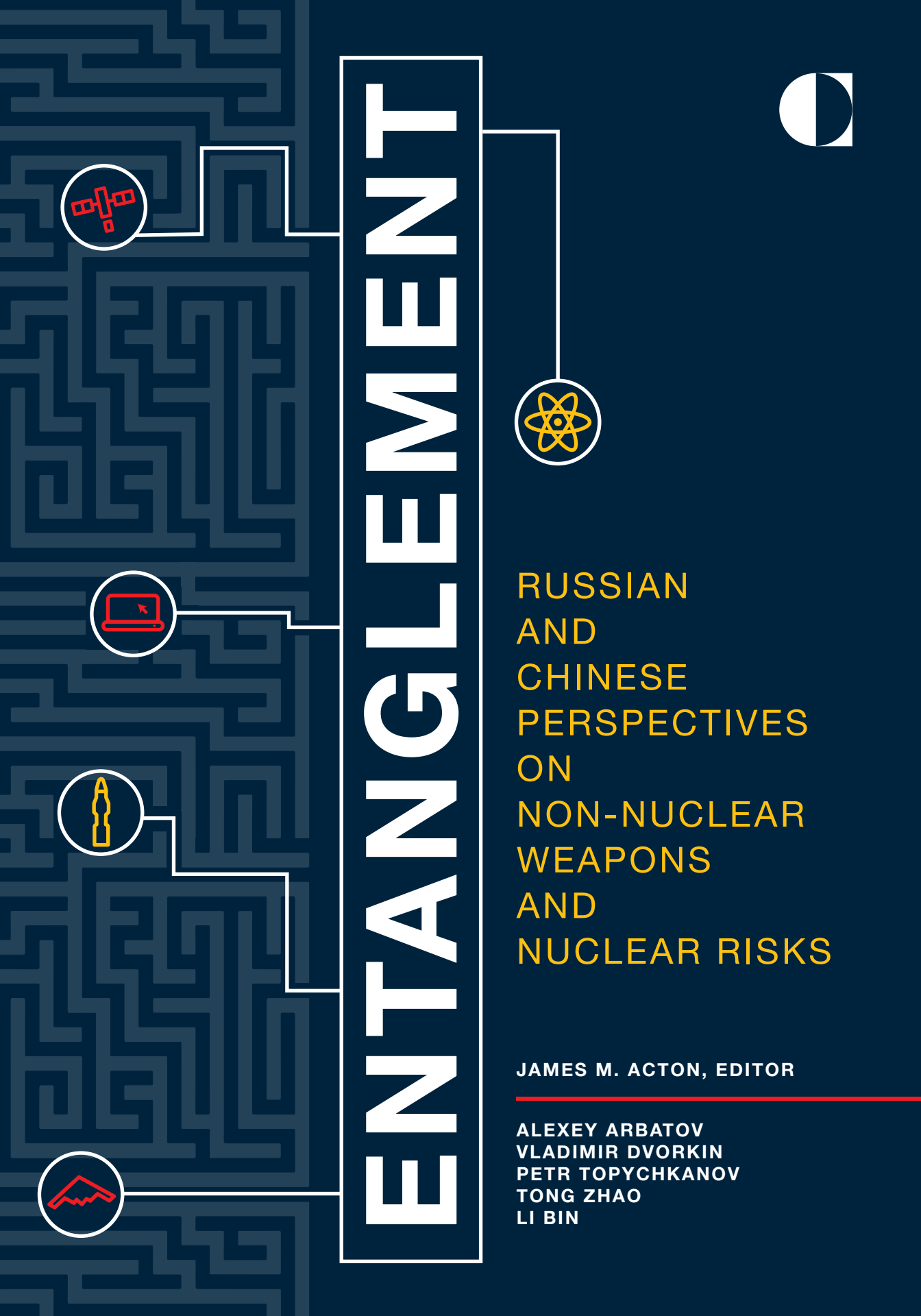

RUSSIAN AND CHINESE PERSPECTIVES ON NON-NUCLEAR WEAPONS AND NUCLEAR RISKS

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INTERNATIONAL PEACE

ENTANGLEMENT

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SUMMARY

The entanglement of non-nuclear weapons with nuclear weapons and their enabling capabilities is exacerbating the risk of inadvertent escalation. Yet so far, the debate about the severity of this risk has been almost exclusively limited to American participants. So Carnegie teams from Russia and China set out to examine the issue and answer two questions: How serious are the escalation risks arising from entanglement? And, how do the authors' views compare to those of their countries' strategic communities?

DEFINING ENTANGLEMENT

Entanglement has various dimensions: dual-use delivery systems that can be armed with nuclear and non-nuclear warheads; the commingling of nuclear and non-nuclear forces and their support structures; and non-nuclear threats to nuclear weapons and their associated command, control, communication, and information (C3I) systems. Technological developments are currently increasing the entanglement of non-nuclear weapons with nuclear weapons and their enabling capabilities.

A RUSSIAN PERSPECTIVE FROM ALEXEY ARBATOV, VLADIMIR DVORKIN, AND PETR TOPYCHKANOV

Entanglement, driven by technological and doctrinal developments in both Russia and the United States, is giving rise to the risk that a non-nuclear conflict—even a local one—might escalate rapidly and unintentionally into a global nuclear war. This danger is underestimated by politicians and military experts—including in Russia—because of a deeply rooted belief that escalation would be deliberate and not inadvertent.

RUSSIAN DOCTRINE AND ENTANGLEMENT

The concept of an "air-space war," which is at the center of contemporary Russian strategic thought, is ill-defined. Russian strategists appear to imagine a relatively prolonged conflict in which the North Atlantic Treaty Organization (NATO) launches non-nuclear air and missile strikes against Russia. Because of the inevitable limitations in Russia's ability to defend against these attacks, it might have to resort to the limited use of nuclear weapons in order to compel the United States and its allies into backing down. Such a conflict, involving nuclear and non-nuclear operations, defensive and offensive capabilities, and ballistic and aerodynamic weapons, would create a breeding ground for entanglement.

THE IMPLICATIONS OF NON-NUCLEAR STRATEGIC ARMS

An enduring concern among Russia's leadership is the threat of a massive disarming strike using non-nuclear high-precision weapons. In a non-nuclear conflict, U.S. strikes might inadvertently spark concern that such a counterforce attack was under way. For example, because strategic submarines and bombers are kept at the same bases as general-purpose naval vessels and aircraft, strikes designed to target the latter might unintentionally destroy the former.

That said, the effectiveness of an attempted disarming strike by the United States using conventional cruise missiles—and, in the future, hypersonic boost-glide weapons—backed up by missile defenses would be highly questionable. Indeed, Russia is already investing in the capabilities needed to ensure the survivability of its nuclear forces.

While this reality may cast doubt on the validity of the concerns held by Russia's leadership, these concerns may actually be motivated by doubts about whether it is possible to deter a conventional first strike by the threat of a massive nuclear response. In practice, however, Moscow might retaliate early with a limited strategic nuclear strike. Alternatively, it might even preempt the United States with selective strategic nuclear strikes to thwart U.S. naval and air forces that were perceived to be deploying for the purpose of initiating, or actually initiating a massive air-space attack.

The co-location of nuclear and general-purpose forces in the Soviet Union and now in Russia was and is prompted by economic and administrative considerations, not by the strategic goal of trying to deter U.S. non-nuclear strikes against Russian general-purpose forces through the threat of nuclear escalation.

At the moment, Russia's capability to launch non-nuclear strikes against U.S. strategic sites is very limited, though could be enhanced by the acquisition of hypersonic weapons. However, selective strikes against, for example, radars in Britain, Greenland, and Alaska, which provide both warning of a missile attack and support for ballistic missile defense operations, would be feasible but potentially escalatory.

ANTI-SPACE WEAPONS AND ENTANGLEMENT

Both the United States and Russia appear to have significant non-dedicated and potential anti-satellite capabilities. According to Russian thinking, the effectiveness of NATO's superior high-precision long-range non-nuclear weapons depends on space-based enabling systems, creating a vulnerability that Russia, even in a non-nuclear war, could not fail to take advantage of. Russia is also concerned about threats to its own satellites.

Entanglement arises because some of the satellites that might be attacked in a non-nuclear conflict also serve the United States' or Russia's strategic nuclear systems. As a result, their destruction would threaten to immediately escalate a war to the nuclear level, especially since strategic forces would probably be on top alert, even in the case of a local armed conflict.

Communication satellites, some of which are important for the command and control of missile submarines at sea and bombers on patrol, would be possible targets. Attacks on early-warning satellites could be even more dangerous. While these satellites would likely remain unaffected by anti-satellite operations during the course of a non-nuclear war, it is difficult to be certain. In particular, for selective nuclear or conventional strategic strikes to be effective, they would have to penetrate the opponent's missile defenses, which might require neutralizing early-warning satellites first.

The loss of Russian early-warning satellites might be considered as a precursor to a counterforce strike and provoke Moscow to initiate the sequence to launch intercontinental ballistic missiles (ICBMs)—though, under standard procedures, the actual launch would probably await attack confirmation by land-based early-warning radars or the destruction of those radars.

A CHINESE PERSPECTIVE FROM TONG ZHAO AND LI BIN

The risks of inadvertent escalation resulting from entanglement are real and growing. Because of Chinese policy choices, however, they are also somewhat less serious than many foreign experts believe.

CHINESE STRATEGIC THINKING ABOUT ESCALATION

Inadvertent escalation has not been a traditional element of Chinese strategic thinking. Moreover, China has had little direct experience with nuclear crises, which taught the Soviet Union and the United States about this danger.

In recent years, China has been paying more attention to inadvertent escalation—although this process has been hindered by the high degree of compartmentalization within the Chinese system. Most (if not all) Chinese experts have complete faith in China's no-first-use commitment and believe it greatly contributes to avoiding escalation. Many experts share the belief that military technologies, in and of themselves, do not necessarily make escalation more or less likely. Instead these experts emphasize the importance of specific deployment and employment strategies. There is also suspicion among Chinese experts that the U.S. stress on escalation risks is intended to undermine China's legitimate military modernization efforts.

MULTIFUNCTIONALITY AND AMBIGUITY

The multifunctionality of certain weapons and of certain military assets that could be targeted in a conflict could lead to inadvertent escalation. For example, some Chinese experts have argued that, in a conventional war, China should consider destroying American early-warning satellites to ensure the efficacy of Chinese conventional missile strikes against regional targets. The United States might, however, interpret such strikes as a very provocative attempt to deliberately undermine the U.S. capability to intercept Chinese ICBMs launched against the U.S. homeland.

Misinterpretation could also be caused by the deployment or employment of offensive weapons capable of threatening both nuclear and conventional targets. Some underwater unmanned vehicle operations, for example, can simultaneously threaten an enemy's nuclear ballistic missile submarines and its attack submarines. Even if the United States wanted to threaten only China's attack submarines and not its ballistic missile submarines, there would be a real risk that China would nonetheless suspect that its sea-based nuclear deterrent capabilities were in danger.

China did not entangle its nuclear and non-nuclear forces for the purpose of protecting the latter. It is now discovering, however, that such entanglement is potentially useful from this perspective and is correspondingly reluctant to increase its vulnerability by embarking on a process of separation.

DIVERGENT VIEWS ABOUT WEAPON DEPLOYMENT AND EMPLOYMENT

Misunderstanding can result from divergent views about the purpose and implications of deploying particular weapons or the circumstances in which those weapons might be used. The United States, for example, probably overestimates the likelihood of China's using anti-satellite weapons in a conflict, potentially making it prone to overreact to ambiguous indicators that Beijing is considering such use by, for example, launching a preemptive strike against perceived Chinese anti-satellite assets and facilities.

Meanwhile, the United States argues the Terminal High Altitude Area Defense (THAAD) system, which has been deployed to South Korea, is exclusively focused on defending against North Korean missiles. Chinese experts have, however, concluded that it is really directed at China, and have argued that China should be prepared to attack the THAAD system in the event of a U.S.-China military conflict. If Beijing were to launch such a strike, the United States and China would have very different understandings about Chinese intentions. China would believe that the strike was quite understandable and justifiable, and that it should not precipitate a U.S. overreaction. American decisionmakers, by contrast, would likely see the strike as extremely provocative.

ENTANGLEMENT AND RISK-TAKING

The development and deployment of certain non-nuclear technologies could influence a country's attitude toward risk-taking during a crisis and make it more or less likely to escalate. For example, Chinese experts believe—based on the statements of U.S. officials and media reporting—that the U.S. government is exploring the option of using cyber weapons to undermine potential enemies' strategic missiles and nuclear C3I systems during a crisis. For the United States to develop effective cyber capabilities, it needs to conduct constant probing during peacetime to map its enemy's network infrastructure and identify potential vulnerabilities. Such cyber reconnaissance may be occasionally detected and could therefore alert the enemy to the potential threat of cyber attacks against its nuclear deterrent. This heightened awareness of vulnerability could make a state more risk-averse—and prone to escalate—in a crisis.

THICKENING THE FOG OF WAR

The introduction of certain non-nuclear technologies could mitigate or exacerbate the fog of war, thus affecting the risks of inadvertent nuclear escalation. Some Chinese analysts, especially those arguing for the use of anti-satellite weapons in a limited regional war against the United States, tend to view the thickened fog of war that would

result from such strikes as a tactical military advantage for China. Another consequence, however, is that the United States might misinterpret Chinese military moves—such as exercises or the mobilization of missile forces—as preparations for actually using nuclear weapons and, as a result, might initiate preemptive strikes against Chinese nuclear forces or facilities. The fog of war can also create problems for the effective flow of information between oneself and the enemy. The increasing use by the United States of unmanned military systems, such as unmanned underwater vehicles, that can potentially undermine China's nuclear capabilities exemplifies this problem.

A U.S. PERSPECTIVE ON POLICY IMPLICATIONS FROM JAMES ACTON

Ironically, the belief that inadvertent escalation is improbable actually makes it more likely because political and military leaders are left less inclined, in peacetime, to take steps that could mitigate the risks, and more inclined, in wartime, to interpret ambiguous events in the worst possible light. Risk mitigation should be a priority for the U.S. government, though there is little evidence to suggest it is.

UNILATERAL MEASURES

Because of poor U.S.-Chinese and U.S.-Russian political relations, and because of disagreements about which state is to blame for causing escalation risks, unilateral actions are currently the most realistic approach to risk-mitigation. Raising awareness of inadvertent escalation risks among the individuals responsible for strategic-level decisionmaking in a crisis and factoring these risks into acquisition policy and war planning could be a powerful approach. Ideally, China, Russia, and the United States would all embark on this process, and each should do so irrespective of whether the others do.

INTERGOVERNMENTAL DIALOGUE

U.S.-China and U.S.-Russia intergovernmental discussions would be more challenging. Initially, the main purpose of these dialogues might simply be to assess escalation risks more accurately by better understanding a potential adversary's perspective. Advanced conventional weapons, the survivability of space-based nuclear C3I assets, and the interactions between cyber weapons and nuclear C3I systems could be initial foci for discussions.

COOPERATIVE MEASURES

Over the long term, cooperative confidence building and even formal arms control could play an important role in risk mitigation—though their prospects are currently bleak. Nonetheless, governments can and should start their homework to develop and assess proposals. The United States and Russia should assess transparency agreements that would preclude the "tacit massing" of platforms for delivering air- and sea-launched cruise missiles within range of the other's "strategic targets"; an agreement to prohibit the testing and deployment of dedicated anti-satellite weapons; and the inclusion of intercontinental boost-glide systems under the central limits of a successor to the New Strategic Arms Reduction Treaty.

There are many challenges to cooperative approaches. However, whatever real and serious U.S.-Russian and U.S.-Chinese disagreements exist, none of these states should want to reach the brink of a nuclear war—or go beyond it—before seeing the value of efforts to mitigate the risks of inadvertent escalation.

JAMES M. ACTON

PREFACE

THE LAST FEW YEARS have seen the reemergence of a debate about the severity of the risks of inadvertent escalation arising from the entanglement of non-nuclear weapons with nuclear weapons and their enabling capabilities. Such entanglement has various dimensions: dual-use delivery systems that can be armed with nuclear and non-nuclear warheads; the commingling of nuclear and non-nuclear forces and their support structures; and, most importantly, non-nuclear threats to nuclear weapons and their associated command, control, communication, and information systems.

To date, this debate has been limited in at least two critical respects: its participants have been, almost exclusively, American. And, it has focused, almost exclusively, on a U.S.-China conflict. There is, however, no obvious a priori reason why entanglement could not spark escalation in a U.S.-Russia conflict (indeed, the consequences of entanglement were first seriously considered in the 1980s in the context of a U.S.-Soviet conflict). Moreover, given the extent to which perceptions are important in driving escalation, the absence of Russian and Chinese views in today's debate is a serious weakness.

This volume represents an attempt to fill both lacunae. The main authors are some of the most distinguished and well-connected nuclear policy scholars in Russia and China: Alexey Arbatov, Major General (retired) Vladimir Dvorkin, and Petr Topychkanov, and Tong Zhao and Li Bin. These teams set out to answer two questions: How serious are the escalation risks arising from entanglement? And, how do the authors' views compare to those of their countries' strategic communities? The conclusion represents my view of the policy implications of their answers.

