini satellites would, however, make winning this competition more difficult for China.

Another possibility for locating mobile missiles is signals intelligence (SIGINT). Based on their 2015 review of the unclassified literature, Austin Long and Brendan Green showed that the United States made large investments in SIGINT dedicated to tracking Soviet mobile ICBMs during the Cold War, that these capabilities had some success locating Soviet missiles, and that U.S. SIGINT assets have improved since then.[53] Fully evaluating the potential

50. See appendix for specifics of this estimate.
51. For example, Skybox, which was acquired by Google, is reported to be able to build satellites that cost only about $15 million each and promise 1-meter resolution and revisit times of less than one day. Planet Labs launched a "flock" of 28 shoebox-size satellites in January 2014; it plans to launch 131 satellites to image the entire Earth every day at a resolution of about 3 meters.
52. See appendix.
53. Long and Green, "Stalking the Secure Second Strike," pp. 51–56, 60–64.

effectiveness of U.S. SIGINT against Chinese mobile missiles is difficult because relatively little information about U.S. programs is available in the open literature, and even less is known about how China operates its nuclear force. Nevertheless, China likely has available approaches for significantly reducing this potential vulnerability, including communicating to satellites via burst transmissions,[54] relying less during crises on communicating via satellite links, and relying more heavily on land lines.

In short, China's mobile missiles are likely highly survivable if deployed in the field with nuclear weapons relatively early in a crisis, before the United States would consider a damage-limiting attack; if China could launch its mobile missiles from unprepared or unidentified sites; and if Chinese missile forces adopted best practices to avoid detection while in the field. In the future, the United States might be able to acquire the ability to target mobile missiles by using space-based radar or a huge fleet of small imaging satellites, but China would be able to adopt countermeasures that could significantly degrade the capability of these satellites.

TARGETING SSBNS

China's first ballistic-missile submarine, the Xia, entered service in 1986. The Xia is said to be slow, noisy, unreliable, and armed with a relatively short-range JL-1 missile, rendering it ineffective as a strategic deterrent. The Xia appears to have remained in port, and U.S. intelligence considers the JL-1 as not deployed.[55]

A second-generation submarine, the Jin, was commissioned in 2010. Four Jin-class submarines are now in service; China may have up to eight operational Jin-class submarines by the end of the decade.[56] The Jin is armed with 12 JL-2 missiles with an estimated range of 7,000 kilometers. The JL-2 is said to be a modification of the DF-31, which like the DF-31 carries a single warhead with a yield of 200–300 kilotons. The Jin is reported to have performed its first deterrent patrol in late 2015.[57]

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54. Long and Green note that the United States could rely on this approach to communicate clandestinely from sensors hidden in China. See ibid., p. 63.
55. Kristensen and Norris, "Chinese Nuclear Forces, 2015," p. 81.
56. There is some discrepancy over these numbers. Office of the Secretary of Defense, *Annual Report to Congress*, p. 9, states that four are operational; Adm. Samuel J. Locklear III, Pacific Command, prepared statement, U.S. House of Representatives Armed Services Committee, April 15, 2015, p. 7, states that three are operational and that "up to five more may enter service by the end of the decade."
57. Richard D. Fisher Jr., "China Advances Sea- and Land-based Nuclear Deterrent Capabilities," *IHS Jane's Defence Weekly*, December 16, 2015, http://www.janes.com/article/56667/china-

Two key factors limit the survivability of Jin-class submarines. First, many nongovernment analysts believe that China's SLBMs are not currently armed with nuclear warheads during peacetime.[58] If so, China would have to load warheads onto its SLBMs in port during a crisis, which would leave the submarines vulnerable to attack. If China becomes more determined to maintain a survivable sea-based deterrent, it could diverge from past policy by sending these submarines to sea with their nuclear warheads.

Second, the Jin-class submarines reportedly have noise levels comparable to 1970s-era Soviet submarines.[59] If so, they would be relatively easy for U.S. attack submarines to detect and track. Because of the limited range of the JL-2 missile, the submarine must sail into the open ocean to threaten U.S. cities, passing through straits to get to the sea, which would facilitate U.S. detection and tracking. Indeed, the submarine would have to travel for almost two weeks to come within range of the continental United States, allowing ample time for U.S. ASW forces to find and destroy it.[60]

China will find it challenging to produce submarines within the next couple of decades that are quiet enough to reliably evade detection by the United States.[61] An alternative, less technically demanding approach is for China to adopt a bastion strategy: China would develop a third-generation submarine large enough to carry a longer-range SLBM capable of reaching the continental United States from its patrol area; and China would continuously deploy at least one of these SSBNs in an area that it can defend against operations by U.S. attack submarines, such as the Bohai Sea or Yellow Sea.[62] For sub-

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advances-sea-and-land-based-nuclear-deterrent-capabilities; and Office of the Secretary of Defense, *Annual Report to Congress*, p. 9.

58. Kristensen and Norris, "Chinese Nuclear Forces, 2015," p. 82.

59. Wu Riqiang, "Survivability of China's Sea-Based Nuclear Forces," *Science and Global Security*, Vol. 19, No. 2 (2011), pp. 91–120; Office of Naval Intelligence, "The People's Liberation Army Navy: A Modern Navy with Chinese Characteristics" (Washington, D.C.: Office of Naval Intelligence, August 2009), http://www.fas.org/irp/agency/oni/pla-navy.pdf; Hans M. Kristensen, "China's Noisy Nuclear Submarines," Federation of American Scientists *Strategic Security* blog, November 21, 2009, http://www.fas.org/blogs/security/2009/11/subnoise/#more-2280; and Jeffrey Lewis, "China's Noisy New Boomer," *Arms Control Wonk* blog, November 24, 2009, http://www.armscontrolwonk.com/archive/202544/chinas-noisy-new-boomer/.

60. The distance from Yulin Naval Base to Los Angeles is about 12,300 kilometers; if the range of the JL-2 is 7,000 kilometers, the submarine would have to travel at least 5,300 kilometers to come within range. This would take eleven to fifteen days at a speed of 15–20 kilometers per hour (to avoid cavitation).

61. We base this judgment on the Soviet experience during the Cold War. See Coté, *The Third Battle*.

62. An intermediate strategy would be operation in shallow coastal waters in the East China Sea or South China Sea. This would require quiet submarines, but not as quiet as would be required for open ocean patrols, because passive sonar detection and tracking is more difficult in shallow

marines based in the Yellow Sea, a missile with a range of 10,000–12,000 kilometers would be needed to hold at risk cities on the west or east coast of the United States.[63] There is speculation that China may be developing a larger third-generation submarine,[64] but little reliable information is publicly available.

In sum, China's current generation of SSBNs appears to be highly vulnerable to U.S. ASW capabilities. To achieve a survivable sea-based leg of its nuclear force, China will require a new, quieter SSBN; a new, longer-range SLBM; improved ASW capabilities; and a new operational doctrine.

targeting command and control

A nuclear retaliatory capability requires not only that a state's nuclear weapons and delivery systems can survive attack, but also that the state has the ability to launch the surviving weapons. If the United States could fully destroy China's nuclear command and control systems before China launched its nuclear forces, then the United States would have a highly effective damage-limitation capability. Even partially destroying China's nuclear C2 could complement other U.S. counterforce capabilities by reducing the fraction of surviving weapons that China could launch.

Relatively little is known about China's C2, but we can assess the challenges that China faces by identifying three broad approaches for addressing nuclear C2 vulnerability: (1) ensuring that the political leadership and the communication links between leaders and launch commanders are survivable; (2) predelegating launch authority down the political and military chains of command; and (3) preparing to launch on warning (LOW) of a U.S. attack. None of these approaches provides an easy route to adequate C2. During the Cold War, the United States developed an elaborate system of sensors, mobile platforms, and organizational procedures to overcome the vulnerability of its C2. These extensive efforts were unable to avoid difficult trade-offs between ensuring the United States' ability to launch a retaliatory attack and increas-

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waters. It would also require somewhat longer-range SLBMs than would be needed for patrols in the Yellow Sea.

63. A U.S. nuclear barrage attack would have a low probability of destroying a Chinese submarine that was operating in this bastion; see appendix.

64. Thomas M. Skypek, "China's Sea-Based Nuclear Deterrent in 2020: Four Alternative Futures for China's SSBN Fleet," in Mark Jansson, ed., *A Collection of Papers from the 2010 Nuclear Scholars Initiative* (Washington, D.C.: Center for Strategic and International Studies, 2010), http://csis.org/files/publication/110916_Skypek.pdf. In its 2015 annual report, the U.S. Department of Defense states that "up to five [Jin-class submarines] may enter service before China begins developing and fielding its next-generation SSBN, the Type 096, over the coming decade." See Office of the Secretary of Defense, *Annual Report to Congress*, p. 9.

ing the probability of an accidental or unauthorized launch of its nuclear weapons.[65] Based on publicly available information, China has not fully pursued any of these approaches and will have to make substantial organizational and technological investments to achieve adequate nuclear C2 capabilities.

Any fixed Chinese leadership and communication assets that the United States had located would be vulnerable to U.S. nuclear attack. Even deep underground facilities can be compromised by attacks on surface features, such as entrances and ventilation, communication, and power facilities. A partial solution to this vulnerability during a crisis or conventional war would be to disperse political and military leaders to hidden locations and/or put them on mobile air-based or ground-based platforms. After surviving a U.S. attack, these mobile platforms would need to be able to communicate with China's mobile ICBMs, which is itself a challenging task.

China would not want its ability to retaliate to depend on its top leader giving a launch command following a U.S. nuclear attack. Relying on a single leader leaves the entire Chinese nuclear arsenal vulnerable to "decapitation"—a small attack that killed the leader or destroyed his ability to communicate with China's nuclear forces would effectively disable the country's entire force.[66] To address this vulnerability, China could predelegate launch authority down the political or military chain of command, or both, thereby greatly increasing the number and diversity of targets that the United States would need to destroy to fully disrupt China's ability to launch. The aforementioned approach of dispersal and mobility would likely also need to incorporate predelegation of launch authority, because relying on a single leader surviving and possessing the connectivity required to order an attack, even on a mobile platform, would be risky. Predelegation of launch authority directly to field commanders early in a crisis would reduce the need to make the Chinese leadership and communications survivable. Predelegation has a major downside, however: early and deep predelegation increases the probability of an unauthorized launch of Chinese nuclear weapons.

The third approach—LOW—avoids China's need to deploy survivable C2 by instead enabling its nuclear forces to launch before a U.S. attack can destroy critical targets. LOW is technically and organizationally demanding: China would have thirty minutes or less to reliably detect by satellite the launch of

65. See Ashton B. Carter, John D. Steinbruner, and Charles A. Zraket, eds., *Managing Nuclear Operations* (Washington, D.C.: Brookings Institution Press, 1987); and Bruce G. Blair, *Strategic Command and Control: Redefining the Nuclear Threat* (Washington, D.C.: Brookings Institution Press, 1985).
66. For an early discussion of this danger in the U.S.-Soviet context, see John D. Steinbruner, "Nuclear Decapitation," *Foreign Policy*, Winter 1981/82, pp. 16–28.

U.S. missiles, provide the attack information to decisionmakers, order the launch of its nuclear weapons, and launch them.[67] Even the most carefully planned systems and procedures cannot eliminate the risk of launching when not under attack and not launching when under attack.

For more than a decade, evaluations of Chinese military strategy have noted that China places a high priority on improving its C2, in general, and its nuclear C2, in particular.[68] Nevertheless, there is little publicly available information on how China plans to ensure its ability to launch its nuclear weapons and how much progress it has made in this regard. Based on a recent authoritative Chinese strategy document, Gregory Kulacki concludes that China has adopted a LOW posture and plans to deploy new early warning capabilities. In contrast, Fiona Cunningham and Taylor Fravel find that the possibility of relying on a LOW posture is currently being debated by Chinese experts.[69] There is little available information on advances in Chinese nuclear C2 systems that indicates a decision by China to shift to LOW.

What we can reasonably say is that China has achieved the technological sophistication required to implement the approaches described above. Consequently, China should be able to adopt policies that ensure its ability to launch its nuclear weapons if the United States launched an attack against China's nuclear C2. Developing and perfecting these systems and organizational procedures promises to be challenging, as it has been for the United States, but they are within reach of a dedicated Chinese effort.

Ballistic missile defense

Ballistic missile defenses can be used in combination with counterforce attacks to limit damage. Current and planned U.S. BMD systems are designed and intended to counter limited missile attacks by regional powers, such as North Korea and Iran, against the United States and its allies.[70] Consistent with the position of earlier administrations, the Barack Obama administration has

67. The warning time would be closer to fifteen minutes for a U.S. attack launched from an SLBM. On LOW, see Richard L. Garwin, "Launch under Attack to Redress Minuteman Vulnerability?" *International Security*, Vol. 4, No. 3 (Winter 1979/80), pp. 117–139; and Office of Technology Assessment, *MX Missile Basing* (Washington, D.C.: GPO, 1981), chap. 4.
68. Stephen Polk, "China's Nuclear Command and Control," in Lyle J. Goldstein, ed., with Andrew S. Erickson, *China's Nuclear Force Modernization*, Newport Papers 22 (Newport, R.I.: Naval War College, 2005), pp. 7–22; and Gregory Kulacki, "The Chinese Military Updates China's Nuclear Strategy" (Cambridge, Mass.: Union of Concerned Scientists, 2015), http://www.ucsusa.org/sites/default/files/attach/2015/03/chinese-nuclear-strategy-full-report.pdf.
69. Cunningham and Fravel, "Assuring Assured Retaliation," pp. 30–31, 39.
70. U.S. Department of Defense, "Ballistic Missile Defense Review Report" (Washington, D.C.: U.S. Department of Defense, February 2010), http://archive.defense.gov/bmdr/docs/BMDR%20as%20of%2026JAN10%200630_for%20web.pdf.

stated that these systems are not oriented toward Russia or China, and it has tried to reassure both countries that its BMD plans do not threaten strategic stability. China nevertheless perceives U.S. BMD as a long-term strategic threat that could undermine its ability to retaliate after a U.S. nuclear attack and thereby give the United States bargaining advantages in a crisis.[71]

China has been particularly critical of U.S. theater missile defense (TMD) plans in East Asia;[72] Chinese concerns have grown with the recently increased probability that the United States will deploy the Terminal High Altitude Area Defense (THAAD) system in South Korea, in reaction to North Korea's missile and nuclear weapons tests.[73] The interceptors deployed as part of the planned Asia-Pacific Phased Adaptive Approach, however, will have no capability against Chinese ICBMs launched from current DF-5A or DF-31A bases. Even with U.S. Navy Aegis ships positioned close to China, interceptor velocities greater than 5.5 kilometers per second would be needed to intercept Chinese warheads targeted against the United States—much higher than the 4.5 kilometers per second assumed for the SM-3 block-IIA.[74] Moving Chinese ICBMs to bases farther inland (or assuming that SM-3 launchers are located at sites that can be more easily defended by U.S. forces) pushes the required interceptor velocities above 7 kilometers per second, providing ample reassurance that theater missile defenses pose no threat to the ability of Chinese strategic forces to reach the U.S. homeland. Chinese concerns are more likely related to the use of theater defenses against Chinese conventional missiles targeted on Taiwan (or U.S. and allied bases and forces participating in a defense of Taiwan), and to the role that cooperation on the deployment of BMD systems plays in deepening U.S. military alliances with South Korea and Japan.

A potentially larger military challenge than TMD is posed by the United

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71. Gregory Kulacki, "Chinese Concerns about U.S. Missile Defense" (Cambridge, Mass.: Union of Concerned Scientists, July 2014), http://www.ucsusa.org/sites/default/files/legacy/assets/documents/nwgs/china-missile-defense.pdf; Christopher P. Twomey and Michael S. Chase, "Chinese Attitudes toward Missile Defense," in Catherine McArdle Kelleher and Peter Dombrowski, eds., *Regional Missile Defense from a Global Perspective* (Stanford, Calif.: Stanford University Press, 2015), pp. 197–216; and Fiona S. Cunningham and M. Taylor Fravel, "Assuring Assured Retaliation: China's Nuclear Posture and U.S.-China Strategic Stability," *International Security*, Vol. 40, No. 2 (Fall 2015), pp. 16–19.

72. Ian E. Rinehart, Steven A. Hildreth, and Susan V. Lawrence, "Ballistic Missile Defense in the Asia-Pacific Region: Cooperation and Opposition" (Washington, D.C.: Congressional Research Service, April 3, 2015), https://fas.org/sgp/crs/nuke/R43116.pdf.

73. Aaron Mehta, "Carter: THAAD in Korea Is 'Going to Happen,'" *DefenseNews*, April 8, 2016, http://www.defensenews.com/story/defense/international/asia-pacific/2016/04/08/carter-thaad-korea-going-happen/82803470/.

74. See appendix; and Jaganath Sankaran, *The United States' European Phased Adaptive Approach Missile Defense System: Defending against Iranian Missile Threats without Diluting the Russian Deterrent* (Santa Monica, Calif.: RAND Corporation, 2015).

States' Ground-based Midcourse Defense (GMD) system, consisting of 40 ground-based interceptors (GBIs) based in Alaska and 4 GBIs in California, plus space-based sensors and radars (including radars deployed in Japan as part of a TMD system that provides tracking information for the GBI). The GMD system is intended to defend against a small number of single-warhead ICBMs, not equipped with countermeasures, that might be launched by North Korea or Iran. These GBIs would be capable, at least in theory, of engaging ICBM warheads launched from China against the United States. It is often assumed that a salvo of 4 or 5 GBIs would be launched against each incoming warhead,[75] in which case 44 GBI would be sufficient to engage about 10 warheads. If GMD met its stated goal for overall system effectiveness—which is greater than 90 percent success per attacker warhead—this could provide a significant damage-limitation capability in the wake of a counterforce attack that left China with a comparable number of surviving warheads. Given these assumptions, it is highly unlikely that a Chinese attack involving ten single-warhead missiles would result in more than one warhead penetrating the defense.[76]

There are good reasons, however, to doubt that the United States could deploy a highly effective missile defense against China. The most widely recognized technical challenge is midcourse discrimination—correctly identifying the ICBM warhead within a cloud of debris (the spent final stage, unburned propellant, separation debris), decoys, and other countermeasures, all of which have similar trajectories in space.[77] A 2012 National Academy of Sciences committee judged that combining high-resolution data from X-band radars with the infrared data collected by optical sensors on the interceptor in rigorous and realistic testing offered the best chance of discrimination against emerging missile states such as North Korea and Iran.[78] But even if discrimination against simple targets can be demonstrated in flight tests, China is capable of deploying sophisticated countermeasures, such as anti-simulation decoys and warheads with very low infrared signatures and radar cross sections, for which discrimination would remain extremely difficult.