This work would not have been possible without the generous support of the Carnegie Corporation of New York. It would also have been impossible without the willingness of numerous current and former government officials and military officers, defense industry representatives, and nongovernmental analysts to engage with the Russian and Chinese research teams. Given that all of these meetings were conducted with a promise of anonymity, we cannot thank interviewees and workshop participants by name, but we are grateful to them nonetheless.

James Acton
Washington, DC
July 2017

ALEXEY ARBATOV, VLADIMIR DVORKIN,
AND PETR TOPYCHKANOV

ENTANGLEMENT AS A NEW SECURITY THREAT: A RUSSIAN PERSPECTIVE

ENTANGLEMENT, DRIVEN BY THE development of new non-nuclear technologies that can threaten nuclear weapons and their associated command, control, communication, and information (C3I) systems, is giving rise to the risk that a non-nuclear conflict—even a local one—between the great powers might escalate rapidly and unintentionally into a global nuclear war. This danger is underestimated by politicians and military experts—including in Russia—because of a deeply rooted idea about the nature of war as "a true political instrument, a continuation of political activity by other means,"[1] to quote the Prussian general and military strategist Carl von Clausewitz. This belief has led to a visceral assumption among contemporary Russian strategists that the decision to use force—including nuclear weapons—would be a rational step.

A corollary is that, since the great powers—Russia, the United States, and China—would inevitably sustain devastating damage in a nuclear war, none of them would consciously start one, making such a conflict extremely unlikely. This assessment is backed up by the apparent infallibility of mutual nuclear deterrence, and reaffirmed by calculations showing that neither the United States nor Russia could, by striking first in an effort to disarm its opponent, reduce the damage from retaliation to an acceptable level (whatever such a level might be). Russian military and political thinking largely ignores the possibility that the outbreak of a war may be unintended, the result of an uncontrolled escalation of

a military action-reaction sequence.[2] This may also be true of the new administration in the United States.

But as the history of wars has shown time and again, especially since 1945, a war between the great powers can arise not as the result of planned large-scale aggression but from a chain reaction of military operations by both sides that leads to the escalation of a crisis or regional war involving allies. In such situations, each side views itself as acting purely defensively, even if it carries out offensive actions, while believing that it is the enemy that has aggressive intentions or is reacting disproportionately.

In the Cold War, the superpowers managed to halt escalation before reaching the precipice of a direct conflict. In today's more complex world order, this luck may one day run out.

The Cuban Missile Crisis of October 1962 is a case in point: it was sheer luck that saved the world, at several points in this crisis, from a nuclear catastrophe, even though neither side wanted war and both feared its possibility. And, while this crisis may have been the most dangerous episode of the Cold War, it was not exceptional. Other crises and conflicts—including the Suez Crisis of 1956–1957, the Berlin Crisis of 1961, and the 1967 and 1973 Arab-Israeli wars in the Middle East—also threatened to spiral out of control. In each of these cases, there was some risk of nuclear war because the Soviet Union and the United States were involved (to varying degrees).

In the Cold War, the superpowers managed to halt escalation before reaching the precipice of a direct conflict. In today's more complex world order, this luck may one day run out, with terrible consequences, even though nuclear deterrence between Russia and the United States remains stable in the sense that neither can execute a disarming strike against the other.

Two trends give rise to this increased danger. The first is a general deterioration in international relations, including the tense militarized standoff over Syria and Ukraine between Russia on one hand and the United States and the North Atlantic Treaty Organization (NATO) on the other. This standoff encompasses a large region extending from the Mediterranean and Black Seas to the Baltic and Arctic regions. Tensions are also increasing in the Western Pacific between China and the United States and its allies—although they are presently less serious than in Europe.

The second trend is the development of new military technologies and exotic strategic concepts (such as "nuclear deescalation" and "limited strategic nuclear exchanges"). Of

particular consequence is the development of new non-nuclear weapons that might be used in a conflict against an enemy's nuclear arms, the bases at which those arms are deployed, and their associated command, control, communication, and information systems. Such entanglement erodes the traditional delineation between nuclear and non-nuclear arms, as well as between offensive and defensive systems, and creates the threat of a swift and unintended escalation of a local conventional armed collision between the great powers into a nuclear war.

More than a quarter of a century after the end of the Cold War, this combination of military and political factors has unexpectedly returned the threat of armed conflict—and even of nuclear war—between the great powers to the forefront of the international security agenda. Most worryingly of all, it is far from certain that today's political and military leaders in Russia and the United States see this danger, for example, in Syria, Ukraine, or the Baltic region.

This chapter provides a Russian perspective on the risks stemming from entanglement. It is divided into three sections. First, relatively new Russian thinking about the concept of a large-scale war involving the use of "air-space weapons" is discussed. This concept is becoming central to Russia's defense strategy and could exacerbate the escalation risks associated with entanglement. The second section focuses on Russian views about kinetic strikes by the United States against Russia's nuclear forces and their C3I system using high-precision conventional weapons, as well as similar strikes by Russia against the United States. The third section discusses Russia's capabilities for and thinking about threatening the United States' satellites, which include crucial elements of its C3I system, as well as Russian views on analogous U.S. capabilities against Russian space assets. One common thread that runs through this analysis is the role of Russia's new Air-Space Forces. Formed on August 1, 2015, from the merger of the Air-Space Defense Force and the Air Force, this new, unified element of Russia's armed forces is responsible for both defending against an air-space attack and conducting airstrikes and space attack operations.[3]

One issue that is not discussed at any length here is cyber threats to nuclear weapons and their C3I systems. Given the high level of secrecy about these issues, it is impossible to say anything even remotely specific about the possible implications of cyber weapons for nuclear escalation risks. Moreover, because the command-and-control systems of strategic nuclear forces are isolated and highly protected, they are, in all probability, not vulnerable to cyber attacks. Radio channels for communicating with and controlling satellites—especially missile early-warning assets—are more vulnerable. Disabling these channels or using them to create false warning of a missile attack could spark an unintended nuclear war, especially while the United States and Russia both have in place plans and systems for launching intercontinental ballistic missiles (ICBMs) upon warning of an incoming

attack. (This danger may be exacerbated if long-range, high-precision hypersonic glide vehicles were deployed in the future because land-based radars could not confirm in a timely manner that an attack using such weapons was taking place, meaning ICBMs would have to be launched only upon receiving warning from satellites.) Because the consequences of cyber interference with C3I systems may include a spontaneous nuclear exchange, such an action is highly unlikely to be taken by any of the world's great powers. It is more likely to be initiated by terrorists, or by rogue states in a crisis situation. The danger could be reduced by cooperation between the great powers in formulating a set of rules and procedures for detecting and exchanging information about, and jointly attributing the source of, cyber attacks.

AIR-SPACE WAR

"Air-space war" is paradoxically one of the most important and widely discussed concepts in the Russian security discourse but, at the same time, one of the least defined aspects of the country's contemporary strategic thinking. Russia's current Military Doctrine states that the most important task of the military is to provide "timely warning to the commander in chief of the Russian armed forces of an air-space attack," along with "guaranteeing the air-space defense of key sites in the Russian Federation and [ensuring] the readiness to repel an air-space attack."[4] The doctrine does not, however, define what an air-space attack is.

Similarly, professional military texts, which frequently discuss the theory of air-space warfare, do not provide a clear and precise definition of its aims and means. This absence does not, however, stop extensive explorations of the concept. Here is just one of numerous examples:

> Analysis of the development of the military and political situation in the world shows that for now and in the near future, the main threat to the Russian Federation in terms of a potential strike against its strategic sites is an air-space attack. In fact, the level of the threat to Russia in the air-space theater will only grow . . . air-space itself will become *the main and, at times, the only sphere* of armed conflict, and military action in it will assume a crucial role and global scale. In these circumstances the enemy will get the opportunity to inflict coordinated, in time and space, high-precision strikes against virtually all targets on Russian territory, and indeed across the entire world.[5] (Emphasis added.)

Against this background, Russian military and technical experts are currently engaged in efforts to elaborate strategies for fighting an air-space war. The following is an attempt

to frame such an integrated doctrine by one of its main theoreticians, Colonel Yuri Krinitsky from the Military Air-Space Defense Academy: "The integration of aerial and space-based means of attack has transformed airspace and space into a specific field of armed conflict: an air-space theater of military operations. United, systematically organized actions of [U.S.] air-space power in this theater should be countered with united and systematically organized actions by the Russian Air-Space Defense Forces. This is required under the National Security Strategy of the Russian Federation and Air-Space Defense Plan approved by the Russian president in 2006."[6] This document goes on to list the tasks of the Air-Space Defense Forces as "monitoring and reconnaissance of the air-space situation; identifying the beginning of an aerial, missile, or space attack; informing state organs and the military leadership of the Russian Federation about it; repelling air-space attacks; and defending command sites of the top levels of state and military command authorities, strategic nuclear forces' groupings, and the elements of missile warning systems."[7]

While picking apart in detail the organizational, operational, and technical aspects of the Air-Space Defense Forces (now part of the Air-Space Forces),[8] military analysts step around the basic question of what constitutes "the means of air-space attack" (SVKN in Russian, MASA in English). This term and "air-space attack" are broadly used in official documents (including the Military Doctrine) and statements, as well as in the new names of military organizations (such as the Air-Space Forces), and in a seemingly infinite number of professional articles, books, and pamphlets.

If MASA refers to aircraft and cruise missiles, then what does space have to do with it? To be sure, various military communication and intelligence, reconnaissance, and surveillance satellites are based in space, but these assets also serve the Navy and Ground Forces without the word "space" tacked onto their names.

If MASA refers to long-range ballistic missiles, which have trajectories that pass mostly through space, then this threat is not new but has existed for more than sixty years. There was—and still is—no defense against a massive ballistic missile strike, and none is likely in the future in spite of U.S. and Russian efforts at missile defense. In the past (and possibly now), one of the possible tasks of ballistic missiles was to break "corridors" in the enemy's air-defense system to enable bombers to penetrate it. But with ballistic missiles being armed with more warheads with improved accuracy, and with the advent of long-range air-launched cruise missiles, it is increasingly unnecessary for bombers to be able to penetrate enemy air defenses. Coordination between air and notional "space" systems has apparently moved to the background of strategic planning. Anyway, this tactic was never considered as air-space warfare before now.

MASA may be used in reference to potential hypersonic boost-glide weapons, which are discussed below. But their role and capabilities are not yet known, so it would clearly be premature to build the theory of air-space war on them, and even more so to start creating defenses against them. In any case, referring to those weapons as MASA is far-fetched: besides a short boost phase, their entire trajectory is in the upper atmosphere at speeds greater than airplanes but lower than ballistic missiles. It is, therefore, even less apt to describe such systems as space arms than it is to refer to traditional long-range ballistic missiles as such. Finally, as for theoretically possible space-based weapons that would conduct strikes against targets on the ground, at sea, and in the air, they do not yet exist, and their future viability is far from clear.

Even if the concept of air-space war is ill-defined, the military and technical experts who propound it reach a predictable conclusion with regard to the capabilities needed to fight one. They typically argue that Russia needs "to counter the air-space attack system with an air-space defense system. . . . A prospective system for destroying and suppressing MASA should be a synergy of anti-missile, anti-satellite, and air-defense missiles, and air units, and radio-electronic warfare forces. And its composition should be multilayered."[9]

Such calls are being translated into policy. Most notably, the air-space defense program, for which the military's top brass and industrial corporations lobbied, is the single largest component of the State Armaments Program through 2020, accounting for about 20 percent of all costs when the program was first announced in 2011—about 3.4 trillion rubles ($106 billion at the time).[10] Along with the modernization of the missile early-warning system by the development and deployment of new Voronezh-type land-based radars and missile-launch detection satellites, the program envisages the deployment of twenty-eight missile regiments of S-400 Triumph air-defense systems (about 450 to 670 launchers), and thirty-eight battalions equipped with the next-generation S-500 Vityaz (recently renamed Prometey) systems (300 to 460 launchers).[11] In total, the plan is to manufacture up to 3,000 missile interceptors of the two types, for which three new production plants were built. A new integrated and fully automatic command-and-control system is being created to facilitate operations by the Air-Space Defense Forces. The Moscow A-135 missile defense system (now renamed A-235) is being modernized with non-nuclear kinetic interceptors to engage incoming ballistic missiles (previously the interceptors were armed with nuclear warheads).[12] The current Russian economic crisis, which has resulted in defense budget cuts in fiscal year 2017, may slow down the air-space armament programs and the scale of arms procurement, but the underlying momentum will be unaffected unless stopped or redirected by a major change in Russia's defense posture.

In a sense, Russian policy may be explained by the visceral desire of the military to break out from the deadlock—the "strangulating effect"—of mutual assured nuclear

destruction, which has made further arms development, high-technology competition, and supposedly fascinating global war scenarios senseless (indeed, it prompted U.S. and Soviet leaders of the 1970s and 1980s to agree that, as then U.S. president Ronald Reagan put it, "a nuclear war cannot be won and must never be fought."[13]) During the four decades of the Cold War, several generations of the Soviet military and defense industrial elite had learned and become accustomed to competing with the most powerful possible opponent, the United States, and such competition became their raison d'être. The end of the Cold War and of the nuclear arms race in the early 1990s deprived them of this supposedly glorious quest, and opposing rogue states and terrorists was not a noble substitute. U.S. and NATO operations in Yugoslavia and Iraq, however, provided a new high-technology challenge, defined in Russia as air-space warfare, which was eagerly embraced as a new and fascinating domain of seemingly endless competition with a worthy counterpart. Besides, this new dimension of warfare doubtless gave the military and associated defense industries an opportunity to impress political leadership with newly discovered esoteric and frightening threats, justifying the prioritization of national defense, and hence arms procurement programs and large defense budgets.

The Russian strategy for air-space war is directly connected to the problem of entanglement.

In any case, the Russian strategy for air-space war is directly connected to the problem of entanglement. Astonishingly—and this makes the concept look quite scholastic—its framers shed no light on the single most important question: Is the context for air-space war a global (or regional) nuclear war, or a non-nuclear war that pits Russia against the United States and NATO?

If it is the former, then in the event of the large-scale use of ballistic missiles armed with nuclear warheads (and in the absence of effective missile defense systems), the Russian Air-Space Forces would be unlikely to function effectively. Except for issuing warnings about incoming missile attacks, they would not be able to fulfill the tasks assigned to them by Russia's Military Doctrine, including "repelling air-space attacks and defending command sites of the top levels of state and military administration, strategic nuclear forces' units, and elements of missile warning systems."[14]

Alternatively, if air-space war assumes a non-nuclear conflict, then the concept raises serious doubts of a different nature. Russian state and military leaders have regularly depicted terrifying scenarios of large-scale conflicts being won through non-nuclear means. Former deputy defense minister General Arkady Bakhin, for example, has described

how "leading world powers are staking everything on winning supremacy in the air and in space, on carrying out massive air-space operations at the outbreak of hostilities, to conduct strikes against sites of strategic and vital importance all across the country."[15] It is difficult to imagine, however, that such a conflict, in reality, would not quickly escalate to a nuclear exchange, especially as strategic forces and their C3I systems were continually attacked by conventional munitions.

Right up until the mid-1980s, the military leadership of the USSR believed that a major war would likely begin in Europe with the early use by Warsaw Pact forces of hundreds of tactical nuclear weapons "as soon as [they] received information" that NATO was preparing to launch a nuclear strike.[16] After that, Soviet armies would reach the English Channel and the Pyrenees in a few weeks, or massive nuclear strikes would be inflicted by the USSR and the United States on one another, and the war would be over in a few hours, or at most in a few days, with catastrophic consequences.[17]

After the end of the Cold War, the task of elaborating probable major war scenarios was practically shelved because such a war had become unthinkable in the new political environment. However, strategic thinking on the next high-technology global war apparently continued in secret (and probably not only in Russia). Now, at a time of renewed confrontation between Russia and the West, the fruits of that work are finally seeing the light of day. In all likelihood, the authors of the strategy imagine that over a relatively long period of time—days or weeks—the West would wage a campaign of air and missile strikes against Russia without using nuclear weapons. Russia, in turn, would defend against such attacks and carry out retaliatory strikes with long-range conventional weapons. Notably, in 2016, Russian Defense Minister Sergei Shoigu stated that "by 2021, it is planned to increase by four times the combat capabilities of the nation's strategic non-nuclear forces, which will provide the possibility of fully implementing the tasks of non-nuclear deterrence."[18]

In other words, the basic premise is that the U.S.-led campaigns against Yugoslavia in 1999 or Iraq in 1990 and 2003 (which are often cited by experts in this context) may be implemented against Russia—but with different results, thanks to the operations of the Russian Air-Space Forces, the Strategic Rocket Forces, and the Navy against the United States and its allies.

The emphasis on defensive and offensive strategic non-nuclear arms does not exclude, but—on the contrary—implies the *limited* use of nuclear weapons at some point of the armed conflict. Sergei Sukhanov, one of the most authoritative representatives of the defense industries as the constructor general of the Vympel Corporation, which is responsible for designing strategic defense systems, has exposed the whole panorama of Russia's

contemporary strategic logic on the interactions between offensive and defensive systems and between nuclear and non-nuclear systems:

> If we cannot exclude the possibility of the large-scale use of air-space attacks by the U.S. and other NATO countries (i.e., if we accept that the Yugoslavian strategy might be applied against Russia), then it is clearly impossible to solve the problem by fighting off air-space attacks with weapons that would neutralize them in the air-space theater, since this would require the creation of highly effective air- and missile defense systems across the country. Therefore, the strategy for solving the air-space defense tasks faced in this eventuality should be based on deterring the enemy from large-scale air-space attacks by implementing *the tasks facing air-space defense in this eventuality* at a scale that would avoid escalation but force the enemy to refrain from further air-space attack.[19] (Emphasis added.)