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75. Dean A Wilkening, "A Simple Model for Calculating Ballistic Missile Defense Effectiveness," *Science and Global Security*, Vol. 8, No. 2 (1999), pp. 198–199.
76. See appendix.
77. Andrew M. Sessler et al., "Countermeasures: A Technical Evaluation of the Operational Effectiveness of the Planned U.S. National Missile Defense System" (Cambridge, Mass.: Union of Concerned Scientists, April 2000).
78. Committee on an Assessment of Concepts and Systems for U.S. Boost-Phase Missile Defense in Comparison to Other Alternatives, *Making Sense of Ballistic Missile Defense: An Assessment of Concepts and Systems for U.S. Boost-Phase Missile Defense in Comparison to Other Alternatives* (Washington, D.C.: National Academies Press, 2012).

According to the U.S. Department of Defense, China is working on a range of technologies to counter ballistic missile defense systems, including multiple reentry vehicles, decoys, chaff, jamming, and thermal shielding. Kulacki reports that "China's own research, development, and testing is reducing Chinese anxieties about the threat missile defense might present to Chinese missile forces."[79]

A BMD countermeasure that has received less attention is direct or indirect attacks on BMD sensor systems. GMD uses data from several radar systems, including ultra-high-frequency (UHF) early warning radars and X-band radars, to establish the missile track used to launch interceptors to a predicted intercept point. The X-band radars necessary for discrimination are forward based; China would have good prospects for destroying these radars with conventional attacks.

If these attacks failed, China would have the option of escalation to nuclear attacks in outer space to interfere with U.S. radars and infrared sensors. Chinese warheads could be detonated intentionally, just outside the range of GBIs, or the warheads could be equipped with a proximity fuse that would trigger the detonation just before the warhead would have been destroyed by an interceptor. A single nuclear explosion at an altitude of 100–1,000 kilometers (where the midcourse intercepts would take place) would cause ionization over a very large volume of space.[80] Electrons and ions spiraling in the Earth's magnetic field would then create moving striations—large variations in electron density in space and time—that would refract radar signals passing through the region.[81] A nuclear explosion would make accurate radar tracking of objects behind the ionized region impossible for UHF early warning radars.[82] Although X-band radars would have much smaller location errors, warhead radar cross sections (and therefore detection ranges) can be much smaller at these higher frequencies, and the fluctuations in the radar signatures of the warhead and

79. Kulacki, "Chinese Concerns about U.S. Missile Defense," p. 5.

80. For example, a 1-megaton burst at an altitude of 400 kilometers would create an ionized region 440 kilometers in diameter and extending from 270 kilometers to more than 1,000 kilometers in altitude. Radar tracking of any targets behind the ionized region would experience interference. See Philip J. Dolan, ed., *Capabilities of Nuclear Weapons*, Part One: *Phenomenology* (Washington, D.C.: Defense Nuclear Agency, July 1972), fig. 8-6.

81. Nonnuclear experiments conducted by the Department of Defense in the 1960s showed rapidly varying deflections in the UHF radar track of a missile behind an ionized region that were equivalent to location errors of 4 kilometers and variations in radar cross section by a factor of 10,000. See Defense Nuclear Agency, *High Altitude Nuclear Weapon Effects*, Part Two: *Systems Interference* (Fort Belvoir, Va.: Defense Nuclear Agency, 1963), https://www.youtube.com/watch?v=T6eLPLR_WPs. See also General Electric TEMPO, *Electromagnetic Blackout Guide: Effects of High Altitude Nuclear Bursts on Electromagnetic Waves*, Vol. 1 (Santa Barbara, Calif.: General Electric, May 1961).

82. See Dolan, *Capabilities of Nuclear Weapons*; and appendix.

other target objects would make discrimination even more difficult. Nuclear detonations would also generate large infrared signals, making it impossible for the sensors on the interceptor kill vehicle to detect incoming warheads against this background over a similarly large area.[83] These effects would greatly—perhaps impossibly—complicate midcourse discrimination.

In summary, it is extremely unlikely that the United States would be able to deploy a midcourse defense that would be effective against a sophisticated and responsive adversary. China has the ability to deploy a wide variety of countermeasures that would defeat U.S. BMD systems.

damage-limitation feasibility: near term versus longer term

The U.S. damage-limitation capability vis-à-vis China is in decline.[84] As recently as a decade and half ago, the United States had a highly effective counterforce capability against China, and BMD held out the possibility of enhancing this capability.[85] In terms of the damage-limitation range we specified at the outset, the United States now has the ability to achieve damage limitation at the higher level (40 EMT) by destroying China's silo-based ICBMs. At the same time, however, the United States appears to lack the ability to protect itself at the lower level (10 warheads on cities).

China's roughly 25 mobile ICBMs are likely survivable. This conclusion covers only politically plausible scenarios—the United States attacks once a crisis has become severe or during a conventional war, not by surprise during peacetime.[86] It also assumes that China alerts its forces early in a crisis, can launch its mobile ICBMs from unprepared positions, adopts best practices for operating its missiles, and can launch its mobile missiles following a U.S. attack against its nuclear C2. If any of these assumptions does not hold, then the United States' damage-limitation capability would likely be much more effective.

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83. A.T. Stair and Randall E. Murphy, *Background Assessment and Sensor Study* (Bedford, Mass.: A.T. Stair Associates, October 1993).

84. Our conclusion is consistent with recent RAND estimates that the number of Chinese warheads that would survive a U.S. counterforce strike will increase from 6 in 2003 to 15–27 in 2017, assuming a low alert posture, and from 15 in 2003 to 41–72 in 2017, assuming a high alert posture. See Eric Heginbotham et al., *The U.S.-China Military Scorecard: Forces, Geography, and the Evolving Balance of Power, 1996–2017* (Santa Monica, Calif.: RAND Corporation, 2015), table 12.7.

85. Charles L. Glaser and Steve Fetter, "National Missile Defense and the Future U.S. Nuclear Weapons Policy," *International Security*, Vol. 26, No. 1 (Summer 2001), pp. 58, 81–84.

86. During the Cold War, the United States gauged the adequacy of its forces against a bolt-from-the-blue surprise attack; this might be an appropriate conservative force-planning criterion, but judging the United States' damage-limitation capability in a surprise attack is not useful, because the scenario is implausible.

Of the 25 Chinese ICBMs that survive a U.S. nuclear attack, some are likely to suffer launch failures. A reasonable estimate of missile reliability is 80 percent; given this assumption, following a U.S. counterforce attack China would be able to launch 20 mobile ICBMs at the United States. If China does not employ countermeasures in response to U.S. BMD and the United States launches 2 GBIs at each warhead, then a reasonable estimate is that 10 of these Chinese warheads would reach the United States.[87] If China employs midcourse decoys and attacks U.S. tracking radars, the vast majority of the warheads it launches can be expected to reach the United States. The resulting damage would exceed the lower threshold of our damage-limitation range.

As the size of China's mobile ICBM force continues to grow, the U.S. damage-limitation capability will almost certainly decrease further. Once the Chinese force approaches 100 mobile missiles, which is the current projection for 2030, the United States will come close to losing its ability to limit damage at the upper edge of our damage-limitation range, if Chinese mobile ICBMs continue to be highly survivable. Assuming that the yield of the DF-31A warhead is 300 kilotons, these weapons would carry slightly more than 45 EMT; if their launch reliability is 80 percent and they are able to penetrate U.S. BMD, China's retaliatory capability would be 36 EMT.[88] Because the technological relationship in the competition between missile defense and countermeasures favors countermeasures, China's ability to defeat U.S. BMD is likely to outpace the United States' ability to improve it. Greater uncertainty about the future effectiveness of China's mobile missile force stems from possible advances in U.S. surveillance capabilities, but here too China is likely to be able to win the competition. And of course, China has the option of increasing its retaliatory capability by deploying more than the 100 mobile ICBMs that it is expected to deploy by 2030.

Our analysis indicates that the greatest uncertainty about China's current and future retaliatory capabilities lies in how effectively China responds to U.S. damage-limitation programs. Based on publicly available information, China has the ability to defeat the full range of U.S. damage-limitation programs by pursuing countermeasures and adopting best operational practices: China has the ability to ensure that its mobile missiles survive, that it can launch its surviving missiles, and that its surviving missiles will penetrate U.S. BMD. The outcome of the competition between U.S. damage-limitation capabilities and China's retaliatory capabilities will be determined by China.

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87. We assume that each GBI has a 30 percent chance of destroying a Chinese warhead.
88. See appendix.

China is likely to pursue the measures necessary to defeat efforts by the United States to preserve its damage-limitation capability. Given the increasing importance that China is placing on deploying an adequate retaliatory capability, it should pursue these policies.[89] Thus, the United States is unlikely to be able to preserve its damage-limitation capability. Of course, there is some chance that China will fail to adopt best practices and necessary countermeasures.

This possibility makes necessary an evaluation of the benefits, risks, and costs of U.S. possession and pursuit of a damage-limitation capability. If the benefits would be sufficiently large, or the risks and costs sufficiently small, then the United States should try to preserve and improve its damage-limitation capability, even if the probability of success is low and depends on China's failure to pursue policies required to meet its force requirements.

Benefits of a U.S. Damage-Limitation Capability

The United States might receive four types of benefits if it preserves and enhances its damage-limitation capability: (1) reduced costs to the United States in an all-out nuclear war; (2) an improved ability to deter a nuclear attack against the U.S. homeland; (3) an enhanced ability to deter attacks against its allies and an improved bargaining position if crises occur; and (4) a strengthened policy of reassurance of U.S. allies, especially Japan, regarding the effectiveness of the United States' extended deterrent, thereby helping preserve the alliances and supporting allies' decisions to forgo nuclear weapons.[90] We explore the benefits that would be provided by a damage-limitation capability of any size and assess the magnitude of the benefits that would be provided by the modest damage-limitation capability that the United States currently possesses.

REDUCING THE COSTS OF A NUCLEAR WAR

The most obvious and direct benefit of a damage-limitation capability is a reduction of the costs the United States would suffer in an all-out nuclear war with China. As discussed above, reasonable people are likely to disagree about

89. There is a reasonable counterpoint to this argument: it applied to the Soviet Union, yet the Soviet Union failed to operate its forces in the ways that were required to ensure their survivability. See Long and Green, "Stalking the Secure Second Strike."

90. These sections draw on and extend our earlier analysis of the benefits and costs of a damage-limitation capability against emerging nuclear powers. See Charles L. Glaser and Steve Fetter, "Counterforce Revisited: Assessing the Nuclear Posture Review's New Missions," *International Security*, Vol. 30, No. 2 (Fall 2005), pp. 84–126.

what constitutes meaningful damage limitation. Nevertheless, there is a substantial difference between the costs that the United States would incur if it were perfectly protected against a Chinese attack and those it would incur if one nuclear weapon exploded on a U.S. city; between the costs inflicted by 1 and by 10 warheads exploding on U.S. cities; and likely between the costs inflicted by 10 and by 100 warheads exploding on U.S. cities. When the number of warheads is larger, disagreement over the cost reduction achieved by U.S. damage-limitation forces is likely to be greater.

As summarized above, our analysis finds that today the United States likely possesses a modest damage-limitation capability—in realistic scenarios, it would likely remain vulnerable to approximately 20 300-kiloton Chinese warheads that would survive a U.S. counterforce attack and reliably launch against the United States. Growth of China's nuclear force will reduce the U.S. damage-limitation capability and whatever benefits it provides. This degradation is likely even if the United States competes with China to prevent it.

Enhancing Deterrence of a Nuclear Attack Against the U.S. Homeland

An indirect benefit of an enhanced damage-limitation capability is that it could reduce the probability of nuclear attacks against the U.S. homeland. A damage-limitation capability reduces the costs of an all-out war. Having such a capability could increase the credibility of U.S. threats to retaliate in response to limited nuclear attacks against the U.S. homeland. Such a capability could also provide the United States with a bargaining advantage in crises that China might escalate to nuclear war. This bargaining advantage could contribute to deterrence of the crisis itself. Whether a damage-limitation capability contributes a lot or a little to any of these outcomes depends on how effective the U.S. homeland deterrent would be without one. If already highly effective, there is little room for a damage-limitation capability to enhance the U.S. deterrent. As we explain below, this is the case for the United States. Consequently, the homeland deterrent value of even a highly effective damage-limitation capability would be small. Given that the United States lacks such an effective capability, the homeland deterrent value of its damage-limitation capability is even smaller.

Deterrence of nuclear attacks against a nuclear state's homeland is generally considered to be easy. An opponent is unlikely to doubt a state's willingness to retaliate following a massive attack on the state's homeland because at that point the state would have little left to lose. States that have survivable nuclear forces, and are therefore capable of nuclear retaliation, will be able to make highly credible retaliatory threats.

The amount of retaliatory damage the United States must be able to threaten

depends on how much the adversary values attacking the U.S. homeland. We therefore need to ask why China might want to attack the United States in the first place. Fortunately, there are no obvious reasons. Although popular discussions during the Cold War often envisioned nuclear war starting with a surprise attack launched under peacetime conditions, a bolt-from-the-blue attack is especially unlikely.[91] The benefits during peacetime of destroying U.S. military capabilities and economic capabilities would be small (or negative), and they would certainly be dwarfed by the enormous costs of a U.S. retaliatory attack that destroyed even a few major Chinese cities and industrial centers.

Whatever the stakes for China, the United States would be able to inflict nuclear retaliatory damage that greatly exceeded them. As we have already discussed, during the Cold War the United States set the maintenance of a redundant assured destruction capability—the ability to destroy in retaliation a substantial fraction of Soviet economic and industrial capability—as a basic nuclear force planning requirement. Even after large reductions in its nuclear forces, the United States still maintains an assured destruction capability vis-à-vis Russia; the U.S. retaliatory capability against China, which lacks the ability to destroy U.S. nuclear forces, is still larger. As a simple illustration, a single U.S. warhead detonated above a Chinese city would kill on the order of 1 million people through blast and fire; the warheads carried by a single U.S. submarine could kill more than 80 million people.[92]

Given the U.S. ability to inflict massive society-destroying damage, the only potential weakness in the U.S. homeland deterrent stems from the credibility of U.S. retaliation following a limited Chinese nuclear attack.[93] For example, if it were losing a conventional war, China might launch a small number of nuclear warheads against the U.S. homeland with the hope of compelling the

91. Preventive attacks intended to destroy a state's nuclear force in the early stages of development or deployment are the possible exceptions. On states' consideration of preventive attacks, see Rachel Elizabeth Whitlark, "All Options on the Table? Nuclear Proliferation, Preventive War, and a Leader's Decision to Intervene," Ph.D. dissertation, George Washington University, 2014; Mark Trachtenberg, "A 'Wasting Asset': American Strategy and the Shifting Nuclear Balance, 1949–1954," *International Security*, Vol. 13, No.3 (Winter 1988/89), pp. 5–49; Marc Trachtenberg, "Preventive War and U.S. Foreign Policy," *Security Studies*, Vol. 16, No. 1 (January/March 2007), pp. 1–31; and William Burr and Jeffrey T. Richelson, "Whether to 'Strangle the Baby in the Cradle': The United States and the Chinese Nuclear Program, 1960–64, *International Security*, Vol. 25, No. 3 (Winter 2000/01), pp. 54–99.

92. See appendix.

93. Meeting the requirements for deterrence does not guarantee that China will refrain from attacking the U.S. homeland; it does mean, however, that the United States cannot expect to reduce the probability that China will do so by acquiring different nuclear forces or adopting a different strategy for their use.

United States to stop fighting.[94] A limited nuclear attack against the U.S. homeland could communicate China's willingness to risk huge costs to prevail in the conflict and thereby convince the United States to back down.

The United States could pursue two approaches for addressing this issue: limited nuclear options (LNOs) and a damage-limitation capability. The threat of a limited U.S. nuclear attack on China should, at least in theory, be more credible than all-out retaliation, because a limited attack preserves Chinese incentives for restraint; China, understanding that the United States expects a limited Chinese response, should find U.S. threats of limited retaliation more credible. The Cold War produced an extensive literature and debate on LNOs.[95] The salient point here is that the bargaining logic of LNOs calls for attacks against targets that China values, not against Chinese nuclear forces.[96] Much of the Cold War nuclear debate hinged on this issue, with proponents of counterforce options offering a variety of rationales for large-scale U.S. counterforce attacks when the United States could not limit damage against the Soviet Union. Those arguments were flawed, among other reasons because they failed to adequately incorporate the bargaining logic of LNOs. Regardless of which LNOs the United States decides to make part of its strategy, none should target China's nuclear forces.[97]

The second approach for enhancing the ability of the United States to deter limited Chinese nuclear attacks against the U.S. homeland is to main-

94. This escalation would seem to violate China's no-first-use doctrine, but China appears to have a more malleable and ambiguous understanding of what constitutes first use than does the United States. See Michael S. Chase, "China's Transition to a More Credible Nuclear Deterrent: Implications and Challenges for the United States," *Asia Policy*, July 2013, pp. 85–88; Thomas J. Christensen, "The Meaning of the Nuclear Evolution: China's Strategic Modernization and U.S.-China Security Relations," *Journal of Security Studies*, Vol. 35, No. 4 (August 2012), pp. 474–481; and M. Taylor Fravel and Evan S. Medeiros, "China's Search for Assured Retaliation: The Evolution of Chinese Nuclear Strategy and Force Structure," *International Security*, Vol. 35, No. 2 (Fall 2010), pp. 79–80.