In other words, because of the inevitable limitations in Russia's ability to defend against air-space attacks, Sukhanov argues that Russia may have to resort to the limited use of nuclear weapons in order to compel the United States and its allies into backing down. This basic logic is widely accepted in Russia.

Judging by the available information, the United States does not have—and is not expected to have for the foreseeable future—the technological means or the operational plans to wage non-nuclear air-space warfare against Russia. However, the fact that a major war with the United States and NATO is seen in contemporary Russian strategic thinking as a prolonged endeavor involving an integrated technological and operational continuum of nuclear and non-nuclear operations, defensive and offensive capabilities, and ballistic and aerodynamic weapons creates a breeding ground for entanglement. The result could be the rapid escalation of a local non-nuclear conflict to a global nuclear war. The remainder of this chapter discusses how new and emerging military technologies might contribute to such an escalation.

NON-NUCLEAR STRATEGIC ARMS AND ENTANGLEMENT

The first and most likely type of entanglement would be interactions between tactical nuclear weapons and non-nuclear arms. There is a risk that tactical nuclear weapons might accidentally be attacked in a conventional conflict because their delivery vehicles are collocated at bases with—and can be used together with—general-purpose forces and weapons. Moreover, they employ dual-use delivery vehicles operated by the Navy, Air Force, and Ground Forces (these include the Iskander and Tochka land-based missile systems operated by the Ground Forces, the Navy's Kalibr sea-launched cruise

missiles, and the Navy's and Air Force's medium bombers and tactical strike aircraft). In addition, command posts and storage depots for tactical nuclear weapons at naval and air force bases, in particular, could be targets for deliberate strikes by non-nuclear attack systems.

Conversely, of course, tactical nuclear weapons could be used to strike non-nuclear targets. Tactical nuclear arms may be effectively used against concentrations of ground force units and their bases, as well as against airfields, naval bases, submarines, and surface ships. Such use could provoke nuclear retaliation against naval bases and airfields. Moreover, land-based Iskander missiles in the Kaliningrad region are openly advertised in Russia as weapons that can be used with nuclear or conventional warheads to attack U.S. ballistic missile defense installations in Europe, in particular the launchers for Standard Missile-3 interceptors and their associated radars in Poland (often referred to as Aegis Ashore).[20] This danger is particularly great in light of new strategic concepts, developed by both Russia and NATO, for the early use of nuclear weapons in a non-nuclear conflict aimed at deescalating it.[21] Such use could, in fact, have the opposite effect, triggering a rapid escalation with devastating consequences.

The first and most likely type of entanglement would be interactions between tactical nuclear weapons and non-nuclear arms.

A large volume of scientific and political analysis has been devoted to the topic of tactical nuclear arms, however. For the remainder of this analysis, the problem of entanglement is viewed primarily in relation to strategic offensive and defensive weapon systems and their C3I complexes.

Limited strategic strikes (that is, limited strikes with ICBMs, sea-launched ballistic missiles, or heavy bombers, most likely against the U.S. homeland) in response to non-nuclear threats represent another form of entanglement. Russia's Military Doctrine reserves the right to use nuclear weapons in response to "aggression against the Russian Federation with the use of non-nuclear weapons, when the state's existence is put under threat," but (like the doctrines of other nuclear-armed states) it does not specify either the meaning of "the state's existence" or the scale of such nuclear weapons use.[22] Presently, limited strategic nuclear strikes are not publicly mentioned in official Russian or U.S. documents in relation to this subject. Still, some information has leaked through the writings of professional military experts at think tanks associated with the Ministry of Defense. For example, a group of such Russian experts points out that

> the main peculiarity is the limited nature of the initial nuclear impact, which is designed not to embitter, but to sober the aggressor, making it stop the attack and get down to negotiations. In the absence of such reaction it is envisioned to escalate the massiveness of nuclear weapons employment in numbers and yield. Hence, it is assumed that the first nuclear use by the Russian Federation is limited. The opponent's reaction is calculated both as a massive and as a limited nuclear strike. The second in our view looks more probable. After all, it was the United States where the concept of a limited nuclear war was born.[23]

There are some reasons to suppose that analogous thinking is elaborated in the U.S. strategic community, which has adopted the concept of "tailored nuclear options for limited use."[24]

Such concepts are as artificial as they are dangerous. If presented in a crisis to a cocky, inexperienced, and strategically ignorant leader, they might turn into a recipe for disaster. Together with the revived concepts of using tactical nuclear arms for deescalation in a local, conventional war between Russia and NATO, they are the most dangerous innovation in contemporary military strategies, creating a high probability of catastrophic entanglement.

An enduring notion has formed in the Russian leadership, and to a large extent within the expert community, about the real possibility that a massive, disarming strike using non-nuclear high-precision weapons could be conducted against key sites of Russia's military nuclear infrastructure. This is an element of the air-space warfare mentality discussed above.

These concerns have even been voiced by President Vladimir Putin. During a speech at the Valdai Discussion Club in 2015, he stated: "A strategy already exists for a so-called first disarming strike, including with the use of long-range, high-precision non-nuclear weapons, the effect of which may be compared to that of nuclear arms."[25] A year earlier, the president had also talked about this concern when discussing a potential reduction in nuclear arms: "Today, the capacities of many kinds of high-precision [non-nuclear] weapons are already close to those of weapons of mass destruction, and in the event that nuclear weapons are given up completely or significantly reduced, countries that are the leaders in creating and manufacturing high-precision systems will have a clear military advantage."[26]

Deputy Prime Minister Dmitry Rogozin has made comments along similar lines, saying that a strike with high-precision conventional weapons could destroy 90 percent of Russia's strategic forces in several hours.[27] Meanwhile, Pavel Sozinov, the constructor general of the military-industrial Almaz-Antey corporation, which designs and manufactures air-defense systems, has spelled out this threat in more detail: "The main threat now is

the massive use of cruise missiles early on in a strike. . . . Under the U.S. rearmament program, primarily for its sea-based forces, the country will in 2015–2016 have about 6,500–7,000 cruise missiles that could be used against key sites in the Russian Federation, and about 5,000 of those will be launched from the sea. . . . Such a massive use of cruise missiles during the first phase of military action could inflict colossal damage on Russia's strategic nuclear sites."[28]

U.S. AND RUSSIAN CAPABILITIES

U.S. subsonic cruise missiles: Currently, the United States is the clear leader in terms of the quality and quantity of its high-precision non-nuclear cruise missiles. The U.S. Navy alone has more than 600 Tomahawk Land-Attack Missiles deployed on four Ohio-class nuclear-powered cruise missile submarines, each carrying 154 missiles; twenty-five Virginia- and Seawolf-class attack submarines carrying a total of 500 missiles; and twenty-two Ticonderoga-class cruisers and sixty-two Arleigh Burke–class destroyers, which together carry about 4,560 missiles. In total, according to unconfirmed reports, by 2020 the United States could deploy about 6,300 Tomahawk cruise missiles. Work on improving this type of weapon continues. In 2014, for example, the U.S. Air Force announced the adoption of a new type of air-to-surface cruise missile, the AGM-158B Joint Air-to-Surface Standoff Missile Extended Range, commonly known as JASSM-ER.[29]

Russian subsonic cruise missiles: Faced with this reality, Russia is striving to dramatically increase its arsenal of high-precision cruise missiles. Currently, long-range missiles are in use that can be fitted with both nuclear and non-nuclear warheads, including the Kh-55SM missile, various modifications of the Kalibr missile, and the new Kh-101/102 air-launched cruise missiles. Public information about the total number of cruise missiles manufactured in Russia is not available. However, in 2013, Shoigu did announce that the number of cruise missiles in service of the Russian armed forces would increase fivefold by 2016, and thirtyfold by 2020.[30] In 2014, the refitting of the *Admiral Nakhimov* nuclear-powered heavy cruiser began with the goal of turning it into the first Russian ship equipped with long-range high-precision cruise missiles. This move suggests that Russia is seeking to implement the the strategy of developing a non-nuclear strategic deterrent, as envisaged by the new version of Russia's Military Doctrine that was approved in December 2014.[31] Regardless of the extent to which these proposed plans are actually implemented because of the current economic crisis, there are obvious signs of an arms race in this area.

The term "hypersonic weapons" generally incorporates two different technologies: hypersonic cruise missiles and boost-glide weapons. The former are being developed by a number of countries, including Russia and the United States, which has recently tested the prototype X-51A.

Hypersonic boost-glide weapons, which can travel over much longer ranges and at much higher speeds than hypersonic cruise missiles, are more significant from a strategic perspective. They are being developed and tested primarily in China, Russia, and the United States. These missiles are being designed to carry out high-precision strikes on various targets in a considerably shorter time period than existing subsonic cruise missiles.

U.S. boost-glide weapons: In the last decade, the United States has conducted flight tests of two intercontinental hypersonic boost-glide vehicles. One set of tests involved the Hypersonic Technology Vehicle-2 (HTV-2) glider, which Lockheed Martin began developing in 2003 and was intended to have a global range. This glider was tested twice, in 2010 and 2011. In both cases, the test was terminated prematurely after less than three minutes of aerodynamic flight due to different problems. Although this program has not been terminated entirely, it is now funded at a very low level, and no more flight tests are currently planned.

The Advanced Hypersonic Weapon (AHW) program has seen more success. This glider is intended to have a range of about 8,000 kilometers (almost 5,000 miles) and has been tested twice. The U.S. Department of Defense has stated that the first test, in 2011 over a distance of 3,800 kilometers, was successful. A second test over a longer distance in 2013 failed before aerodynamic flight was even achieved because of a booster failure. Further flight tests of this system are expected. To date, the U.S. Department of Defense has not announced any plans for deploying the system.

Soviet and Russian boost-glide weapons: The first Russian development efforts and flight tests of hypersonic systems took place in the late 1970s and early 1980s, probably under the Albatross project (later reports have assigned this project the code name 4202). The start of intensive work in this area, as in many others, was prompted by the American Strategic Defense Initiative (SDI), announced by Reagan in 1983. SDI envisaged a multilayered ballistic missile defense system consisting of space-, air-, sea-, and land-based components to defend against a massive Soviet ballistic missile attack.

In response to the SDI, the Soviet Union undertook a series of symmetrical and asymmetrical countermeasures. The Albatross project belonged to the latter group. The details of this project remain secret, although information about various versions of the system has recently begun to leak to the Russian media.[32]

According to that information, in 1987, the development of an actual missile system was begun by the Machine-Building Scientific Manufacturing Center after a government decree. In theory, the system was intended to use a liquid-fueled UR-100N UTTKh (SS-19) intercontinental ballistic missile to boost a hypersonic glide vehicle into space, after which it would turn back and accelerate toward the earth before gliding, initially

at an altitude of 80 to 90 kilometers (roughly 50 to 55 miles), over intercontinental distances at hypersonic speeds. The glider, armed with a nuclear weapon, would make rapid cross-range maneuvers to evade U.S. missile defenses. The first Albatross flight tests were reportedly conducted in 1991 and 1992.[33] According to media reports, further tests have taken place since 2001. These tests reportedly involved UR-100N (SS-19) missiles, launched from silos, the doors of which could not be closed because of the size of the glide vehicle. Various plans to deploy hypersonic glide vehicles on three-stage solid-propellant missiles—including the Universal ICBM (which was scrapped during the development phase) and the Topol-M (SS-27) ICBM—were developed but did not materialize. More recently, it has been reported that glide vehicles could be deployed on the next generation Sarmat RS-28 liquid-fueled heavy ICBM.[34]

Contrary to some descriptions, maneuvering to evade ground-based missile defense systems was probably not the main purpose of the Albatross glider, especially since its speed decreased significantly while descending through the atmosphere, rendering it vulnerable to interception even by U.S. Patriot anti-aircraft missiles. Instead, the flight trajectory was probably intended to reduce the likelihood of the reentry vehicle being intercepted by the space-based missile defense systems envisaged by SDI.

At present, there is no available information about how the gliders developed under the Albatross project attempt to defeat ground-based missile defenses while they are decelerating during the terminal phase of their trajectory. Judging by the information available from open sources, it is also not clear whether Russian hypersonic boost-glide weapons will be fitted with conventional warheads for the conventional deterrent purposes mentioned in Russia's Military Doctrine,[35] or with nuclear warheads. If the latter, the primary purpose of these weapons would be to ensure that a limited strike—perhaps even just one weapon—could penetrate any future U.S. missile defense system.[36]

THE EFFECTIVENESS OF NON-NUCLEAR DISARMING STRIKES

This threat of a non-nuclear disarming strike is a central topic of discussion among Russian experts and government officials. The key bone of contention is whether the United States might attempt a massive conventional counterforce attack against Russia (which would inevitably be less effective than a nuclear counterforce strike), assuming that Moscow would be reluctant to respond with nuclear weapons given the certainty of follow-on nuclear retaliation by the United States. A particular issue of concern is that Russia's emphasis on the threat of a conventional disarming strike could be perceived in the United States as evidence of Moscow's unwillingness to use nuclear arms to counter such a strike, prompting the United States to start precisely this kind of conventional air campaign to attain escalation dominance in a local or regional conflict.

In reality, however, and in contrast to such strategic calculations, Moscow might retaliate early with a limited strategic nuclear strike in the event that the United States launched a conventional counterforce operation against Russia's nuclear forces (in accordance with Russia's launch-under-attack doctrine). Alternatively, Moscow might even preempt the United States with selective strategic nuclear strikes to thwart U.S. naval and air forces that were engaged in a conventional conflict and perceived as conducting a conventional counterforce offensive by launching attacks against airfields, naval bases, and their C3I facilities. In the latter case, Moscow would count on the United States' responding selectively with "tailored strategic options" even after nuclear explosions had occurred on its territory. In reality, the U.S. response might be a large-scale nuclear attack against Russia, provoking a massive nuclear exchange. In any case, the more concerned that Moscow is about the survivability of its nuclear forces, the more likely escalation becomes.

Moscow might retaliate early with a limited strategic nuclear strike in the event that the United States launched a conventional counterforce operation against Russia's nuclear forces.

Targets for a non-nuclear disarming strike might include super-hardened command centers at various echelons, ICBM silos, light shelters for land-based mobile missiles, exposed mobile ICBM launchers in the field, ballistic missile submarines at their bases, heavy bombers at main and reserve airfields, communication sites on land, early-warning radars, command centers for the missile early-warning system, and storage depots for nuclear weapons.

The vulnerability of these targets depends on how well they are defended and concealed, and on the effectiveness of countermeasures against incoming weapons. Early-warning radars, light shelters for mobile ICBM launchers, missile submarines at their bases, and heavy bombers at airfields, as well as C3I centers and sites that are not deeply buried, can be incapacitated relatively easily if the attacking weapons have sufficient range and good targeting.

In the event of a local or regional conventional conflict between Russia and NATO in Eastern Europe or the Arctic, airstrikes and cruise missile attacks against these sites would most likely cause rapid escalation to a nuclear war. In particular, early U.S. strikes against such targets might not be deliberate since Russian strategic submarines and bombers are kept at the same bases as general-purpose naval vessels and aircraft, and strikes designed to target the latter may inadvertently destroy the former. Unlike the logic that may be behind Chinese policies, the co-location of nuclear and general-purpose forces in the

USSR and now in Russia was and is prompted by economic and administrative considerations, not by the strategic goal of trying to deter U.S. non-nuclear strikes against Russian general-purpose forces through the threat of nuclear escalation.

The interception of heavy and medium dual-use bombers in flight during a conventional conflict also makes entanglement virtually inevitable. These bombers might take part in conventional missions, but might also be sent out on patrol with nuclear weapons to decrease their vulnerability in case the conflict escalates. If these aircraft were destroyed while carrying nuclear weapons, there would be a real risk of escalation. A similar risk could arise from conventional threats to Russian nuclear-armed ballistic and cruise missile submarines in the Arctic, North Atlantic, and Pacific Oceans.

There is more of a debate in Russia about the vulnerability of hardened sites, such as ICBM silos. While the official position is that such sites could be threatened by non-nuclear weapons, some analysts, including professionals from Ministry of Defense institutes, disagree. For example, in one article, the possibility of an effective disarming strike against ICBM silos using subsonic cruise missiles with non-nuclear warheads is dismissed on the following grounds:[37]

- The destructive power of nuclear and non-nuclear weapons in a strike against hardened point sites is incomparable, which means a large number of non-nuclear weapons would have to be used.
- The possibility of jamming cruise missile guidance systems, hence rendering the missiles less effective, would increase this number even further and require an aggressor to amass a very large number of cruise missiles and their delivery platforms.
- It would be extremely difficult to plan simultaneous strikes of this nature against several hundred targets located across Russia's vast territory (since missiles launched from different locations would almost inevitably reach their targets at different times, Russia would have the opportunity to launch at least some nuclear weapons before they were destroyed).
- It would be necessary to assess the results of strikes, and repeat them if necessary.
- An operation using cruise missiles would be impossible to implement in one attack wave, or even in one day, which would give Russia an opportunity to retaliate during the course of attack.
- It would take a long time to generate the required forces for this operation. Such preparations would be impossible to conceal, giving Russia time to put its nuclear arms, early-warning systems, and command systems on high alert.