95. See, for example, Morton H. Halperin, *Limited War in the Nuclear Age* (New York: John Wiley and Sons, 1963); and Andrew L. Ross, "The Origins of Limited Nuclear War Theory," in Jeffrey A. Larsen and Kerry M. Kartchner, eds., *On Limited Nuclear War in the 21st Century* (Stanford, Calif.: Stanford University Press, 2014), pp. 21–48.

96. We distinguish between targets that are valued primarily for instrumental military purposes and targets that have inherent value.

97. There is a sound argument that LNOs should not be targeted against conventional military forces, or at least that the dominant consideration when choosing targets should be the implications for escalation of the war, not the impact on the battlefield. See Thomas C. Schelling, *Arms and Influence* (New Haven, Conn.: Yale University Press, 1966), pp. 105–116. Nonmilitary targets that might be considered appropriate for LNOs could include a range of economic and industrial facilities, including those that produce conventional weapon systems; oil refineries, chemical plants, and power plants; and factories that produce major industrial equipment. Many such facilities are located in less-populated areas outside city limits and could be subject to nuclear attack without destroying nearby cities. See appendix.

tain a significant damage-limitation capability. At least in theory, a damage-limitation capability could increase the credibility of U.S. threats to launch a limited nuclear attack in retaliation for a Chinese limited nuclear attack. The logic has two basic steps. First, by promising to reduce the costs of an all-out nuclear war, the U.S. damage-limitation capability increases the United States' willingness to pursue actions that raise the probability that the war would escalate to all-out war. A U.S. limited nuclear attack would certainly entail this risk. Second, assuming that China would appreciate this shift in U.S. incentives, the U.S. damage-limitation capability would increase Chinese estimates of the credibility of U.S. retaliation to a Chinese limited nuclear attack.

The U.S. damage-limitation capability also could increase China's estimate that the United States would launch a massive counterforce attack in response to China's limited nuclear attack; China's increased estimate of the massive U.S. attack could in turn contribute to deterrence of China's limited nuclear attack. Fearing that the war was going to become unlimited, the United States would likely consider launching a damage-limitation attack to reduce the costs; the costs would still greatly exceed the stakes over which the war was being fought, but would be smaller than if the United States suffered a full Chinese nuclear attack. If China appreciates the incentives the United States would have to launch this type of attack, it would be more likely to be deterred from launching a limited nuclear attack in the first place.[98] Recognition of these rationales for possible U.S. retaliation might also contribute to deterring China from starting a crisis or conventional war that it imagined could lead to nuclear war; that is, it might enhance the U.S. extended deterrent, which we address in the following section.

How much a damage-limitation capability would enhance the U.S. ability to deter a Chinese limited nuclear attack against the U.S. homeland must be judged relative to the deterrent value of the United States' massive retaliatory capabilities and its LNOs. These nuclear capabilities alone provide the United States with a highly effective homeland deterrent. If it were contemplating an attack, China would have to fear that its initial limited nuclear attack against the United States would lead to an all-out war through an unforeseeable series of escalating LNOs. In addition, even if China believed its limited nuclear attack might not lead to all-out war, it would almost certainly be deterred by the the prospect of a series of U.S. limited nuclear retaliatory attacks. Thus, there is little room for even a highly effective U.S. damage-limitation capability to im-

98. We explore these incentives, which are captured in the "stability-instability paradox," more fully in the section on the costs of a damage-limitation capability.

prove the United States' homeland deterrent. The modest damage-limitation capability that the United States currently possess would contribute even less. Because it is only partially effective (and declining)—China would be able to kill tens of millions of Americans in retaliation following a U.S. damage-limitation attack—the U.S. damage-limitation capability adds little to the credibility of U.S. retaliation. Consequently, its marginal contribution to the United States' homeland deterrent is exceedingly small.

ENHANCING EXTENDED DETERRENCE

Establishing sufficiently credible extended deterrence threats—that is, threats intended to deter attacks on U.S. allies—is widely believed to be much more difficult than establishing sufficiently credible homeland deterrent threats.[99] Because the interests of the United States in protecting its allies are smaller than its interests in protecting itself, China is more likely to doubt that the United States would carry out risky threats designed to protect its allies. Consequently, a damage-limitation capability might contribute more to extended nuclear deterrence than to homeland deterrence.

A damage-limitation capability could increase U.S. credibility vis-à-vis China in two ways. First, following the logic presented above, by providing the United States with the ability to reduce the costs of an all-out nuclear attack, a damage-limitation capability could convince China that the United States is more willing to escalate to nuclear use following a conventional attack against a U.S. ally, as well as to retaliate following a limited nuclear attack. Second, a damage-limitation capability could communicate to China the value the United States places on protecting its allies. Maintaining the U.S. damage-limitation capability would require the United States to make large investments in forces designed to counter China's growing nuclear force. The United States' willingness to make these investments, and thereby forgo other valuable uses of these resources, could signal to China that the United States places great value on protecting its allies. Whether a state should use competitive military policies, of which damage limitation is one among many, to communicate resolve is part of a long-standing debate over the relative merits of competitive and cooperative policies.[100] The risk is that competition may do more harm

99. For an early articulation of this position, see Glenn H. Snyder, *Deterrence and Defense: Toward a Theory of National Security* (Princeton, N.J.: Princeton University Press, 1961).

100. The divide is captured in the spiral and deterrence models. See Robert Jervis, *Perception and Misperception in International Politics* (Princeton, N.J.: Princeton University Press, 1976), chap. 3; Andrew H. Kydd, *Trust and Mistrust in International Relations* (Princeton, N.J.: Princeton University Press, 2007); and Charles L. Glaser, *Rational Theory of International Politics: The Logic of Competi-*

than good, generating insecurity instead of communicating resolve. The key issue is the extent to which an adversary is driven by insecurity rather than by revisionist/greedy motives. Thus, the wisdom of the United States pursuing a damage-limitation capability to communicate resolve depends partly on judgments about China's motives and goals.

Historically, the possibility that a damage-limitation capability would enhance the U.S. extended deterrent focused on conventional attacks, not nuclear attacks, against U.S. allies. During the Cold War, the United States relied on a first-use doctrine, threatening to escalate a conventional war in Europe to a nuclear war to deter a Soviet conventional attack. Soviet acquisition of the ability to inflict massive damage on the United States with nuclear weapons created doubts about the credibility of U.S. threats to escalate from conventional to nuclear war, and the United States spent much of the remainder of the Cold War developing forces and doctrines designed to maintain adequate credibility.

The value of a damage-limitation capability for enhancing conventional deterrence depends on the adequacy of U.S. and allied conventional deterrent capabilities. If conventional capabilities are adequate to deter the adversary's attack, then the marginal value of adding a credible nuclear escalatory threat is small. The problem during the Cold War was that NATO believed that the Soviet Union might have a serious interest in conquering Western Europe and that NATO's conventional forces were inferior to those of the Warsaw Pact.[101]

The situation the United States faces in Northeast Asia is very different from that faced by NATO during the Cold War. Although China's conventional capabilities have improved significantly, the United States' key allies, in combination with the United States, have excellent prospects for deterring large Chinese conventional attacks. Consider the critical case of Japan. Most U.S. analysts believe that the defense of the Japanese mainland is a vital U.S. interest and that preserving the U.S.-Japan alliance deserves a central place in U.S. grand strategy.[102] Thus, U.S. interests in Japan are sufficient to warrant U.S. threats to escalate to nuclear war.

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tion and Cooperation (Princeton, N.J.: Princeton University Press, 2010). On this rationale for U.S. counterforce policies during the Cold War, see Glaser, *Analyzing Strategic Nuclear Policy*, pp. 61–102, 240–242.

101. In fact, NATO conventional forces were likely much more capable than they were commonly given credit for. See John J. Mearsheimer, "Why the Soviets Can't Win Quickly in Central Europe," *International Security*, Vol. 7, No. 1 (Summer 1982), pp. 3–39; and Barry R. Posen, "Measuring the European Conventional Balance: Coping with Complexity in Threat Assessment," *International Security*, Vol. 9, No. 3 (Winter 1984/85), pp. 47–88.