The authors cite calculations of the effectiveness of simultaneous attacks by cruise missiles against Russian ICBM silos in the deployment area of Tatishchevo (which could be reached by cruise missiles launched from the Black Sea), where about 90 silos are located. To be 95 percent certain of hitting just one silo would require 14 cruise missiles with an accuracy (circular error probable) of 5 meters. An accuracy of 8 meters would require 35 missiles, which would imply using altogether 3,150 cruise missiles against just one deployment area. Moreover, many other ICBM basing areas are simply out of range for sea-launched cruise missiles. The United States does not have the number of cruise missiles needed to carry out simultaneous attacks against all such targets, and will not for the foreseeable future.

Russia seeks to use defensive systems and offensive non-nuclear arms to postpone the need for nuclear retaliation at least during an initial phase of the air-space war.

In fact, there are many other measures that could be taken to counter attacks by cruise missiles: the location of mobile ICBM launchers could be changed frequently during high-risk periods; decoy targets that are superficially similar to real ICBM launchers could be deployed; strategic missile submarines could be sent to sea and protected by other naval forces; bombers could be dispersed and placed on strip or airborne alert; fixed strategic sites could be defended with highly effective Pantzir-S2 close-range anti-aircraft gun and missile complexes, as well as by other air- and missile defense systems.

The ineffectiveness of an attempted disarming strike by the United States with cruise missiles—as well as its lack of the required number of missiles—casts doubt on the validity of the concerns held by Russia's leadership. These concerns may, however, be motivated by doubts about whether it is possible for Russia to deter such a strike with the threat of a massive nuclear response; after all, such a response would certainly invite massive nuclear retaliation by the United States. As a result, Moscow's concerns about conventional counterforce remain unabated, and it has placed a heavy emphasis on air-space defense, conventional deterrence, and limited nuclear strike options, which, it is hoped, would not provoke massive nuclear retaliation by the United States, but would instead make Washington stop fighting and start negotiating.

The Russian strategy for deterring a counterforce strike with cruise missiles does not, therefore, rely on the threat of rapid nuclear escalation (which is possibly China's approach). Instead, Russia seeks to use defensive systems and offensive non-nuclear arms to postpone the need for nuclear retaliation at least during an initial phase of the air-space war—at any rate, this is what the Air-Space Forces' doctrine assumes. In practice, however, a real

conflict might develop quite differently from how Russia hopes it would. In particular, if Russia were to conduct a limited nuclear strike against the United States at some stage, it is very unclear whether the United States' nuclear response would be limited.

Looking forward, Russia's leadership worries about the potential for hypersonic weapons to contribute to conventional counterforce. The likelihood of a counterforce attack by the United States using non-nuclear hypersonic systems also seems low in both political and military terms, considering the high risk of a retaliatory nuclear strike by Russia. Nonetheless, from a purely technical perspective, hypersonic weapons would have certain advantages for counterforce compared to existing weapons.

Hypersonic cruise missiles being developed in Russia and the United States would travel at much higher speeds than existing cruise missiles. Although they can be detected at quite long distances because of the altitude at which they travel, their speed makes it more difficult for both anti-aircraft systems and air-defense fighters to intercept them.

The main potential threat to strategic targets, however, comes from boost-glide weapons. Boost-glide systems could solve or alleviate some of the challenges associated with the use of existing subsonic cruise missiles:

- Deploying intercontinental gliders in the United States would significantly reduce the time required to prepare for an attack, and make such preparations less noticeable by Russia.
- Boost-glide weapons could reach their targets much more quickly than existing cruise missiles (in forty to sixty minutes for boost-glide weapons launched from the continental United States compared to two to two-and-a-half hours for subsonic cruise missiles launched by aircraft and submarines in their forward launch positions. The duration of the first attack wave would also be much shorter.
- Fewer missiles would be required since the defender's ability to intercept them would be reduced.

Boost-glide weapons could also have certain advantages over ballistic missiles. To be sure, modern strategic land- and sea-based ballistic missiles, all of which are currently armed with nuclear warheads, travel at higher average speeds than boost-glide weapons and have shorter flight times. Moreover, there is no protection from a massive ballistic missile attack. However, boost-glide weapons have the potential to be much more accurate. Ballistic missiles use inertial guidance (supplemented by a celestial navigation system in some weapons), which typically gives them an accuracy of 100–200 meters—all that is required given they are armed with nuclear warheads. Boost-glide weapons, by contrast, are likely

to utilize external navigation signals (such as those generated by the Global Positioning System), and could also have terminal homing capability (such as terrain mapping).

Even more importantly, there are key differences in the trajectories between ballistic missiles and boost-glide weapons. The trajectories of ballistic missiles are predictable and observable. Their launch can be detected by early-warning satellites in the first few minutes of their flight. Their trajectory can then be confirmed by missile early-warning radars ten to fifteen minutes before the impact of their warheads. In theory at least, these characteristics give the opponent's missile defense system the chance to intercept the incoming missiles in the middle or at the end of their trajectories. More plausibly, they give the opponent the opportunity to carry out a retaliatory strike before the aggressor's warheads detonate.

The launch of boost-glide weapons could, like ballistic missiles, be detected by satellites. However, they then enter the atmosphere and fly at much lower altitudes than ICBMs or sea-launched ballistic missiles at hypersonic speeds along unpredictable trajectories. Because of the altitude at which they fly, boost-glide weapons would be largely invisible to missile early-warning radars, leading to much-reduced warning times. Missile early-warning radars might only detect incoming boost-glide weapons three or four minutes before impact, while anti-aircraft defense radars might detect them less than three minutes before their impact.[38]

To detect such strikes with enough time to track and intercept them, Russia would have to dramatically modify its early-warning and command-and-control systems, and deploy new interceptors—such as the S-500 and Pantzir-S2 air-defense systems—in significant numbers, which would come with a large price tag.

Although there would be significant challenges to detecting and intercepting boost-glide weapons, it is questionable whether they would be accurate enough, if armed with non-nuclear warheads, to destroy hardened ICBM silos and command centers. Meanwhile, attacking land-based mobile systems would require course correction at the final stage of the incoming missile's trajectory. If the required information was obtained though satellites or aircraft, it would create a vulnerability the defender could exploit by, for example, radio-electronic warfare to interfere with satellite signals. Alternatively, autonomous terminal homing would probably require a boost-glide weapon to decelerate sharply, giving the defender an opportunity to physically intercept it.

Finally, it is unclear whether the United States will manufacture boost-glide missiles, which would be expensive, in large enough quantities (in the hundreds) to present a threat to Russia's strategic deterrent. Some Russian experts argue that such missiles, even in a limited quantity, could be used to hit crucial command centers in the Moscow

region and other locations housing national leadership. Such concerns are unfounded, however, since Russia's redundant command-and-control system for its strategic nuclear forces would be very hard to destroy. In fact, some command centers are hardened so they could withstand even a direct nuclear impact—never mind strikes by high-precision conventional warheads.

That said, military and civilian defense officials in Russia are obliged to consider a worst-case scenario. In particular, the trajectory of a boost-glide weapon could make it difficult to launch ICBMs under attack (launch-under-attack is still Russia's main—but not exclusive—operational concept for a large-scale nuclear war and the main criterion for assessing the sufficiency of its strategic forces). Ground-based radars would only detect an incoming glider late in flight—too late, in fact, to launch ICBMs before they were hit. As a result, a launch-under-attack option would have to be executed exclusively on the basis of satellites' detecting the launch of boost-glide weapons, without confirmation of an attack from ground-based radars.

Incidentally, an attack by boost-glide weapons against Russia's strategic forces would be still more effective if the gliders were armed with nuclear warheads. For this reason, Moscow is seriously suspicious that U.S. boost-glide systems will be nuclear armed, although this concept has not been openly discussed in the United States since the end of the Cold War. That said, however boost-glide weapons are armed, their introduction—and the threat they would pose to Russia's nuclear forces—would significantly increase the likelihood of a nuclear war resulting from a false alarm by early-warning satellites. This danger is probably the biggest risk created by entanglement involving boost-glide weapons.

Russia is responding to the threat posed by hypersonic weapons. The S-500 air-defense complexes (which are under development) are designed precisely to protect strategic nuclear sites from future hypersonic cruise missiles and boost-glide weapons. To this end, they are due to be integrated into a unified C3I system with both space- and land-based missile early-warning assets. To protect Russia's military and political leadership from ballistic missiles and non-nuclear boost-glide weapons, Russia is modernizing the Moscow A-135 missile defense system as well as deploying the S-400 and, in the future, S-500 air-defense systems.

Non-nuclear hit-to-kill ballistic missile defenses exacerbate Moscow's concerns about U.S. non-nuclear offensive systems. The most simplistic logic postulates that the United States would count on destroying the bulk of Russian strategic forces—90 percent, according to Rogozin, as noted above—through a conventional counterforce operation. The remainder—50 to 60 missiles, if 10 percent of the force survived—would be intercepted by U.S. and allied ballistic missile defenses deployed in Europe, Asia, Alaska, California, and, in the future, a possible site in the northeastern United States. At present, the number of U.S.

interceptors is estimated in Russia at more than 300, including Ground-Based Interceptors in the United States, Terminal High Altitude Area Defense (THAAD) system interceptors at various locations across the globe, and Standard Missile-3 interceptors in Europe and on ships. By 2020, their number is projected to stand at more than 1,000.[39] A more sophisticated concern is that even though the U.S. missile defense system would be unable to stop a massive missile attack by Russia, it would be capable of thwarting selective or limited strategic strikes, which are envisioned as Russia's answer to conventional air-space aggression. Future Russian conventional or nuclear boost-glide systems are considered as a potential means to penetrate such defenses, thus further blurring the line between conventional and nuclear warfare and aggravating the threat of entanglement.

At the moment, Russia's capability to launch non-nuclear strikes against U.S. strategic sites lags far behind the United States' ability to target equivalent Russian sites with non-nuclear means.

At the moment, Russia's capability to launch non-nuclear strikes against U.S. strategic sites lags far behind the United States' ability to target equivalent Russian sites with non-nuclear means. Russian capabilities mainly affect U.S. allies in Europe and Asia, and in particular targets such as depots of U.S. tactical nuclear weapons, missile defense components (including radars and launchers), key industrial sites, and possibly British and French strategic forces (specifically submarines and aircraft at their bases).

It would be difficult for Russian heavy bombers, nuclear-powered attack submarines, and ships, which are the delivery platforms for high-precision conventional cruise missiles, to break through the defenses of the United States and its allies—though selective strikes are feasible against radars in Britain, Greenland, and Alaska that provide both warning of a missile attack and support for ballistic missile defense operations, as well as against some other strategic sites. Russia would have a greater chance of inflicting damage with potential hypersonic systems. If these systems were to be equipped with non-nuclear warheads, the result could be entanglement that could trigger escalation of a conflict to nuclear war.

ANTI-SPACE WEAPONS AND ENTANGLEMENT

In addition to high-precision conventional attacks against an opponent's nuclear forces on land and at sea, along with their supporting infrastructure, the biggest threat of entanglement would come from the use, during a local or large-scale conventional war,

of anti-satellite weapons equipped with non-nuclear warheads against satellites that are a crucial part of the opponent's strategic C3I system.

Military satellites operate at all types of orbit. About 25 percent of them (including many intelligence, surveillance, and reconnaissance satellites) are located in low-earth orbit, while another 20 percent (including the satellites involved in navigation) occupy medium-earth orbit. The remaining 55 percent, which include early-warning and strategic communication satellites, operate in highly elliptical and geostationary orbits. The vast majority of defense spacecraft belong to the United States; funding for its military space program significantly exceeds that of all the other countries with such programs combined.[40]

Space systems have become an integral part of the combat capability of the armed forces of the world's most powerful countries. Without them, military action by those countries would be virtually impossible or at least ineffective in today's world. The space-based capabilities that make the biggest contribution to the effectiveness of military action are information and communication systems.

U.S. AND RUSSIAN CAPABILITIES

U.S. anti-satellite programs: The United States began serious work into anti-satellite technology in 1957. From 1963, nuclear-armed interceptors, based initially on the Nike-Zeus missile and then the Thor missile, were placed on alert on two Pacific islands. In 1974, these interceptors were withdrawn from service and mothballed.

In 1977, the United States reinvigorated its anti-satellite weapon efforts, including by developing the Miniature Air-Launched System (MALS). This missile, launched by an F-15 fighter, would carry a miniature homing vehicle designed to destroy a satellite kinetically up to an altitude of about 1,000 kilometers (over 600 miles). In 1984–1986, this system underwent flight tests that included one test against a physical target in space. Russia anticipated that the United States planned to use the system to hit up to three satellites operating in low-earth orbit in twenty-four to thirty-six hours. In 1988, the MALS program was canceled. Moscow believes that preparing the system for use today would take several months.

In 1989, efforts to develop a ground-based anti-satellite system, the Kinetic Energy Anti-Satellite program, were initiated. It was described as "ecologically friendly" because it was designed to minimize the risks associated with orbital debris. Russia believed that this system was intended to destroy all low-earth orbit military satellites within a week. This system was never deployed, even though the United States manufactured three kill vehicles, and funding eventually fizzled out in the early 2000s.

The United States also experimented with using a ground-based laser, the Mid-Infrared Advanced Chemical Laser based at the U.S. Army's White Sands Missile Range in New Mexico, as an anti-satellite weapon. In October 1997, it was used in a test that reportedly damaged the sensor of a satellite operating at an altitude of 420 kilometers (about 260 miles).[41]

Interest in anti-satellite technologies was renewed during the administration of then president George W. Bush. Funding was provided to develop lightweight lasers, including for potential deployment in space. Moreover, U.S. missile defense efforts, which were scaled up significantly during that administration, have provided the United States with a significant anti-satellite capability—even if Washington has not acknowledged that such efforts are being pursued, at least in part, for this reason. The Airborne Laser, for example, which consisted of a powerful laser mounted on a Boeing 747 aircraft and was designed to intercept ballistic missiles during their boost-phase, could be used to attack satellites in low-earth orbit. This system was tested successfully against ballistic missiles on various occasions, and although it was cancelled in 2011, there has been some talk of its revival. From the perspective of anti-satellite operations, the most significant U.S. missile defense capability is the Standard Missile-3 interceptor, which is deployed on various U.S. Navy ships as part of the Aegis ballistic-missile defense (BMD) system. In 2008, one of these missiles was actually used to destroy a nonresponsive U.S. satellite in a decaying orbit, which U.S. officials claimed posed a threat to humans on the Earth's surface.

Soviet and Russian anti-satellite programs: The destruction of an opponent's space systems was seen in the Soviet Union as an entirely natural and legitimate aspect of a possible global nuclear war from as early as the 1960s.[42] To this end, radio-electronic jamming systems and interceptors were developed as and when permitted by technology and financing.

The Soviet Union's most important program was a ground-based, missile-launched co-orbital "satellite killer" designed to destroy satellites in low-earth orbit kinetically. The key elements of this system were in place by 1967, and the first successful interception was conducted on November 1, 1968. Field testing of this system, which was capable of destroying satellites at altitudes of between 250 and 1,000 kilometers (about 150 to 600 miles), began in February 1973 at the Baikonur space launch facility. After further development, including an increase in its interception range, the weapon entered service in 1978 with the designation IS-M.

In April 1980, the Soviet Union restarted testing of this anti-satellite system with the updated designation IS-MU. More than twenty full-scale experiments were carried out, of which one-quarter involved physical targets. The final test was conducted on June 18, 1982.[43] The IS-MU remained in service until 1993, when then Russian president Boris

Yeltsin ordered it to be withdrawn from service.[44] This complex was designed to intercept enemy satellites less than one orbital revolution after its launch, which would prevent the United States from tracking it using ground stations and thus taking evasive actions. The biggest threat it posed was to U.S. KH-11-type reconnaissance satellites.[45]

The Soviet Union conducted work on other anti-satellite systems, too. The Kontakt air-launched missile system, which would have been carried by a MiG-31 fighter-interceptor and was similar to the U.S. MALS, was under development until the early 1990s. Funding ran out, however, before tests could be completed. This system would have enabled the interception of all low-Earth-orbit satellites flying over central Russia.

In August 1983, the Soviet Union pledged not to deploy any kinds of weapons in space first, "so long as other states refrain from deploying any kinds of anti-satellite weapons in space."[46] However, this did not stop its most ambitious research and development projects: the Kaskad and Skif orbital anti-satellite stations armed with missiles and lasers. The decision to develop them was taken in the late 1970s. Flight tests of the anti-satellite missiles were planned for 1985–1986, but were never carried out (probably because of then Soviet leader Mikhail Gorbachev's objections on political and economic grounds), and the orbital stations were never deployed.

Major Soviet efforts to develop anti-satellite weapons were reinvigorated in the early 1980s in response to the Strategic Defense Initiative. In 1985, all Soviet strategic development programs were refocused on countering U.S. space-based ballistic missile defense systems, including by developing capabilities to attack those systems directly (as well as by improving offensive missiles' penetration capabilities and developing analogous Soviet space-based defenses).[47] Soviet responses included, in particular, the SK-1000 "multi-purpose military space systems" program, which involved more than twenty research and development projects focusing on space strike systems, and about the same number devoted to space- and land-based information support systems. One of these projects, the Naryad-V, which aimed to develop an anti-satellite interceptor carried by UR-100N and UR-100UTTKh (SS-19) ballistic missiles launched from silos, was terminated halfway through the flight tests.