102. For recent contributions in the long-evolving grand strategy debate, see Stephen G. Brooks, G. John Ikenberry, and William C. Wohlforth, "Don't Come Home, America: The Case against Re-

U.S. strategy for extending deterrence to Japan has received much less attention than did its strategy for extending deterrence to Western Europe,[103] in large part because Japan did not face a military threat comparable to the Soviet threat to Western Europe. The growth in China's conventional and nuclear forces is beginning to raise questions about the adequacy of the U.S. extended deterrent and possibilities for sustaining its effectiveness. Although China's conventional capabilities have increased substantially, they have not begun to pose a serious threat of successful invasion or embargo of the Japanese mainland. The limited extent of China's offensive capabilities reflects geography (Japan's distance across water from China), substantial Japanese and U.S. conventional capabilities, and China's current military goals—the latter of which have focused on reducing the ability of the United States to fight near China's periphery, not on projecting Chinese power. Although Japan's current situation is sometimes compared to West Germany's during the Cold War, there are important differences in the threat that Japan faces. As Richard Bush argues, China's conventional forces do not "pose the kind of material threat that the Soviet Union posed to Western Europe. China may some day have robust conventional forces that threaten the Japanese home islands, but that is a long-term problem. Moreover, Japan has the advantage of terrain that West Germany lacked: the Sea of Japan is not the North German plain. . . . So Japanese security specialists who tend to believe that their country is in the same structural position as West Germany in the Cold War have created a misplaced analogy."[104] Although China is increasingly able to use conventionally armed ballistic missiles to attack military targets in Japan, this is not the front edge of a capability for invading Japan or coercing it over vital interests.[105]

In addition, the credibility of the United States for using its conventional forces to defend Japan is high. Not only would vital U.S. interests be at stake, but, in a large war with Japan, China would almost certainly attack U.S. conventional forces deployed in Japan and elsewhere in the region. China's

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trenchment," *International Security*, Vol. 37, No. 3 (Winter 2012/13), pp. 7–51; and Barry R. Posen, *Restraint: A New Foundation for U.S. Grand Strategy* (Ithaca, N.Y.: Cornell University Press, 2014).

103. James L. Schoff, "Changing Perceptions of Extended Deterrence in Japan," in Toshi Yoshihara and James R. Holmes, eds., *Strategy in the Second Nuclear Age: Power, Ambition, and the Ultimate Weapon* (Washington, D.C.: Georgetown University Press, 2012), p. 104.

104. Richard C. Bush, "The U.S. Policy of Extended Deterrence in East Asia: History, Current Views, and Implications," Brookings Arms Control Series, paper 5 (Washington, D.C.: Brookings Institution, February 2011), p. 15.

105. On the long-term limits of China's A2/AD capabilities against Japan, see Stephen Biddle and Ivan Oelrich, "Future Warfare in the Western Pacific: Chinese Antiaccess/Area Denial, U.S. AirSea Battle, and Command of the Commons in East Asia," *International Security*, Vol. 41, No. 1 (Summer 2016), pp. 7–48.

antiaccess/area-denial strategy, which is designed to undermine the U.S. military's ability to operate effectively in East Asia, envisions preemptive attacks against U.S. forces based in the Western Pacific, including eventually Guam.[106] Consequently, in addition to providing the United States with a deterrence-by-denial capability, U.S. conventional forces have a tripwire function that parallels the role they played in Cold War Europe. The combination of highly effective deterrence-by-denial capabilities and the high credibility of the U.S. commitment to defend Japan meets the requirements for conventional deterrence. There is no plausible scenario in which Chinese leaders could reasonably foresee a quick and decisive victory.[107]

This military logic is reinforced by current political circumstances. Although tensions between China and Japan have been growing, there is no reason to believe that China is interested in invading Japan. As Brad Roberts has argued, "There are potential military flashpoints, but none has reason to fear outright invasion by another: most analysts assess the plausible pathways to major war as few or none, although there are growing concerns about armed clashes that might escalate into a war no one might have sought."[108]

Although the strength of the U.S.-Japan conventional deterrent weakens the case for a damage-limitation capability, the United States could nevertheless try to enhance its deterrent by relying on the threat of nuclear escalation. Based on the logic laid out above, a damage-limitation capability could increase the credibility of U.S threats. The marginal increase would be small, however, partly because the U.S. conventional deterrent is already so effective; and partly because the modest damage-limitation capability that the United States possesses, and might reasonably hope to maintain, would leave the U.S. homeland highly vulnerable to retaliation. In addition, if China believes that the damage that could be inflicted by a very small number of nuclear weapons is sufficient to deter essentially all U.S. attacks, which is China's long-stated position,[109] then the deterrent value of a modest U.S. damage-limitation capability would be still smaller.

In the context of a Japan scenario, the other purpose for which the United

106. On Chinese A2/AD capabilities and operations, see Roger Cliff et al., "Entering the Dragon's Lair: Chinese Antiaccess Strategies and Their Implications for the United States" (Santa Monica, Calif.: RAND Corporation, 2007).
107. On this criterion for effective conventional deterrence, see John J. Mearsheimer, *Conventional Deterrence* (Ithaca, N.Y.: Cornell University Press, 1983).
108. Brad Roberts, "Extended Deterrence and Strategic Stability in Northeast Asia" (Tokyo: National Institute for Defense Studies, August 9, 2013), p. 6, http://www.nids.go.jp/english/publication/visiting/pdf/01.pdf.
109. Fravel and Medeiros, "China's Search for Assured Retaliation."

States could rely on a damage-limitation capability is to deter Chinese limited first use of nuclear weapons against Japan or the United States.[110] A U.S. damage-limitation capability could increase the credibility of U.S. retaliatory threats, by reducing the potential costs of Chinese escalation to attacks against the U.S. homeland. The increase in U.S. credibility, however, would be even smaller than the increase that a damage-limitation capability would provide to U.S. threats of first use: having used nuclear weapons first, China would be more likely to expect the United States to retaliate with nuclear weapons. Moreover, as we discussed above, the United States can have a highly effectively deterrent of Chinese attacks against the U.S. homeland without a damage-limitation capability.

Whereas the case for the United States pursuing a damage-limitation capability against China is weak, the United States should prepare LNOs for deterring a Chinese limited nuclear attack against Japan. A U.S. doctrine that called only for all-out retaliation could fuel Chinese doubts about whether the United States would retaliate at all. China would appreciate that the United States would expect that China would unleash an all-out attack in response to the United States' all-out attack, and therefore that the United States would not launch such an attack. U.S. LNOs should be designed to deter additional Chinese attacks and possibly to improve the alliance's bargaining position over the terms for ending the war. The LNOs should be small and should not be used against Chinese nuclear and C2 targets.

The exception to this assessment is Taiwan. The U.S. ability to defeat, and thereby deter, a Chinese invasion of Taiwan has decreased over the past couple of decades. Whereas fifteen years ago China had virtually no prospect of invading Taiwan, today it can reasonably imagine a successful invasion.[111] Possibly more important, China has increased its capabilities for coercing Taiwan via conventional missile attacks or blockade.[112] Consequently, the potential value of nuclear escalation to deter Chinese conventional attacks may have increased, even though cross-strait relations are currently relatively good.[113]

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110. Although the ambiguity that exists in current Chinese doctrine would not permit first use of nuclear weapons by China in a war with Japan, we do not exclude this possibility.
111. On the cross-strait balance, see Heginbotham et al., *The U.S.-China Military Scorecard*; and David A. Shlapak et al., *A Question of Balance: Political Context and Military Aspects of the China-Taiwan Dispute* (Santa Monica, Calif.: RAND Corporation, 2009). On the future of the balance, see Biddle and Oelrich, "Future Warfare in the Western Pacific."
112. Biddle and Oelrich, "Future Warfare in the Western Pacific."
113. On the cross-strait relationship, see Scott L. Kastner, "Is the Taiwan Strait Still a Flash Point? Rethinking the Prospects for Armed Conflict between China and Taiwan." *International Security*, Vol. 40, No. 3 (Winter 2015/16), pp. 54–92.

Although little is known publicly about U.S. nuclear planning vis-à-vis China, we do know that a nuclear role for protecting Taiwan would not be new. The 2002 Nuclear Posture Review, in describing the types of scenarios against which the United States needed to plan, characterized "immediate contingencies" as involving "well-recognized current dangers. Current examples of immediate contingencies include an Iraqi attack on Israel or its neighbors, a North Korean attack on South Korea, or a military confrontation over the status of Taiwan."[114] This document does not describe how and why the United States might use nuclear weapons—whether it would be to destroy Chinese conventional forces, to demonstrate U.S. resolve, or to destroy China's nuclear retaliatory capability.

Whether the United States should preserve and enhance its damage-limitation capability to increase its ability to deter a Chinese conventional attack on Taiwan depends partially on the value the United States places on protecting Taiwan. Analysts disagree about whether Taiwan is a vital American interest, but few would rank its importance with U.S. allies in Western Europe or Japan. We believe that Taiwan is a secondary interest—important, but not nearly a vital interest. The case against U.S. reliance on a damage-limitation capability is further weakened by the asymmetry of interests between China and the United States. China considers Taiwan part of its homeland—an undisputable core interest—and has made clear its willingness to use force to prevent Taiwan from gaining independence.[115] In a crisis or war over Taiwan, the balance of interests would therefore strongly favor China. Although a U.S. damage-limitation capability could partly offset this asymmetry, by making the possibility of an all-out nuclear war less risky for the United States than for China, the modest and declining U.S. damage-limitation capability would leave the United States at a significant bargaining disadvantage. Given the limited U.S. interests at stake, the overall benefit offered by a modest U.S. damage-limitation capability is proportionately smaller.

Enhancing allies' confidence in U.S. extended deterrence

Even though the United States can meet its extended deterrence requirements without a damage-limitation capability, U.S. allies might not be confident that the U.S. extended deterrent is adequate: allies are generally harder to reassure

114. U.S. Department of Defense, "Nuclear Posture Review," p. 16. For a recent discussion of limited nuclear war that includes a possible scenario involving Taiwan, see Thomas G. Mahnken, "Future Scenarios of Limited Nuclear Conflict," in Larsen and Kartchner, *On Limited Nuclear War in the 21st Century*, pp. 138–140.