The first decade of the new century saw a renewed interest in space arms, prompted by the Bush administration's military space programs and its uncompromising position on the militarization of space, including its refusal to discuss any proposals to limit space weapons. Given the traditional and increasing opacity of military plans and programs in Russia, the progress of recent efforts to develop anti-satellite weapons can only be judged using data from independent sources—with the important exception of a 2009 interview with then deputy defense minister General Vladimir Popovkin.[48] It represents the last occasion on which official information on this subject was made available.

Popovkin said that in order "not to complicate global politics," Russia was adhering to a "Lego" principle, in which separate parts of anti-satellite weapons were being developed and improved, but would only be assembled into combat systems when a clear enemy threat emerged. Popovkin also gave details of a number of specific programs and developments:

- Command and information support systems were being modernized as part of the development of air-space defenses, including by the acquisition of new computer and information display systems.
- Russia was also improving its space situational awareness. The OS-1 and OS-2 satellite detector centers were being updated. The entire system of ground-based missile early-warning stations was being modernized, including by gradually replacing old radars along Russia's borders and in the Krasnoyarsk region with new and more effective Voronezh-type radars. (Early-warning radars are used not only for the detection and tracking of ballistic missiles in flight, but also for tracking spacecraft.)
- Despite the withdrawal from service of the IS-MU anti-satellite system in 1993, its ground command computer and launch platform were preserved at Baikonur and kept in working condition.
- Although work on the Kontakt air-launched anti-satellite system was stopped in 1995, all of the system's elements—its command post, the ground-based Krona satellite recognition and targeting system, the MiG-31 jet, and the long-range missile—were continuing "to be refined." In 2012, a second Krona complex was due to begin operating in Russia's Far East, to enable the monitoring of satellites launched from Vandenberg Air Force Base in the western United States.
- The IS-MD complex for intercepting satellites in geostationary orbit (which is based on the IS-MU system) remained under development. One of the system's space tracking components—the Okno complex in Tajikistan—was functional. This complex identifies the coordinates of satellites in geostationary orbit and can assign targets for interception. A second complex was being built in the Maritime Province in Russia's Far East to cover the equatorial zone's skies visible from Russian territory.
- The equipment stockpile for the Naryad-VN and Naryad-VR anti-satellite complexes had been preserved.
- The Almaz-Antey Corporation was developing and testing a prototype air-launched laser complex to counter U.S. reconnaissance satellites and early-warning satellites used for detecting and tracking the launch of ballistic missiles.
- A capability for targeting satellites in low-earth orbit was also envisioned for the S-400 and S-500 air-defense complexes.

RUSSIAN THINKING AND ITS CONSEQUENCES FOR ENTANGLEMENT

In recent years, Russian strategic thinking has put more emphasis on space as a new and crucial military domain, where Russia must be present, both technically and strategically. The professional literature on this subject abounds with references to the threatening nature of American plans and weapon systems. In 2008, for example, analysts with close links to official circles argued that "American [space] policy, and that of its allies—above all NATO—is unambiguously aimed at obtaining strategic military dominance over Russia and other countries and reducing her nuclear deterrent potential. And this is a fundamental position rather than a trend, and has nothing to do with ideological differences."[49]

In recent years, Russian strategic thinking has put more emphasis on space as a new and crucial military domain, where Russia must be present, both technically and strategically.

Unlike in the Soviet period, however, anti-satellite weapons are relevant not only to the strategy for a global nuclear war but also to non-nuclear conflicts. In such conflicts, according to Russian thinking, the United States and NATO will have superior high-precision long-range non-nuclear weapons. This capability will, however, depend on space-based C3I assets, creating a vulnerability that Russia cannot fail to take advantage of.

This thinking is reflected in numerous professional publications by military experts. In one pragmatic expression from 2014, two such experts state that "it can now safely be said that a new field of armed conflict has emerged: a theater of military operations in space. And the importance of this sphere is growing constantly, as its nature means that the effectiveness of military action on land, at sea, or in the air is increasingly dependent on the efficiency of the use and capabilities of space weapons."[50]

Similarly, in 2009, a retired lieutenant general wrote that "the widespread use and increasing importance of space systems for the functioning and defense capabilities of states makes them extremely attractive targets, destruction of which could become a deciding factor in one side's victory in the event of an armed conflict. In this respect, anti-satellite systems can be viewed as being designed specifically to destroy another state's information and intelligence infrastructure assets in space, one of their main purposes being to provide centralized military command systems."[51]

The most detailed description of Russia's military space thinking comes from specialists at the Vympel design bureau, which is involved in the development of anti-satellite weapons:

> Taking into account that the effectiveness of using modern weapons is increasingly dependent on elements in space, the enormous cost of modern multi-purpose space systems, their role and place in the global economy, and their relative lack of protection from a range of hostile actions, the threat of attacking the enemy's space systems can be viewed as an additional, and even, in many situations, decisive deterrent to potential aggressors. The clear advantages of establishing a deterrent based on weapon systems that have the potential to destroy satellites are the theoretical possibility of using them in conflicts of various levels, and the possibility of using them to inflict a decisive blow against the enemy without harming the population. . . . Considering the developing military and political situation, the overall trend of the militarization of space and its transformation into a key independent theater of military operations, the potential development of weapon systems by leading states and the focus of their military policies, and the presence of anti-satellite weapons in the U.S. and China, it is essential to promptly examine and introduce strategic decisions regarding a whole range of issues related to space defense (measures to counter the space-based weapons of the opposing side), including questions of priority funding for work in this field.[52]

Russia is also concerned about threats to its own satellites. It is not clear, however, whether the policy in Russia's Military Doctrine of permitting the use of nuclear weapons in response to a non-nuclear attack "when the state's existence is put under threat" is applicable when applicable to responding to strikes against space-based information and communication systems. Nonetheless, the combination of doctrine and technology does create risks of entanglement.

Earth-observation, communication, and navigation satellites would probably be considered legitimate targets for radio-electronic jamming or physical attack in the early stages of a hypothetical non-nuclear conflict—even a local or regional one—that pitted Russia against the United States and NATO. The most likely targets would be reconnaissance satellites in low-earth orbit. If the opposing sides deployed anti-satellite weapons with the necessary technical specifications, satellites operating in higher orbits would also be at risk. These would include navigation satellites in medium-earth orbit, currently Russia's GLONASS system (Kosmos series) and the U.S. NAVSTAR constellation (which provides Global Positioning System signals). Communications satellites in geostationary and highly elliptical orbits—including the United States' MILSTAR and Advanced Extremely High Frequency constellations and Russia's Meridian, Raduga, and, in the future, Sfera-V series—could also become vulnerable.[53] Indeed, in his 2009 interview, Popovkin stated that the Naryad-VN and Naryad-VR anti-satellite systems were capable of reaching geostationary and other types of high orbit, implying that they could pose a threat to exactly these U.S. military satellites.

Entanglement arises because some of these satellites simultaneously serve the United States' or Russia's strategic nuclear systems. As a result, their destruction would threaten to immediately escalate a war to the nuclear level, especially since strategic forces would probably be on top alert, even in the case of a local armed conflict. In particular, communication satellites are important for the command and control of missile submarines at sea and bombers on patrol, especially in a crisis or local war when as many submarines and aircraft as possible would be dispersed.

From the point of view of entanglement, attacks on missile early-warning satellites could be even more dangerous. Such satellites are located in geostationary or highly elliptical orbits. At the moment, Russia has only two operational early-warning satellites of the new Tundra class, but it has plans, under the State Armaments Programs from 2020 to 2025, to deploy more as part of a Unified Space System for military command and threat detection.[54] The United States meanwhile is replacing its older Defense Support Program satellites with the new Space-Based Infrared System (SBIRS) satellites.

The logic of limited strategic strikes, as dubious as it is, implies preserving each other's early-warning satellites in order to keep any nuclear exchange limited as long as possible.

These satellites would likely remain unaffected by anti-satellite operations during the course of a non-nuclear war. However, given the lack of clarity in Russian air-space military strategy, which blurs the lines between a global non-nuclear war and a nuclear one, it is difficult to be certain about the immunity of missile early-warning satellites. In particular, in order to achieve the desired effect, selective nuclear or conventional strategic strikes would have to penetrate the opponent's limited BMD system, which might require, among other methods, neutralizing early-warning satellites in geostationary orbit and long-range land- and sea-based radars.

Since Russian ICBMs would be ready for launch-on-warning or launch-under-attack, the loss of early-warning satellites might be considered as a precursor to a counterforce strike and provoke Moscow to initiate the sequence to launch those missiles—though, under standard procedures, the actual launch would probably await attack confirmation by land-based early-warning radars or the destruction of those radars. If ground-based radars along Russia's periphery were also attacked, simultaneously or beforehand, the danger would, therefore, be even higher. Moscow believes that the United States understands all the consequences of attacking this kind of Russian satellite, and that the United States would react in exactly the same way to an analogous attack on its own missile

early-warning satellites. The logic of limited strategic strikes, as dubious as it is, implies preserving each other's early-warning satellites in order to keep any nuclear exchange limited as long as possible. However, since dual-use communications satellites, which are also deployed in geostationary orbit, would be considered fair game for anti-satellite warfare, even in the course of a local or regional conventional conflict, there would be a very high probability that a few early-warning satellites would be inadvertently destroyed with all the ensuing consequences. This interaction constitutes yet another form of entanglement and serves as an argument against artificial and dangerous concepts of selective or tailored strategic nuclear options that are blurring the line between conventional and nuclear warfare and thus lowering the nuclear threshold.

Strikes against early-warning satellites would be particularly dangerous if hypersonic boost-glide weapons were deployed, due to the difficulty of detecting and tracking them using ground-based radars. In fact, disabling an opponent's space-based missile early-warning system would practically "blind" it to an attack using hypersonic weapons.

Overall, attacks against early-warning satellites are probably seen in Moscow as more dangerous than attacks on space-based communication systems. Russia is less reliant on communication satellites than the United States, because most possible theaters of military operations are directly adjacent or close to its territory, and its ground forces, rather than its air force or navy, are likely to play the principal role in operations in those theaters. (The Russian operation in Syria is certainly an exception to this paradigm, but it was never conceived as a military action against the United States or its principal allies.) At the same time, since the main leg of Russia's strategic forces is composed of silo-based ICBMs armed with multiple independently targetable reentry vehicles (including old and future types of heavy missiles), Moscow depends much more than the United States on saving this leg from destruction. As a result, Russia relies much more than the United States on launch-on-warning or launch-under-attack. Such strategies are not feasible without early-warning satellites to provide the first alarm signal to start the launch command sequence in the expectation that the attack could be confirmed by land-based radars.

CONCLUSIONS

Political leaders in both Washington and Moscow should be informed about the danger of entanglement and prepared for the scenarios outlined above. They need to understand the potentially destabilizing role of new weapons and their associated operational concepts that create the threat of entanglement and perhaps an unstoppable plunge to global catastrophe. Preventing this threat would require monumental political will and

diplomatic effort in addition to both strategic and technical expertise. All three are presently sorely lacking.

Bilateral strategic arms control, if it were ever revived, could provide a way of mitigating the risk posed by boost-glide systems. The counting rules for delivery vehicles and warheads in a follow-on agreement to the New Strategic Arms Reduction Treaty (New START) could be applied to intercontinental boost-glide systems (such as the HTV-2, the AHW, and Project 4202), regardless of whether they were armed with conventional or nuclear warheads. Limiting their numbers in this way would alleviate Russia's fear of their being used for a conventional counterforce attack, which endangers its military security and, even in peacetime, politically devalues its nuclear potential—one of the few remaining vestiges of Russia's former superpower status. Land-based medium- or intermediate-range boost-glide systems should be banned by extending the provisions of the 1987 Intermediate-Range Nuclear Forces Treaty.

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The real or imagined threat of counterforce attacks by sea- and air-launched conventional cruise missiles could perhaps be managed through confidence-building and transparency agreements that would preclude the tacit massing of naval and air forces within range of each other's strategic targets. Under such agreements, the redeployment of U.S. aircraft and surface ships to forward locations as well as the dispatch from port of more cruise missile submarines than are usually deployed would, if not accompanied by a notification and credible benign explanation, serve as a warning to Russia. In this case, Moscow could place its offensive and defensive forces on high alert and thus reduce the prospects for a successful surprise attack.

If Russia's concerns about boost-glide weapons and conventional cruise missiles were managed by such agreements, Russia's Air-Space Forces could be redirected from the exotic concept of an air-space war to the realistic threat of limited nuclear missile and air attacks against urban-industrial centers by third nations, rogue regimes, and terrorists. In this case, the cooperative development and operation of defense systems by the United States and Russia would become feasible again.

In terms of the entanglement risks of anti-satellite weapons, the only good news is that, at present, neither the United States nor Russia is deploying dedicated operational anti-satellite weapons. The only existing anti-satellite capabilities are inherent to dual-use systems (such as U.S. Standard Missile-3 interceptors and Ground-Based Interceptors,

and Russia's S-400 and forthcoming S-500 air- and missile defense systems). Other anti-satellites capabilities are mothballed, or at various stages of research and development. This still leaves some chance to negotiate realistic and verifiable limitations on the testing and thus on the deployment of dedicated anti-satellite weapons. Key space-based nuclear C3I capabilities—early-warning and communications satellites, in particular—are in geostationary or highly elliptical orbits and could probably only be threatened by dedicated anti-satellite capabilities (dual-use air- and missile defense systems do not appear able to reach such orbits). As a result, an agreement that ensured the security of satellites critical to nuclear C3I, even if it could not reduce the anti-satellite threat posed by dual-use air- and missile defense systems, would still help to manage at least one dangerous aspect of entanglement.

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TONG ZHAO AND LI BIN

THE UNDERAPPRECIATED RISKS OF ENTANGLEMENT: A CHINESE PERSPECTIVE

INTRODUCTION

THE NUCLEAR DOMAIN IS no longer isolated due to at least two key developments in military technology. First, a wide range of non-nuclear technologies are emerging that can interact with nuclear weapons and their command, control, communication, and information (C3I) systems. These technologies include hypersonic, anti-space, cyber, and unmanned autonomous weapons, as well as precision-guided munitions and missile defenses. Second, multifunctional military technologies that can play a role in both conventional and nuclear operations or threaten both the nuclear and conventional assets of a potential enemy are becoming increasingly common.

This entanglement of non-nuclear and nuclear technologies has important implications for escalation dynamics between the conventional and nuclear realms. While American scholars have started to study these risks, there has been no systematic research into Chinese perspectives. Yet, this issue is relevant to China. Advanced American non-nuclear weapons could threaten China's nuclear forces and their C3I infrastructure. China has been closely watching the United States, and to a lesser extent Russia, develop these non-nuclear technologies and has invested in its own similar development programs. When fielded, these weapons could threaten the U.S. nuclear C3I infrastructure.

Against this background, this chapter focuses on four potential pathways of escalation from a non-nuclear conflict to a nuclear one as a result of entanglement. First, the multifunctionality of certain weapons and other military assets could cause a misinterpretation that leads to inadvertent escalation. Both multifunction strike weapons and multifunction targets, including weapons or enabling capabilities, could create this kind of misinterpretation.

Entanglement of non-nuclear and nuclear technologies has important implications for escalation dynamics between the conventional and nuclear realms.

Second, strategic misunderstanding and miscalculation can result from divergent views about the purpose and implications of deploying particular weapons or the circumstances in which those weapons might be used. The United States and China, for example, have divergent understandings about the circumstances under which each one might use anti-satellite (ASAT) weapons, and they interpret the purpose and implications behind the deployment of the Terminal High Altitude Area Defense (THAAD) system in South Korea quite differently. These differences could lead to inadvertent escalation during crisis.

Third, the development and deployment of certain non-nuclear technologies could influence a country's attitude toward risk-taking during a crisis and make it more or less likely to escalate deliberately. Fourth, the introduction of certain non-nuclear technologies could mitigate or exacerbate the fog of war—that is, the inevitable uncertainty in situational awareness of the battlefield—thus affecting the risks of inadvertent nuclear escalation.

For each of these pathways, this chapter seeks to present and explain Chinese scholars' understandings of the escalation risks stemming from entanglement and to compare them to their Western counterparts' views. It also presents the authors' own views about these escalation risks. In addition, this chapter explores whether, as some Western scholars have argued, China has been deliberately making use of the escalation risks stemming from entanglement as a way of enhancing deterrence. It avoids rehearsing China's real and serious—but well-known—concerns about the implications of U.S. conventional precision strike weapons and missile defenses for its nuclear deterrent.

To understand Chinese perspectives on each of the escalation pathways, the authors conducted a comprehensive review of openly available documents and publications, carried out extensive interviewing, and organized a closed-door roundtable with senior

Chinese experts from the military, the foreign policy community, the defense industry, think tanks, and academia. One key theme that emerged from these interactions is that China is not a monolithic entity. Accordingly, this chapter explains the major schools of thought, and highlights some minority views that may also be of interest to an international audience.

CHINESE THINKING ABOUT ESCALATION

Inadvertent escalation has not been a traditional focus of Chinese thinking about security.[1] Ancient Chinese military thinking did not touch on inadvertent escalation or crisis management. During China's revolutionary years under Mao Zedong, China's security policy emphasized the importance of tactics to confuse the enemy by creating the utmost uncertainty in its mind. The purpose was to keep the enemy from understanding China's own capabilities and true objectives, while understanding the enemy's capabilities and intentions as much as possible.[2] This traditional thinking is quite different from the Western school of thought that argues that allowing an adversary to correctly ascertain one's intentions and capabilities can help avoid inadvertent escalation.