115. See, for example, Michael D. Swaine, "Trouble in Taiwan," *Foreign Affairs*, Vol. 83, No. 2 (March/April 2014), pp. 39–49.

than adversaries are to deter. Our discussion focuses on Japan; the basic points apply to other U.S. allies in Northeast Asia. A key dimension of Japan's satisfaction with U.S. extended deterrence capabilities has been the lack of a conventional existential threat to Japan. If China's conventional military capabilities improve to the point where they appear to pose such a threat, Japan may become dissatisfied with current U.S. extended deterrence capabilities.[116] Similarly, enlargement and improvements in China's nuclear force are beginning to raise questions in Japan about the adequacy of the U.S. extended deterrent. Richard Samuels and James Schoff observe that "Japanese strategists have to ask how much vulnerability the United States is willing to tolerate amid China's strategic modernization and what it is prepared to do on Japan's behalf, if anything, in response to China's moves."[117] There is a precedent for Japan's anxiety: during the Cold War, some Japanese strategists argued that Soviet acquisition of nuclear parity had undermined the effectiveness of the U.S. extended deterrent commitment.[118]

Japan and the United States will have a variety of options for trying to maintain the credibility of the U.S. extended deterrent. During the Cold War, the United States lacked a damage-limitation capability and relied successfully on a variety of other approaches to maintain the credibility of its commitment to Western Europe, including enhancing its large forward-deployed conventional forces, tightening the integration of its military capabilities with those of its NATO partners, deploying theater nuclear weapons on the soil of its NATO allies, and building LNOs into its strategic nuclear war plans. Because the threat facing the U.S.-Japan alliance is much less severe than that posed by the Soviet Union to NATO, these approaches should be sufficient to maintain Japan's confidence in its alliance with the United States, and they should not require U.S. deployment of nuclear weapons in Japan.[119] Recent changes, including the establishment of the Extended Deterrence Dialogue and the revision of the U.S.-Japan defense cooperation guidelines, indicate that the alliance is already striving to preserve U.S. credibility.[120]

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116. Richard J. Samuels and James L. Schoff, "Japan's Nuclear Hedge: Beyond 'Allergy' and Breakout," in Ashley J. Tellis, Abraham M. Denmark, and Travis Tanner, eds., *Strategic Asia 2013–14: Asia in the Second Nuclear Age* (Seattle, Wash.: National Bureau of Asian Research, 2013), pp. 245–246. More broadly on extending deterrence to Northeast Asia, see Roberts, *The Case for Nuclear Weapons on the 21st Century*, chap. 7.

117. Samuels and Schoff, "Japan's Nuclear Hedge," p. 250.

118. Mike M. Mochizuki, "Japan Tests the Nuclear Taboo," *Nonproliferation Review*, Vol. 14, No. 2 (July 2007), p. 312.

119. On possible ways for Japan to share U.S. nuclear weapons deployed on its soil, see Samuels and Schoff, "Japan's Nuclear Hedge," pp. 258–260.

120. On the Extended Deterrence Dialogue, see Roberts, "Extended Deterrence and Strategic Stability in Northeast Asia," p. 14; Government of the United States and Government of Japan, "The

Costs of a U.S. Damage-Limitation Capability

This section addresses two potential costs of pursuing a U.S. damage-limitation capability: increased pressures for escalation during a crisis or war; and negative impacts on Chinese security and U.S.-China relations, which might increase the likelihood of a crisis or war.[121]

Escalatory pressures and risks

A U.S. damage-limitation capability could increase the likelihood of Chinese escalation to nuclear war through a variety of paths, including intentional escalation and accidental and unauthorized use of nuclear weapons. It could also create incentives for the United States to escalate to nuclear use early in a crisis or conventional war. The current U.S. damage-limitation capability already creates these dangers. Improvements in the U.S. capability and certain Chinese reactions to U.S. damage-limitation capabilities would increase these dangers.

Unfortunately, most of these dangers would arise even if the United States lacked a significant damage-limitation capability, or any at all, because the dangers would result from policies that China adopted to undermine U.S. damage-limitation forces and from U.S. reactions to those policies. Certain of these dangers—for example, intentional Chinese escalation—would not exist, however, if the United States lacked a damage-limitation capability, and both the United States and China appreciate this fact. But even in situations in which the United States lacks a damage-limitation capability, the possibility that one or both countries believe incorrectly that the United States does possess one would re-create these dangers. Moreover, U.S. policies dedicated to damage limitation, whether or not successful, would increase the likelihood that both countries suffer this misperception.[122]

The vulnerability of China's nuclear forces could create incentives for China to use them early in a crisis or conventional war. If China plans to rely on the threat of limited nuclear attacks to coerce the United States to back down in a conflict over Taiwan or some other regional dispute, it could feel pressure to escalate early, fearing the United States would attempt to deny this option

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Guidelines for U.S.-Japan Defense Cooperation," April 27, 2015, http://archive.defense.gov/pubs/20150427_—_GUIDELINES_FOR_US-JAPAN_DEFENSE_COOPERATION.pdf; and Jonathan Soble, "Japan Moves to Allow Military Combat for First Time in 70 Years," *New York Times*, July 17, 2015.

121. A third cost, which we do not analyze here, is the economic cost of building the forces required to limit damage.

122. On these dangers during the Cold War, see Glaser, *Analyzing Strategic Nuclear Policy*, pp. 245–249.

to China by launching a damage-limitation attack early in the conflict.[123] The time pressure created by the United States' damage-limitation capability would thereby reduce the prospects for terminating a war before it escalates to the nuclear level. Even if the United States lacked a significant damage-limitation capability, continued U.S. pursuit of damage limitation could lead Chinese leaders to anticipate an American attack and therefore to make the decision escalate.

A different type of escalatory danger could result if China adopts a launch-on-warning posture to reduce the effectiveness of a U.S. damage-limitation attack. The danger created by a LOW posture is that China could decide to launch its nuclear weapons based on flawed information that led it to believe incorrectly that the United States had launched an attack against China's nuclear forces. Given the time pressures that accompany a LOW posture, a state is more likely to act on flawed information because it lacks time to adequately assess warning information. As noted in our discussion of C2, China would require vastly improved early warning systems to make possible a LOW posture, but the required technologies are within its reach.

The dangers of escalation would be even greater if China believes that the United States can cripple its command and control facilities. As discussed above, even if a U.S. attack against Chinese missiles would not by itself significantly limit damage, the United States might succeed by also attacking China's C2, thereby decreasing or even eliminating China's ability to launch whatever missiles survive. To reduce this vulnerability, the Chinese leadership could predelegate launch authority and capability to the military officers who operate the weapons, enabling them to launch an attack if the Chinese command authority had been destroyed. The danger is that field commanders might then launch an attack that the national leadership had not authorized, possibly because they believed their weapons are going to be destroyed or because they misunderstood an order from the leadership. In addition, the danger of an unauthorized launch might increase simply because, under tense and demanding conditions, there would be more individuals who were capable of launching a nuclear attack. Although current U.S. capabilities are sufficient to generate these dangers, improvements in U.S. damage-limitation capabilities would increase them. For example, if China believes that the United States is

123. This pressure is quite different and likely much weaker than the standard interlocking preemptive incentives that were the focus of much Cold War concern and analysis. That type of pressure does not currently exist, because China lacks the ability to destroy much of the U.S. nuclear force.

capable of destroying many of its mobile missiles, as well as much of its C2, and that U.S. BMD can intercept some of China's missiles that survive a U.S. counterforce attack, its leaders will believe that the United States is more likely to attack, and therefore they will feel greater pressure to decentralize China's launch authority.

The ability to destroy China's forces could also create incentives for the United States to attack early in a conventional conflict. If China has the capability to make its nuclear forces more survivable as a crisis deepens—as it likely would by increasing the alert rate and dispersal of its mobile missiles and by predelegating launch authority—the United States would face time pressure to launch a counter-nuclear attack before China is able to institute these survivability measures. The United States would face a "tactical window" of opportunity that created time pressures to attack China's nuclear capabilities,[124] even though the United States would prefer the conflict remain at the conventional level. It is, of course, extremely unlikely that the United States would take advantage of this opportunity to attack in response to Chinese mobilization early in a crisis, unless it believed that escalation to nuclear war was quite likely. A series of crisis interactions, however, could increase the probability of such a U.S. attack: improvements in U.S. damage-limitation capabilities would increase China's incentives in a crisis to disperse its forces and predelegate launch authority; these Chinese actions would create incentives for the United States to attack earlier, while its counterforce options were still effective; and the United States might interpret China's alert as indicating that China was planning to attack, thereby further increasing the time pressure for the United States to launch a damage-limitation attack.