Chinese political and military leaders have consistently expressed the view that military action should only be taken when there is absolute certainty (or near certainty) of victory. Among the three principles for warfare stressed by Mao Zedong, one concerned the circumstances in which to employ military force: "[It] is the winning principle. We either do not fight them; or if we do choose to go into a fight, we must win. We should never fight a war for which we are not very well prepared and which we do not have full confidence of winning."[3] Because of this principle, Chinese strategists have generally not devoted much thinking to scenarios other than complete victory or defeat. This principle is also illustrative of the traditional Chinese belief that the course of a war can be well controlled and managed by top commanders. The various uncertainties associated with waging a war or the possibility that top commanders may not fully understand the situation or be able to effectively control military operations has not been seriously considered.

Following China's acquisition of a nuclear weapon capability in the mid-1960s, it has had little real experience with being directly involved in nuclear crises.

Following China's acquisition of a nuclear weapon capability in the mid-1960s, it has had little real experience with being directly involved in nuclear crises, with the exception of the Sino-Soviet border crisis in 1969, during which the Soviet Union reportedly made an implicit threat of conducting a surgical strike against China's rudimentary nuclear capability.[4] By contrast, the United States and the Soviet Union became involved in a number of serious nuclear crises, including the Cuban Missile Crisis in 1962. Such nuclear crises taught them firsthand lessons about the real risks of inadvertent escalation, and resulted in cooperative U.S.-Soviet efforts, such as the bilateral Prevention of Nuclear War Agreement and the establishment of Nuclear Risk Reduction Centers. By contrast, China's lack of experience with nuclear crises may have contributed to a lack of thinking about inadvertent escalation risks.

In recent decades, Chinese thinking has evolved, as the country has opened up and as its strategic community has engaged more frequently with its Western counterparts.

Before the 1980s, Chinese discussions focused on how most international crises stemmed from domestic turmoil rather than international tensions.[5] Moreover, the traditional Chinese view is that discussing escalation or crisis management sends, in and of itself, a signal of weakness.[6] China also viewed never compromising with the enemy as a sacred principle and a key quality in a decisionmaker. This viewpoint further reduced Chinese experts' interest in studying how to avoid or mitigate escalation.

In recent decades, Chinese thinking has evolved, as the country has opened up and as its strategic community has engaged more frequently with its Western counterparts. As Chinese experts have been introduced to and embraced concepts in the Western literature, including escalation and crisis stability, domestic discussions on escalation have become more frequent. A growing number of Chinese experts have started to analyze strategic security issues for their implications for arms control and crisis stability. This development has, in turn, facilitated effective and in-depth exchanges between strategic communities in China and the West.[7]

That said, traditional views and perceptions still—to varying degrees—affect China's overall understanding of these issues. The resulting combination of traditional Chinese views and Western thinking has made current Chinese perspectives on the relationship between entanglement and inadvertent escalation complex and important to explore.

MISINTERPRETATION DUE TO MULTIFUNCTION CAPABILITIES

MULTIFUNCTION TARGETS

Some weapon systems or enabling capabilities play a role in both conventional and nuclear military operations. In a conventional conflict, if these assets were struck, the attacked state could have difficulty in accurately interpreting the underlying intentions of its enemy because the strike could be aimed at undermining its conventional military capability or, a much greater concern, its nuclear capability. If the attacked state concluded that its nuclear capability were under threat, it might launch a nuclear retaliation.

For instance, U.S. early-warning satellites provide both strategic early warning of a nuclear attack and enhance U.S. regional missile defense capabilities (which are primarily designed to defend against conventionally armed missiles). For a theater missile defense system, the area it can protect depends strongly on warning time: the longer the warning time, the larger the area.[8] U.S. early-warning satellites can generally provide earlier warning of an incoming missile attack than existing U.S. land-based radars and therefore can improve the combat capability of theater missile defense systems. The United States has expressed concerns that its early-warning satellites might be targeted by China, including in the 2016 version of the Department of Defense's annual report to Congress on *Military and Security Developments Involving the People's Republic of China*.[9] U.S. scholars have also cited People's Liberation Army (PLA) publications that argue that "shooting down U.S. early-warning satellites would be a de-escalatory and stabilizing action in a naval encounter with the United States."[10] Senior U.S. officials have publicly noted these reports.[11]

Some Chinese experts have indeed argued that if a conventional war breaks out between the United States and China in the Taiwan Strait, China should consider destroying American early-warning satellites to degrade U.S. theater missile defense capabilities and hence to ensure the efficacy of Chinese conventional missile strikes against American and/or Taiwanese targets in the region.[12] For the United States, given the importance of early-warning satellites in the American nuclear C3I system, Chinese strikes against such satellites could be (mis)interpreted as an attempt to deliberately undermine the U.S. capability to quickly detect and intercept Chinese intercontinental ballistic missiles (ICBMs) launched against the U.S. homeland. Fearing that the Chinese strikes against its early-warning satellites might be a sign that Beijing was preparing for ICBM strikes against the United States, Washington might feel compelled to launch preemptive strikes against China's strategic offensive capabilities. In this way, attacks against multifunction military assets—U.S. early-warning satellites in this case—could lead to inadvertent escalation.

Similarly, there has been concern in the U.S. strategic community that China does not have a dedicated nuclear command-and-control system and that some Chinese communication capabilities play a role in supporting both nuclear and conventional military operations.[13] Whether this is indeed the case in China is difficult to assess at the open-source level, and even Chinese experts do not seem to have a consensus view due to the lack of a clear definition of what constitutes a dedicated nuclear command-and-control system. Foreign experts have also raised the concern that some Chinese ballistic missiles, such as the DF-21 and DF-26, reportedly have both nuclear and conventional variants, creating the risk that the United States might mistake a nuclear-armed missile for a conventional one and trigger inadvertent escalation by striking it. Furthermore, both nuclear and conventional missiles are believed to be deployed at some Chinese missile bases and may "share the same support capabilities and facilities."[14] This co-location of nuclear and conventional missiles creates another potential cause of inadvertent escalation.

So far, Chinese analysts have not developed the same level of appreciation as many Western experts about the escalation risks of multifunction capabilities or commingling. Most Chinese experts—from both the policy and technical communities—do not seem to recognize the inherent risks of multifunction capabilities and commingling, and rarely take them into consideration during policy deliberations.[15] In fact, one can hardly find discussions of such risks in the Chinese literature.

This absence may be partially attributable to the relatively high level of nuclear secrecy in China. To some extent, Chinese security and military experts, both inside and outside of government, still work in a compartmentalized system where communication between agencies and services is less effective than it should be. Many Chinese experts who are cleared to attend international exchanges and dialogues may not know the operational arrangements concerning China's nuclear forces, and do not appear to be familiar with the specific policy issues related to commingling. Their views on, say, how China might respond to a U.S. conventional strike that was aimed at China's conventional capabilities but ended up undermining Chinese nuclear capabilities seem to be speculative and not based on previous internal discussions. This stove-piping adds to the difficulty of having substantive discussions and reaching common views.

Different understandings between Chinese experts and their foreign counterparts about the purpose and implications of specific actions make the former more likely to dismiss escalation risks. For instance, from the Chinese perspective, in a U.S.-China conventional war in the Taiwan Strait, a Chinese attack against American early-warning satellites would clearly constitute a tactical military operation with the limited objective of undermining U.S. theater missile defense capabilities in the region. Although some Chinese experts understand that these satellites also provide strategic early warning of

an incoming nuclear strike, these experts seem to expect the United States to be able to correctly interpret the use of ASAT weapons in a war that is conventional, limited, and regional. They reason that because China appears to have no capability to undermine the United States' massive nuclear forces, it would make no military sense for China to even try to do so. However, they neglect the possibility that the United States might interpret such strikes as preparations for the first use of nuclear weapons designed to scare rather than disarm.

By contrast, American officials and experts have quite different views about the purpose and implications of such an attack. They generally agree that strikes against early-warning satellites would be viewed as seriously threatening to the U.S. nuclear C3I system and hence highly provocative and escalatory.[16] This important gap in understandings could lead to miscalculations and unexpected escalation.

These differences in thinking between Chinese and Western strategists help explain their differing interpretations of China's nuclear posture. Some foreign analysts suggest that China may deliberately commingle its nuclear and conventional capabilities—or may do so to a greater extent in the future—to protect its conventional missiles from enemy strikes.[17] The logic they attribute to China is that, in a limited conventional conflict, an enemy would avoid attacking any Chinese conventional forces that were deployed close to China's nuclear forces because the risk of mistakenly striking those forces would be too high.

The fact that Chinese strategists have not given much thought to the implications of commingling suggests that it is not a deliberate strategy.

In practice, however, there is no hard evidence that China has deliberately commingled nuclear and conventional capabilities for this reason or that it would consider doing so in the future. The fact that Chinese strategists have not given much thought to the implications of commingling suggests that it is not a deliberate strategy. Moreover, Chinese experts do not seem to embrace the thinking that nuclear forces should be used to protect conventional forces. On the contrary, for Chinese strategists, the survivability of nuclear forces is a much higher priority than that of conventional forces. From this perspective, it would make no sense for Chinese military planners to use nuclear forces to protect conventional forces.[18]

In fact, Chinese commingling seems to be driven primarily by engineering and logistical convenience. Experts from the Academy of Military Sciences of the PLA recently

mentioned that the newly revealed DF-26 intermediate-range ballistic missile uses the "same missile body" for both nuclear and conventional warheads—in fact, it can change between nuclear and conventional warheads quickly, depending on specific battlefield requirements. They argue that, given China's policy of maintaining a small nuclear arsenal, enabling nuclear missiles to launch conventional warheads increases China's capability to deal with "diverse security threats."[19] It appears that China commingles its conventional and nuclear forces for similar reasons.

MULTIFUNCTION STRIKE WEAPONS

Misinterpretation could also be caused by the deployment or employment of offensive weapons capable of threatening both nuclear and conventional targets. A number of new types of non-nuclear weapons are potentially capable of threatening a wide range of different targets. For example, the potential targets for conventional hypersonic weapons could include high-value terrorists, radars, ASAT weapons, and the transporter-erector-launchers (TELs) for both nuclear and conventional missiles. Moreover, hypersonic weapons are maneuverable, creating uncertainty about their aim points—a problem known as destination ambiguity. Thus, if China detected a hypersonic weapon launched from the United States headed in its direction, it would not initially know whether the target was somewhere in North Korea, eastern Russia, or China. If it became clear, later in flight, that the target was in China, Beijing would still be unsure whether the United States was aiming for, say, a population center, a command-and-control facility, a missile base, a nuclear missile TEL on patrol, or an ASAT weapon launcher. China would also have difficulties in determining whether the weapon was armed with a conventional or nuclear warhead—a problem known as warhead ambiguity. The combination of destination and warhead ambiguity associated with weapons that can destroy both nuclear and conventional targets could create significant escalation risks.[20]

Chinese experts do not appear to have paid much attention to such ambiguities and the associated escalation risks. One reason seems to be that they have always assumed that the United States is interested in deliberately using hypersonic weapons to preemptively attack China's nuclear forces. Even if such weapons are armed only with conventional warheads, Chinese analysts fear that their high speed and precision will mean they could be used in a first strike.[21] Chinese concerns have only increased over time with the inclusion, in the 2002 U.S. Nuclear Posture Review, of "nonnuclear strike capabilities" in the New Triad (a concept that called for the development of nuclear and non-nuclear strike capabilities, strategic defenses, and a responsive infrastructure),[22] and with technological breakthroughs associated with the U.S. Conventional Prompt Global Strike program (an effort to develop long-range hypersonic non-nuclear weapons). China, therefore, is more

prone to interpret an ambiguous event as an attack against its nuclear forces for two primary reasons: Beijing believes that Washington is developing hypersonic weapons for potential use against China's nuclear forces, and Beijing has failed to fully study and appreciate the risks of misinterpretation as a result of warhead and destination ambiguities.

Unmanned underwater vehicles (UUVs) are another example of an emerging non-nuclear capability that may cause inadvertent escalation as a result of their multifunctionality. Some UUV operations can simultaneously threaten an enemy's nuclear ballistic missile submarines (SSBNs) and its attack submarines. For instance, UUVs can be used to collect data about an enemy's submarine deployment areas or travel routes to prepare for anti-submarine warfare (ASW) operations. Even in peacetime, such activities can increase tensions, as demonstrated by the December 2016 face-off between the U.S. and Chinese navies over the deployment of two American UUVs, one of which was seized by China, in the southeastern part of the South China Sea.[23]

More importantly, in a crisis, UUVs could be deployed at the entrance to an enemy's submarine base or near a maritime chokepoint to track and trail submarines. The U.S. Navy master plans for UUV development explicitly identify "hold at risk" as one important mission for UUVs.[24] Such UUV operations would appear equally threatening to Chinese SSBNs and attack submarines, and, in a crisis, it would be difficult for China to determine U.S. intentions. Thus, even if the United States wanted to threaten only China's attack submarines and not its SSBNs, there would be a real risk that China would nonetheless suspect that its sea-based nuclear deterrent capabilities were in danger. In this case, China might react in ways that could appear to the United States as particularly provocative and escalatory. Indeed, Chinese reports implied that the reason why China seized the U.S. UUV in December 2016 was directly related to the perceived threat to Chinese SSBNs in the region.[25] In a future confrontation, if China believed its SSBNs were under threat, it could again take very assertive measures to dispel U.S. forces and conduct very aggressive operations to defend those submarines. Such activities could be viewed as disproportionately aggressive by the United States and hence prove escalatory.

DIVERGENT UNDERSTANDINGS OF NON-NUCLEAR CAPABILITIES AND THEIR CONSEQUENCES

Very often, states have divergent understandings about certain capabilities. Such differences can have important implications for crisis stability in two ways. First, they can lead to differences in perception about the possessor's propensity to use a given capability in a crisis. Second, they can lead to differences in perception about the purpose behind the

deployment of that capability, which can, in turn, affect interpretations of the other's willingness to escalate or deescalate during a crisis.

DIVERGENT UNDERSTANDINGS ABOUT THE LIKELIHOOD OF USE

Ever since China's successful test of an ASAT weapon in 2007, its interest in this technology has received considerable international attention. At the same time, many Chinese military analysts and commentators have painted a grave future in which outer space will become a new battlefield.[26] Given the significant role that space-based assets play in modern military operations, many Chinese analysts have speculated in public writings and commentaries that ASAT weapons may, in the future, become a strategic capability to greatly influence the outcome of future wars.[27] Some U.S. officials and analysts suspect that some of China's missile defense tests in recent years were really disguised ASAT tests.[28] That said, because of the inherent commonality between ASAT and missile defense technologies and a lack of technical data about the tests, it is difficult to draw objective conclusions about China's level of interest in deploying, let alone using, ASAT weapons. Nonetheless, U.S. officials and analysts are becoming seriously concerned that Beijing might use ASAT weapons in a future conflict to try and nullify the significant benefits the United States gains through its use of space.

Interviews with the Chinese strategic community revealed that an important perception gap may exist between American and Chinese experts.

Interviews with the Chinese strategic community revealed that an important perception gap may exist between American and Chinese experts.[29] Most Chinese experts raised serious doubts about the true efficacy of ASAT weapons. The most common view was that there has been far too much theoretical discussion in China about the role that ASAT weapons could play, and a lack of serious study in the open literature that systematically and realistically examines the likelihood that such weapons could significantly affect the course of future wars. In fact, most experts were skeptical that ASAT weapons could help achieve any decisive and asymmetric advantage. This view, which is very common among Chinese technical experts, is consistent with some recent studies conducted by foreign scholars that suggest serious limitations in ASAT weapons' battlefield utility.[30] By contrast, Chinese experts who are more supportive of using ASAT weapons on a battlefield tend to be theoretical strategists.

This lack of consensus within the Chinese strategic community suggests that China may actually be less inclined to use ASAT weapons during a future military conflict than most

American officials and experts expect. This potential reluctance has obvious benefits for crisis stability. However, because the United States does not perceive that hesitancy, these benefits are much less likely to be realized than they may otherwise have been. In a crisis, believing that China would be likely to use ASAT weapons, the United States could misinterpret ambiguous signs—such as movements of ASAT capabilities—as signals that China might be preparing for such use when it is, in fact, not. If so, the United States might overreact by launching a preemptive strike against perceived Chinese ASAT assets and facilities, risking an unnecessary war or precipitating serious escalation.

Differences in perception about capabilities also create differences in perception about which state is responsible for causing the escalation risks.

To complicate matters further, differences in perception about capabilities also create differences in perception about which state is responsible for causing the escalation risks, complicating efforts to resolve the problem. A number of Chinese experts acknowledged the potential escalation risks, but argued that because they are the result of the U.S. nuclear doctrine of launch-under-attack, it is the United States that should be responsible for making efforts to reduce such risks by, for instance, abandoning its launch-under-attack posture. China, they argue, should not feel inhibited.

DIVERGENT UNDERSTANDINGS ABOUT THE PURPOSE OF DEPLOYMENTS

Recent disputes about the deployment of the U.S. THAAD anti-missile system in South Korea provide another illustration of how divergent understandings about the capabilities of a particular technology can create escalation risks. In this case, however, there is an added complication compared to Chinese ASAT weapons. The United States correctly understands the motives behind China's potential acquisition of ASAT weapons, but it may overestimate China's willingness to use such capabilities. By contrast, in the case of THAAD, a divergence in perceptions about capabilities has created a similar divergence about the very purpose of the system's deployment, further exacerbating escalation risks and hindering the development of any solution.

In July 2016, Washington and Seoul agreed to deploy the THAAD system in South Korea. The country's existing missile defense system only consists of low-altitude capabilities, such as the Patriot Advanced Capability-2, that intercept incoming missiles shortly before impact.[31] THAAD is intended to provide an extra layer of defense by intercepting

longer-range missiles at higher altitudes. Given the increasing ballistic missile threat from North Korea, the United States and South Korea see the deployment of THAAD as a technical necessity for the purpose of protecting South Korea's population as well as American military bases in the country.

China has a totally different understanding about THAAD and the purpose of its deployment. Chinese experts believe that THAAD is mostly useful for intercepting ballistic missiles with ranges longer than 1,000 kilometers (about 600 miles). Because the Korean Peninsula is only about 900 kilometers from north to south, the primary North Korean missile threat to South Korea comes from missiles with ranges less than 1,000 kilometers. Chinese experts have, therefore, drawn the conclusion that THAAD cannot protect South Korea from the North Korean missile threat and that its deployment must really be directed at China.[32]

China also has deep suspicions that the THAAD deployment is just one step of a comprehensive U.S. strategy to "ring China with missile defenses" in an effort to undermine China's nuclear deterrent.[33] Chinese technical experts point out that the powerful X-band AN/TPY-2 radar associated with the THAAD system might be able to monitor the process of releasing warheads and decoys from Chinese ICBMs. They are also concerned that the radar might be capable of detecting and tracking the launch of Chinese sea-launched ballistic missiles from SSBNs in Bohai Bay. Such data could be shared with the American homeland missile defense system, considerably improving its effectiveness against Chinese nuclear missiles.[34] For these reasons, Chinese experts believe that the deployment of THAAD could seriously undermine China's nuclear deterrent and therefore poses a strategic security threat.

U.S. experts, including senior State Department officials, have disagreed, both publicly and privately, with the Chinese assessment that THAAD is unable to intercept North Korea's short-range missiles, yet does have the potential to undermine China's nuclear deterrent. The United States assesses that the impact of the AN/TPY-2 radar on China's deterrent will be very marginal—if it has any impact at all—and will not significantly undermine China's nuclear deterrent because of China's advanced countermeasures against ballistic missile defenses. Most American experts dismiss Chinese concerns as unfounded or as politically motivated exaggerations.

The divergence in perceptions between the United States and China could create escalation problems. Senior Chinese military experts, such as retired Major General Yin Zhuo and retired Rear Admiral Yang Yi, have argued that China should be prepared to attack THAAD if a military conflict breaks out between the United States and China.[35] Yin even argued that China should consider striking THAAD as its first move at the very

beginning of a future military conflict with the United States.[36] If Beijing were to launch such a strike, the United States and China would have very different understandings about Chinese intentions.

From the Chinese perspective, the United States should understand that the Chinese strike was simply intended to remove an infringement on a key Chinese national interest—the survivability of its nuclear deterrent—and to restore the status quo ante. China would believe that the strike was quite understandable and justifiable, and that it should not precipitate a U.S. overreaction. American and South Korean decisionmakers, by contrast, would likely see the strike as extremely provocative, given that they don't believe that THAAD poses a real threat to China. In fact, because the primary declared U.S. and South Korean objective for deploying THAAD is to counter the North Korean missile threat, Washington and Seoul might even see the Chinese strike as being designed to embolden Pyongyang and encourage it to carry out more serious military provocations. Under these circumstances, the United States and South Korea on one side and China on the other would end up playing different games, with totally different interests at stake. These differences would then impact how the United States and South Korea reacted and how China interpreted their reactions.

THE IMPACT OF NON-NUCLEAR TECHNOLOGIES ON RISK-TAKING

Non-nuclear technologies could influence escalation dynamics by affecting a country's attitude toward risk-taking during a crisis. If a state is confident in its ability to respond to an enemy's provocation, it can be said to be relatively risk-tolerant, in the sense that it can afford to wait while the enemy's provocation unfolds before initiating a countermove. Conversely, if a state is less confident in its ability to respond, it is relatively risk-averse, meaning it feels pressure to react early in a crisis while it still has the capability to do so. Non-nuclear technology could change a state's confidence in its ability to respond effectively during crisis and hence affect its propensity to escalate.

Non-nuclear technologies could influence escalation dynamics by affecting a country's attitude toward risk-taking during a crisis.

If a state knows that its enemy is developing capabilities that could undermine its nuclear deterrent—such as ASAT weapons that could strike early-warning satellites, or

cyber weapons that could undermine nuclear C3I—its confidence in the survivability of its nuclear second-strike capability could decrease during a crisis. As a result, the country might become more risk-averse and feel compelled to use nuclear weapons early while it still could.

For example, it is no secret to Chinese experts that the U.S. government is exploring the option of using cyber weapons to undermine potential enemies' strategic missiles and nuclear C3I systems during a crisis to prevent the enemies from launching such missiles.[37] There have been open reports that the U.S. military has conducted serious studies on this subject.[38] Most significantly, then president Barack Obama's administration reportedly intensified the U.S. pursuit of such "left of launch" capabilities against North Korea in 2014.[39] (Left of launch capabilities seek to preemptively destroy or disable enemy missiles before they can be fired through both kinetic and nonkinetic means, including cyber and electronic interference.[40])

Senior defense officials have acknowledged these efforts—at least in general terms. In 2016, Brian P. McKeon, then principal deputy under secretary of defense for policy, testified before Congress that "we need to develop a wider range of tools and that includes the efforts underway to address such threats before they are launched, or 'left of launch.' The development of left-of-launch capabilities will provide U.S. decision-makers additional tools and opportunities to defeat missiles. This will in turn reduce the burden on our 'right-of-launch' ballistic missile defense capabilities."[41] At the same hearing, Lieutenant General David L. Mann, then the commanding general of the U.S. Army Space and Missile Defense Command/Army Strategic Forces Command and the Joint Functional Component Command for Integrated Missile Defense, explicitly acknowledged that cyber operations were part of the Defense Department's "holistic missile defense strategy."[42] Chinese experts worry that these approaches could be applied to China.

For the United States to develop effective cyber capabilities, able to infiltrate an enemy's nuclear C3I system, which is extremely secretive, complex, and presumably well protected, it needs to conduct constant probing during peacetime to map its enemy's network infrastructure and identify potential weakness and vulnerabilities.[43] Such cyber reconnaissance may be occasionally detected by the enemy and could therefore alert it to the potential threat of cyber attacks against its nuclear deterrent. This heightened awareness of one's own vulnerability could make a state more risk-averse in a crisis, increasing inadvertent escalation risks for several reasons.

First, the attacker might underestimate how threatening even a relatively benign cyber intrusion could appear to the target country. The target country's nuclear C3I system is presumably complex and secret. From the attacker's perspective, merely penetrating it

would not necessarily enable the attacker to do damage. The target country, however, might overestimate the capabilities and/or intentions of the attacker. During a crisis, if traces of enemy cyber infiltration into its nuclear C3I system were detected, the target country might not be able to quickly examine and understand the full scale of the infiltration and might therefore have to assume the worst. For example, the target country might worry that fatal damage was about to be done by altering critical data and/or code in the system, even if the attacker lacked such an intention or thought it did not have the capability to do so. This perception of acute vulnerability coupled with the perceived possibility of serious imminent damage might prompt the target country to use nuclear weapons quickly, before it lost control of them.

Second, the target country might interpret a cyber attack as the precursor to kinetic attacks against its nuclear forces. If a state detected a cyber infiltration in its nuclear C3I system during a crisis, it might see the attack as evidence that the attacker had crossed the ultimate line and was in the process of implementing preemptive disarming strikes against its nuclear capabilities—especially because cyber infiltration could be useful in collecting intelligence to enable a kinetic strike. As a result, the target country might worry that kinetic preemptive strikes were about to follow, potentially leading it to overreact. In the case of a U.S.-China military confrontation, China seems to have legitimate reasons to worry about what might follow a perceived U.S. cyber attack, as some American scholars suggest that U.S. cyber attacks are likely to precede or accompany a nuclear first strike.[44]

Third, even just the knowledge that an enemy might have the capability to undermine a state's nuclear C3I system could lead to misinterpretation and overreaction in a crisis. For example, if a state detected a cyber attack from an unknown source in its nuclear C3I system or if this system happened to encounter a problem, it might mistakenly conclude that it was the victim of a deliberate cyber attack by the other protagonist in the crisis, potentially sparking escalation. Indeed, such risks could arise with other types of weapons. For example, if an early-warning satellite encountered an unknown problem during a crisis and stopped working properly, its owner might mistakenly attribute the problem to a deliberate attack, if it knew that its enemy was developing ASAT capabilities.

Fourth, defenses against cyber attacks may make the accidental or unauthorized use of nuclear weapons more likely, both during peacetime and a crisis. If a state believes that an enemy has the capability to prevent it from launching its nuclear weapons, it may prioritize ensuring that those weapons can be launched once the order has been given over ensuring that unauthorized or mistaken launches can be prevented. Given there are trade-offs between these two goals, the perceived threat may prompt the target country to become more risk-tolerant about unauthorized or mistaken launches but

more risk-averse about any failure to launch nuclear weapons quickly when ordered. For instance, to avert the accidental or unauthorized launch of nuclear weapons, states have adopted various procedures to authenticate orders to use them. However, if a state is concerned that cyber weapons can interfere with this process and prevent an authorized launch, it may implement alternative procedures that are more difficult to hack but that also increase the risk of an accidental launch.

Chinese analysts have demonstrated an acute awareness of the potential vulnerabilities of the country's nuclear C3I system, particularly against cyber infiltrations. When commenting on the 2010 incident at F. E. Warren Air Force Base in the United States—in which personnel lost communications with fifty ICBMs because of a technical malfunction—senior military experts from the PLA National Defense University raised the prospect of an enemy's deliberately hacking a country's nuclear command-and-control system, and stressed the possibility that cyber attacks could lead to similar—if not much more serious—incidents.[45] Chinese civilian scholars have also emphasized the cyber threat to China's nuclear command-and-control system.[46] It is very likely that China has implemented passive protection measures for its nuclear C3I system by, for instance, installing air gaps and employing electromagnetic shielding technologies,[47] but there is no public discussion about specifics. Moreover, even the installation of such protective measures is no silver bullet. As revealed by Stuxnet, the cyber weapon apparently developed by the United States and Israel to attack Iran's centrifuge facility at Natanz, air-gapped systems can still be vulnerable to sophisticated interference efforts.[48]

Most Chinese experts interviewed for this chapter believe that the emergence of cyber threats to a state's nuclear C3I system does not by itself increase escalation risks. Whether it does lead to an increase depends fundamentally on the state's strategic choices rather than technology. For instance, if a state is concerned about the cyber vulnerability of its nuclear C3I system, it faces two options: it can plan to use nuclear weapons early, before this system is undermined, or it can deploy a backup C3I system that does not rely on cyber networks at all as an emergency alternative. Such a backup system has clear advantages for crisis stability, if it can be implemented despite the obvious challenges of cost, effectiveness, and potential vulnerability to other means of interference. Chinese experts also observed that a state's doctrine for responding to a cyber attack provides another example of how strategic choices affect escalation risks. Because of China's no-first-use policy, China would not launch a nuclear response to a cyber attack. However, some U.S. government–sponsored studies have argued for keeping open the option of launching a nuclear retaliation in response to a cyber attack.[49]

Some Chinese experts have challenged the popular view that cyber technology will negatively affect crisis stability, because they believe this conclusion is based completely

on logical deduction, instead of empirical evidence. These experts have noted that states are usually very cautious about launching military retaliations to cyber attacks, and it is very rare for cyber attacks to lead to escalation.[50] Some experts also expressed the view that some cyber technologies are unlikely to be used because their developers may be self-deterred. Their reasoning is similar to the argument made by the military strategist Dean Cheng that "most cyber weapons can realistically only be used once," because once a cyber weapon has been revealed, the target will take remedial actions to prevent future attacks.[51]

Finally, a few Chinese experts even argued that cyber technology can have a positive impact on crisis stability. They believe that the development of cyber technology makes cross-border communications easier, not only between decisionmakers but also between the general public in different countries. With advanced cyber technology, the public has more opportunities to learn about the escalation risks of nuclear confrontations, making it more risk-averse and therefore more willing to pressure national leaders to focus on effective crisis communication, to adopt conciliatory measures, and to defuse military tensions.

TECHNOLOGY, THE FOG OF WAR, AND ESCALATION

The phrase "fog of war" describes the ignorance or uncertainty of military leaders about the situation on the battlefield.[52] It can lead to misinterpretation and miscalculation. A number of the emerging non-nuclear technologies discussed in this chapter have the potential to increase or decrease the fog of war and therefore affect escalation dynamics.

A number of the emerging non-nuclear technologies discussed in this chapter have the potential to increase or decrease the fog of war and therefore affect escalation dynamics.

On one hand, during interviews, some Chinese experts expressed the view that cyber technology can help the government to obtain and track information. They believe that advanced cyber technology can help improve the management of nuclear weapons and nuclear materials by enabling the government to become more effective at monitoring their storage and movement in a detailed and timely manner, and by detecting any signs of an anomaly more quickly. Such experts believe cyber technology can, therefore, reduce the chances of an accidental launch of nuclear weapons or of nuclear materials falling into the wrong hands.

On the other hand, Chinese analysts also understand that the use of certain non-nuclear weapons could reduce the enemy's situational awareness of the battlefield. Some Chinese analysts, especially those arguing for the use of ASAT weapons against American reconnaissance and communication satellites in a limited regional war, tend to view the fog of war resulting from such strikes as a tactical military advantage for China by undermining the efficacy of the U.S. C3I system.[53]

There is little discussion, however, about whether degrading U.S. situational awareness and communication capabilities might have negative consequences for China. The Chinese experts interviewed did not believe that a limited attack against U.S. space-based C3I assets would lead to nuclear retaliation because such a response would be disproportionate. No one raised the possibility that because of the increased fog of war, the United States might misinterpret other Chinese military moves—such as exercises or the mobilization of missile forces—as preparations for actually using nuclear weapons and, as a result, might initiate preemptive strikes against Chinese nuclear forces or facilities.

This lack of concern may be connected to China's long-standing policy of unconditional no first use. Because of this policy, Chinese experts believe that their American colleagues must know—as well as they do themselves—that China has no intention of using nuclear weapons first in a conventional conflict. These experts therefore believe that the United States is unlikely to misread other Chinese military moves as signs of the imminent use of nuclear weapons. For example, one senior Chinese expert, who acknowledges that "anti-satellite weapons might be used to destroy the other side's systems for command, control, communications, and intelligence," explicitly argues that "for nuclear weapon states that maintain a no-first-use policy—including China—anti-satellite weapons could not, by definition, provoke a nuclear attack."[54] This view is characteristic of widespread Chinese thinking that rejects the possibility that nuclear weapons could be used because of misperceptions and misinterpretations; the impact that the fog of war created by technologies, such as ASAT weapons, might have on the enemy's understanding and decisionmaking is not considered.

Incidents that took place at a time when the fog of war was particularly thick could also be very dangerous. For example, if American early-warning satellites were crippled due to a Chinese ASAT attack, the chances of a false alarm about a missile launch would increase. Indeed, in 1995, Russian early-warning radars detected the launch of a Norwegian sounding rocket that was mistakenly identified as a possible U.S. Trident submarine-launched ballistic missile. Many analysts believe that Russia was able to identify its mistake in the end, before launching a nuclear retaliation, because it had a network of functioning early-warning satellites that helped clarify the situation.[55] In the U.S.-China case, if U.S. early-warning satellites were inoperable and if the United States had to rely only on ground- and sea-based radars for detecting and verifying incoming missile

attacks, there might be an increased chance of a false alarm that could not be clarified. Under these circumstances, an incident would be more likely to escalate accidentally, perhaps even resulting in a nuclear exchange. Such possibilities do not seem to have been explored or even considered by Chinese analysts.

The fog of war can create problems, not only for the enemy's access to information but also for the effective flow of information between oneself and the enemy. The increasing use by the United States of unmanned military systems that can potentially undermine China's nuclear capabilities highlights this problem.

The deployment of unmanned systems—such as UUVs, especially in an ASW role—introduces new communication challenges, including between one state's unmanned systems and another's manned systems for a variety of reasons. Some unmanned systems are autonomous, rather than remotely piloted. The communication links between non-autonomous unmanned systems and their controllers could be severed. And unmanned systems may simply be incapable of communicating. As a result, direct communication between manned and unmanned systems to signal and clarify their intentions when they encounter one another at sea is more difficult than between two manned systems. Indeed, the newly drafted U.S.-China Memorandum of Understanding on the Rules of Behavior for Safety of Air and Maritime Encounters wouldn't be easily applicable to unmanned systems.[56] Thus, if something happened to a remotely piloted UUV, for example, its operators might face difficulties in quickly identifying the cause and accurately evaluating enemy intentions. The resulting uncertainty could cause exaggerated threat perceptions and lead to inadvertent escalation.