Although we believe that these damage-limitation-fueled escalatory pressures reduce U.S. security, there is a counterargument: they enhance the U.S. ability to deter Chinese conventional attack and thereby increase U.S. security. According to this line of argument, without these escalatory pressures China might believe that a conventional war was so unlikely to escalate to a nuclear war that it would essentially disregard, or at least heavily discount, the danger posed by U.S. nuclear weapons. In other words, without creating these escalatory pressures, the contribution of U.S. nuclear forces to conventional deterrence is undermined by the "stability-instability paradox." During the Cold War, there was an extensive debate over the magnitude of this paradox and how best to address it.[125] We emphasize two key points. First, even without

124. On window pressures, see Stephen Van Evera, *Causes of War: Power and the Roots of Conflict* (Ithaca, N.Y.: Cornell University Press, 1999), chap. 4.
125. See, for example, Glenn A. Kent and David E. Thaler, *First Strike Stability: A Methodology for*

these counterforce-driven escalatory pressures, the possibility of a U.S.-China nuclear war should contribute substantially to deterrence of major Chinese provocations. The United States would be able to threaten limited nuclear strikes that should be far more credible than threats of an unlimited nuclear attack. Likely still more important, Chinese leaders should be concerned that a large conventional war, complicated by the "fog of war" and unforeseen twists and exigencies, would escalate.[126] Second, China and the United States could become involved in a large conventional war that escalated in unforeseeable ways from a much smaller confrontation.[127] In this type of scenario, pressures to escalate to nuclear war would do nothing to deter the original provocation; these pressures would, however, still increase the probability of escalation to nuclear war.

In short, through a variety of potential paths, U.S. damage-limitation capabilities and efforts to preserve and enhance them are likely to create pressures that increase the probability that a conventional war would escalate to nuclear war. Thus, even if U.S. damage-limitation capabilities did enhance deterrence of Chinese attacks against the U.S. homeland and extended deterrence, the United States would face a complex trade-off. Given the serious doubts our assessment raises about the extended deterrent value of U.S. damage-limitation capabilities, and the shortcomings of the stability-instability arguments, we conclude that these escalatory pressures would increase the overall probability of nuclear war between the United States and China.

NEGATIVE POLITICAL IMPACT ON U.S.-CHINA RELATIONS

A state's competitive military policies can reduce an adversary's security both by undermining military capabilities that it believes are necessary to protect its vital security interests and by communicating that the state has malign motives. Through the logic of the security dilemma, the adversary's increased insecurity can reduce the state's own security because a more insecure adversary is more likely to place greater value on expansion, to adopt riskier policies to prevail in disputes over territory, to pursue assertive foreign policies designed to divide the state's allies, and to compete intensely to improve its military capabilities. These policies can in turn lead the state to become more insecure

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Evaluating Strategic Forces (Santa Monica, Calif.: RAND Corporation, August 1989); and Glaser, *Analyzing Strategic Nuclear Policy*, pp. 224–226.

126. Nevertheless, there is evidence that suggests Chinese leaders are confident that a conventional war will not escalate. See Cunningham and Fravel, "Assuring Assured Retaliation," pp. 34–47.

127. Avery Goldstein, "First Things First: The Pressing Danger of Crisis Instability in U.S.-China Relations," *International Security*, Vol. 37, No. 4 (Spring 2013), pp. 49–89.

and to feel compelled to adopt more competitive policies of its own.[128] More specifically, U.S. damage-limitation efforts could further convince China that the United States wants to continue to dominate Northeast Asia, contribute to China's determination to undermine U.S. power projection capabilities, and encourage Beijing to pursue uncompromising policies in regional disputes.

Efforts by the United States to maintain its damage-limitation capability are likely to set in motion these dynamics, because they would be designed to deny retaliatory capabilities that China believes are necessary to protect its vital interests. China is especially likely to interpret competitive U.S. nuclear policies as reflecting malign U.S. motives because the United States has the option of choosing a less threatening strategy that promises to be highly effective—a full spectrum of nuclear retaliatory options without a damage-limitation capability. In other words, the United States would be choosing an offensive strategy—one that attempts to take away China's retaliatory capability and provide the United States with a clear nuclear advantage—instead of a defensive strategy that relies on retaliatory capabilities and accepts China's possession of the same. Nuclear weapons largely eliminate the security dilemma, but the United States would nevertheless be choosing an offensive strategy, which thereby clearly signals hostile motives.

Because the United States already deploys key components of a damage-limitation capability—nuclear forces capable of destroying all fixed land-based targets and highly capable ASW assets—the most significant addition to its damage-limitation programs would likely be real-time surveillance capabilities designed to track Chinese mobile missiles. Although, as discussed above, China would likely be able to defeat these U.S. surveillance capabilities, it would correctly interpret these U.S. systems as deployed to undermine its nuclear retaliatory capability. U.S. BMD designed to counter Chinese ballistic missiles would pose a second significant addition. Although Chinese countermeasures would almost certainly be capable of greatly reducing the effectiveness of U.S. BMD, here again China would likely perceive a significantly increased threat. China has long worried that U.S. BMD programs pose a threat to its retaliatory capabilities;[129] a U.S. program intended to intercept Chinese intercontinental-range missiles would generate even more concern.

128. The foundation of these arguments is built on the security dilemma and the spiral model. See footnote 100.

129. Jing-dong Yuan, "Chinese Response to U.S. Missile Defense: Implications for Arms Control and Regional Security," *Nonproliferation Review*, Vol. 10, No. 1 (Spring 2003), pp. 75–96; Kulacki, "Chinese Concerns about U.S. Missile Defense"; Twomey and Chase, "Chinese Attitudes toward Missile Defense"; and Cunningham and Fravel, "Assuring Assured Retaliation."

Prompt conventional weapons are a third type of new system that would likely generate Chinese concerns about a useable U.S. damage-limitation capability and, in turn, fuel Chinese beliefs that the United States has malign motives. If deployed in sufficiently large numbers, prompt conventional strike weapons could raise the specter of a U.S. damage-limitation capability that does not rely on nuclear weapons. These forces would be effective only if used before China alerted its nuclear forces, but they could appear more threatening if China believes that the United States would be more likely to use them.[130]

By forgoing deployment of these new systems, the United States would avoid sending China negative signals about its motives; doing so might even be interpreted as a positive signal. This signaling would be especially valuable because other efforts by the United States to send positive signals by reducing its existing damage-limitation capability would be harder to design and implement. Given the large number of U.S. nuclear warheads and the relatively small size of China's nuclear force, the deep cuts in the U.S. arsenal that would be required would not be strategically wise or politically feasible.

Conclusion

Whether the United States should try to preserve and enhance its ability to reduce its costs of a nuclear war with China is less clear-cut than the choice the United States faced during the Cold War. The Soviet Union deployed such a large and sophisticated force that available technologies held virtually no prospect of providing meaningful protection to the United States in an all-out nuclear war. In contrast, the United States currently possesses some capability to lower the costs of an all-out Chinese nuclear attack. This capability is being reduced by China's deployment of mobile ICBMs and might eventually be further reduced by Chinese SSBNs. A full-scale U.S. effort to challenge China's retaliatory capabilities might slow their growth. Over the longer term, however, China has excellent odds of prevailing in a contest between its retaliatory capabilities and the United States' damage-limitation capabilities.

The United States should not engage in such a competition with China because the benefits would be small compared to the risks. Working with its key allies, the United States can continue to meet the requirements for conventional deterrence without relying on the threat of nuclear escalation. Moreover, even without a damage-limitation capability, the possibility that an intense

130. For a nuanced discussion of Chinese views, see Cunningham and Fravel, "Assuring Assured Retaliation," pp. 19–23.

conventional war could escalate to nuclear war should contribute significantly to deterring China from launching a large conventional attack against a U.S. ally. Finally, because the United States possesses only a modest (and declining) damage-limitation capability, its marginal contribution to the U.S. extended deterrent is still smaller than would be provided by an effective damage-limitation capability, which this article shows is beyond the United States' reach. This assessment could change if China's conventional forces become much more capable and are not countered by corresponding improvements in U.S. and allied conventional defenses. Even then, the deterrent value of a modest damage-limitation capability would remain small. Taiwan is the exception here, because it is much more vulnerable to Chinese conventional capabilities. But given the asymmetry of interests—vital Chinese interests compared to limited U.S. interests—the increased risks generated by a damage-limitation strategy are not warranted.

There are political and military risks associated with possessing a modest damage-limitation capability and attempting to preserve it. Although such a capability could in certain situations reduce the probability of conventional and nuclear war, on net it is more likely to increase these probabilities. Intensified military competition would unavoidably accompany U.S. efforts to preserve its damage limitation capability. This competition would contribute to strains in U.S.-China relations during peacetime, and could increase the probability of conflict between the United States and China by leading each country to see the other as more threatening and therefore to be more unwilling to make political compromises. On the military side, U.S. possession of a damage-limitation capability creates pressures for China to alert its nuclear forces, predelegate launch authority, or prepare to launch on warning, or perhaps all of these, which increase the probability that a severe crisis or conventional war will escalate to nuclear war.

Other analysts may weight the benefits and risks of a modest damage-limitation capability differently. Nevertheless, once the poor prospects of success in the competition between U.S. damage-limitation forces and Chinese retaliatory forces are factored in, efforts by the United States to preserve its currently modest damage-limitation capability are a doubly bad bet.