More seriously, China already suspects that American UUVs will soon be capable of attacking Chinese SSBNs. Given this concern, in a crisis, China might feel it had no choice but to assume that the United States was conducting ASW operations against its SSBNs if it detected evidence of U.S. UUVs near its SSBNs, their sailing routes, or their bases.[57] In response, China might raise the alert status of its SSBN forces and mobilize other forces to conduct potentially aggressive operations to defend its SSBNs. Such measures could escalate tensions. If the United States did not fully understand Chinese motivations, it might overreact. Although similar escalation dynamics could occur if China perceived that manned nuclear-powered attack submarines (SSNs) were threatening its SSBNs, the risks would likely be more serious with unmanned systems. Most importantly, UUVs might behave more aggressively than SSNs toward Chinese submarines because the commander of an SSN is likely to be more experienced than the controller of a UUV and have a much greater incentive not to endanger his or her ship and its crew. Moreover, precisely because SSNs are manned, China might be more wary of employing aggressive countermeasures against them than against UUVs.

Other technologies, such as cyber and hypersonic weapons, can greatly increase the pace of warfare and shorten the time for decisionmaking, exacerbating the problems created by the fog of war and severely complicating escalation management. For instance, U.S. generals have warned that hypersonic weapons, artificial intelligence, and automated weapons will accelerate future conflicts and make future wars with Russia and China "extremely lethal and fast."[58] Chinese experts share the same view about cyber and hypersonic weapons, and stress such weapons "greatly reduce the response time," thereby requiring the development of better intelligence and information processing technologies.[59] Overall, Chinese experts seem to agree with their Western counterparts that the quickening pace of modern warfare is inherently escalatory, but they appear slightly more optimistic about the prospects for risk management because they believe the risks can be addressed or mitigated through the development of new capabilities and operational procedures to meet the growing demand for quick information processing and decisionmaking.

Chinese experts seem to agree with their Western counterparts that the quickening pace of modern warfare is inherently escalatory.

Decisions to use nuclear weapons might be made under extreme time pressure. According to open-source research about the U.S. launch-under-attack posture, personnel at the North American Aerospace Defense Command (NORAD) have only about two to three minutes to evaluate and confirm initial indications from early-warning systems of an incoming attack.[60] If cyber weapons were used to undermine the computer systems at NORAD and interfere with communications or the processing of data, it could be impossible to authenticate the warning signals within the allocated timeframe. This failure could reduce the U.S. president's ability to obtain a full understanding of the situation and might force him or her to make hasty decisions with incomplete information. Chinese analysts, however, have not explored in much depth how the thickened fog of war might affect China's decisionmaking and that of its enemies, and hence affect escalation dynamics.

CONCLUSIONS

The development and introduction of new and advanced non-nuclear military technologies is increasing entanglement between nuclear and non-nuclear capabilities and generating the possibility of increasingly complex and dangerous escalation dynamics. These dynamics are still relatively new to most experts in the Chinese nuclear and strategic

security communities. Many experts have expressed concerns about them in Chinese writings but have not considered them systematically. Nonetheless, it is clear that, for various reasons, there are significant differences between Chinese and Western thinking on the subject.

First, general distrust between China and some Western countries—the United States in particular—makes China less willing to address potential escalation risks, including of inadvertent escalation. Because of the prevailing belief that decisions about whether to escalate or deescalate a crisis—and when and how to do so—have a direct impact on whether a state can achieve its strategic objectives, the competitive relationship with the United States undermines China's interest in joint discussions about escalation risks and the potential for jointly managing them. Specifically, Beijing worries that, by reducing U.S. concerns about the potential dangers of escalation during a crisis, it might embolden the United States to behave more aggressively in peacetime and to escalate crises when it sees fit, potentially even opening up China to nuclear coercion.

Second, some Chinese experts seem to be suspicious that the U.S. stress on escalation risks is intended to undermine China's legitimate military modernization efforts, especially those that are focused on new military technologies that may exacerbate those risks. In general, the perceived need to develop military capabilities to counter Western containment has received a higher priority than—and has overshadowed any serious consideration of—escalation risks.

Third, China's traditional strategic and military culture is equally important. In contrast to their Western counterparts, Chinese strategists have traditionally not addressed escalation—especially inadvertent escalation. Even today, very few Chinese experts have written on the subject, let alone conducted in-depth research. China's lack of firsthand experience as a participant in serious nuclear crises has also hampered its appreciation of the risk of inadvertent nuclear escalation.

Fourth, many Chinese experts share the belief that military technologies, in and of themselves, do not necessarily make escalation more or less likely. Instead, they emphasize the importance of specific deployment and employment strategies and argue that, at the end of the day, those strategies are what really matter. That said, it is also true that, to date, there have not been in-depth Chinese studies into the implications of specific deployment and employment strategies for escalation.

Fifth, as a result of the high degree of compartmentalization within the Chinese system, most Chinese experts within the nuclear and strategic communities focus only on their narrow specialty areas. However, in-depth research into escalation requires knowledge of at least three different subject areas: China's strategic-weapon deployment and

employment policies; other states' strategic-weapon deployment and employment policies; and strategy, military diplomacy, and arms control. Compartmentalization hinders frequent and substantive exchanges between experts from these subject areas, preventing many Chinese experts from developing the comprehensive understanding necessary to study escalation. Not only does it thus prevent the Chinese strategic community as a whole from studying escalation issues, but it also obstructs substantive and meaningful discussions with foreign experts.

Sixth, even where there is shared recognition of escalation risks, China and the United States disagree about which state is responsible for creating the risks and therefore for addressing them. In the case of a hypothetical Chinese strike against U.S. early-warning satellites, for example, the United States sees China's reported strategy of conducting preemptive ASAT strikes as the cause of inadvertent escalation risks, whereas Chinese experts believe the U.S. policy of launch-under-attack is the real problem. As a result, each side believes that the other is responsible for addressing the risks and sees no need to take corrective measures itself. Such a narrow way of thinking works to maintain the divergence of views on how to address escalation risks.

In spite of these challenges, it is important to promote common understanding between major nuclear powers about inadvertent escalation risks.

Seventh, Chinese experts worry that some Western proposals for addressing escalation risks—such as decoupling nuclear and conventional forces—might be exploited by potential enemies, which could feel more comfortable with conducting strikes against Chinese conventional capabilities. For this reason, although China did not entangle its nuclear and non-nuclear forces for the purpose of protecting the latter, it is now discovering that such entanglement is potentially useful from this perspective and is correspondingly reluctant to increase its vulnerability by embarking on a process of separation.

In spite of these challenges, it is important to promote common understanding between major nuclear powers about inadvertent escalation risks. Such risks are real and growing as a result of entanglement. However, because of Chinese policy choices, they are also somewhat less serious than many foreign experts believe.

One cause of concern among foreign experts is skepticism about the sincerity or practicality of China's unconditional no-first-use policy. Under this policy, China has even gone so far as to explicitly and firmly commit itself not to *threaten* to use nuclear weapons first. From the Chinese perspective, this policy essentially takes the option of China's

unilaterally escalating a conventional war to the nuclear level off the table. Because of their deep understanding about the making and implementation of Chinese nuclear policy, most (if not all) Chinese experts have complete faith in this commitment. There is a strong consensus among these experts that China has no intention whatsoever to—and would never—use nuclear weapons without absolute confirmation that China has already been struck by nuclear weapons. They believe no first use greatly contributes to avoiding the escalation of tensions and conflict. By contrast, many foreign analysts tend to challenge the unconditionality of China's no-first-use commitment, and accordingly reach a particularly pessimistic assessment about the risk of escalation between the United States and China.

Moreover, China's highly centralized command-and-control system makes unauthorized or hasty nuclear use less likely than many foreign analysts imagine. A high degree of centralization of command and control is an important feature of the PLA as a whole, including its conventional and nuclear forces. At the operational level, there is usually less freedom of action compared with many Western militaries, and an important aspect of PLA culture is that military commanders avoid risks when there is no clear guidance from the top. As a result, during a time of crisis, PLA commanders would be more likely to avoid bold and decisive actions, even at the risk of sacrificing rapid response capabilities, than to rashly launch nuclear weapons.

The authority to use nuclear weapons rests exclusively with China's top political leaders, and most likely with a group that will decide collectively as opposed to one specific person. Specifically, either the Standing Committee of the Politburo or the Central Military Commission (acting jointly in some cases) appears to be the ultimate decisionmaking body for nuclear employment. This institutional design makes the chance of China hastily initiating a nuclear war lower than some foreign analysts seem to believe.

Moreover, in recent years, China has been paying more attention to inadvertent escalation. Through engagement with their Western counterparts at various levels, Chinese officials and experts have developed a deeper understanding of the potential risks. China has worked with the United States to establish codes of conduct and rules of behavior for air and maritime military encounters. While these procedures are not directly related to nuclear forces and are far from perfect, they do demonstrate China's growing awareness of—and interest in—addressing the risks of military incidents and inadvertent escalation. They pave the way for further engagement and cooperation in nuclear-risk reduction in the future.

That said, the future could also see the emergence of new challenges. As the influence of Western nuclear thinking on China has grown, some Chinese experts have started to

advocate for certain U.S. nuclear practices. For instance, some military experts believe that China should abandon its long-standing practice of maintaining a low level of alert for its nuclear weapons during peacetime and should consider shifting to a posture of launch on warning.[61] The ongoing development of China's early-warning system could lay the groundwork for such a shift in policy, if the decision to change posture were made.[62]

The continued U.S. investment in new military technologies—such as cyber weapons that could interfere with C3I systems, unmanned vehicles that could threaten enemy SSBNs, and hypersonic weapons that could create considerable ambiguity—will also motivate other countries, including China, to follow suit and compete technologically. Such emulation could increase entanglement and complicate escalation management in the future.

To address the challenges of entanglement and inadvertent escalation, political trust between the United States and China has to be improved. The current lack of trust contributes directly to Chinese skepticism about U.S. strategic intentions and a lack of interest in engaging with American experts on the subject. That said, operational-level engagement on addressing escalation risks and efforts to increase political trust may in fact be mutually reinforcing. Long-term and sustainable dialogues between foreign and Chinese experts on technical risk reduction would provide an opportunity for both sides to develop in-depth and sophisticated understanding about each other's real thinking and concerns. In the long run, such a process could help both sides to gradually reduce and remove current suspicions about each other's intentions, contributing to the building of political trust. In this way, a positive cycle of mutual beneficial interactions could be set in motion.

To address the challenges of entanglement and inadvertent escalation, political trust between the United States and China has to be improved.

Confidence-building measures could be useful for promoting deeper cooperation in addressing the escalation risks that result from entanglement. It would be very helpful for Washington to convey to Chinese leaders its recognition that mutual vulnerability is a fact, and that the United States will plan and posture its strategic forces on that basis. Such a political commitment would not be verifiable, but could still help to reduce Chinese concerns that Washington deliberately seeks to use non-nuclear means to counter China's small nuclear arsenal. It would, in turn, make China more willing to discuss entanglement with the United States and to work cooperatively to address specific

escalation risks. Reciprocally, China could shed more light on its thinking about some of its own programs that create entanglement and are of most concern to the United States. For example, China could explain its thinking on whether future hypersonic weapons would be armed with conventional or nuclear warheads, and on what space-based assets might be considered legitimate targets and under what conditions.

Such transparency measures would not reveal sensitive military information or undermine national security, but would help catalyze a substantive discussion aimed at clarifying and reducing exaggerated threat perceptions and the possibility of overreactions during crises. Given that the United States and China share a common interest in reducing risks of inadvertent escalation, such a dialogue would hopefully lead to in-depth exchanges and the exploration of unilateral and cooperative risk-reduction measures for an era of advanced non-nuclear technologies.

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JAMES M. ACTON

A U.S. PERSPECTIVE ON POLICY IMPLICATIONS

ANY ATTEMPT TO MITIGATE the risks of inadvertent escalation generated by the growing entanglement of non-nuclear weapons with nuclear forces and their enabling capabilities must begin with a serious effort to understand these risks. Given the extent to which they depend on perceptual factors—what one side in a conflict perceives its adversary's intent to be—it is critical that Washington understands Moscow's and Beijing's concerns, and that Moscow and Beijing understand Washington's (whether or not those concerns are viewed as fair or reasonable).

In this context, perhaps the single most important observation from the preceding chapters is that, within traditional and contemporary strategic thought in both China and Russia, very little attention has been given to the possibility that escalation might be unintended. It is quite unusual for experts from these countries to express serious concern about inadvertent escalation, as the authors in this volume do (even if Tong Zhao and Li Bin stress that they are somewhat more sanguine than many of their Western counterparts). The prevailing assumption in both China and Russia is that any increase in the level of violence in a conflict would be deliberate. Alexey Arbatov, Vladimir Dvorkin, and Petr Topychkanov, for example, describe "a visceral assumption among contemporary Russian strategists that the decision to use force—including nuclear weapons—would be a rational step." In a similar vein, Zhao and Li note the existence of a

> traditional Chinese belief that the course of a war can be well controlled and managed by top commanders. The various uncertainties associated with waging a war or the

> possibility that top commanders may not fully understand the situation or be able to effectively control military operations has not been seriously considered.

Ironically, the belief that inadvertent escalation is improbable actually makes it more likely because political and military leaders are left less inclined, in peacetime, to take steps that could mitigate the risks, and more inclined, in wartime, to interpret ambiguous events in the worst possible light.

Moscow and Beijing share the assumption that the United States seeks to undermine their nuclear deterrents with advanced conventional capabilities. As a result, U.S. non-nuclear operations that inadvertently implicated either of their nuclear forces would risk being interpreted as the beginning of a conventional counterforce campaign. In a major conventional conflict, such operations would be worryingly likely. Arbatov, Dvorkin, and Topychkanov, for example, note that "Russian strategic submarines and bombers are kept at the same bases as general-purpose naval vessels and aircraft, and [non-nuclear] strikes designed to target the latter might inadvertently destroy the former."

Even more acute risks of escalation might stem from non-nuclear attacks against dual-use enabling capabilities, especially early-warning satellites. In this regard, both sets of authors are unusual in recognizing that it is not just U.S. attacks against China or Russia that could prove escalatory—Chinese or Russian attacks against the United States could do so too.

Zhao and Li, for example, note calls within the Chinese strategic community to attack U.S. early-warning satellites in a conflict in order "to degrade U.S. theater missile defense capabilities and hence to ensure the efficacy of Chinese conventional missile strikes against American and/or Taiwanese targets in the region." They go on to argue that

> although some Chinese experts understand that these satellites also provide strategic early warning of an incoming nuclear strike, these experts seem to expect the United States to be able to correctly interpret the use of [anti-satellite] weapons in a war that is conventional, limited, and regional. They reason that because China appears to have no capability to undermine the United States' massive nuclear forces, it would make no military sense for China to even try to do so. However, they neglect the possibility that the United States might interpret such strikes as preparations for the first use of nuclear weapons designed to scare rather than disarm.

That said, the focus in both analyses is escalation risks generated by U.S. capabilities. In this context, both sets of authors see trouble brewing in the form of various technological developments, in hypersonic boost-glide weapons in particular. According to Zhao and Li, Chinese experts "have always assumed that the United States is interested in deliberately using hypersonic weapons to preemptively attack China's nuclear forces," and that, as a result, Beijing would be "more prone to interpret an ambiguous event as an attack

against its nuclear forces." (Unlike ballistic missiles, boost-glide weapons are maneuverable so their targets are not clear until impact. This characteristic could generate ambiguity in the event the United States launched such a weapon at a region of China containing both nuclear and non-nuclear forces.)

Arbatov, Dvorkin, and Topychkanov, meanwhile, focus on the challenges of detecting an incoming boost-glide attack. Early detection is particularly important for Russia, which still leans heavily on launch-under-attack as a way of enhancing the survivability of its intercontinental ballistic missile (ICBM) force. Arbatov, Dvorkin, and Topychkanov argue that

> ground-based radars would only detect an incoming glider late in flight—too late, in fact, to launch ICBMs before they were hit. As a result, a launch-under-attack option would have to be executed exclusively on the basis of satellites' detecting the launch of boost-glide weapons, without confirmation of an attack from ground-based radars.

The undesirability of Russia's adopting a policy of launching ICBMs on the basis of a single detection technology does not need to be spelled out. Over time, China may face pressure to adopt a similar policy. Zhao and Li note that there are calls within China to adopt a launch-on-warning strategy, and that China is developing the technology that would enable it to do so. If China does make this shift, it will face the same challenges as Russia in preparing plans to counter a U.S. boost-glide attack.

That said, Russia and China have very different nuclear force postures today, and there are also important differences in the character of the conventional war that each might wage against the United States. As a result, the escalation dynamics in a U.S.-Russia conflict could have important differences from those in a U.S.-China conflict. Understanding the peculiarities of each scenario is critically important.

At the center of contemporary Russian strategic thought is the concept of an "air-space war" against the United States and the North Atlantic Treaty Organization. While the meaning of this concept may, as Arbatov, Dvorkin, and Topychkanov argue, be frustratingly elusive, an air-space war is viewed "as a prolonged endeavor involving an integrated technological and operational continuum of nuclear and non-nuclear operations, defensive and offensive capabilities, and ballistic and aerodynamic weapons." Such a conflict, they argue, would create "a breeding ground for entanglement."

Russia's nuclear posture contributes to this entanglement. Russia has a large force of tactical nuclear weapons, which it might employ early in a conflict. Arbatov, Dvorkin, and Topychkanov assess that these weapons "might accidentally be attacked . . . because their delivery vehicles are collocated at bases with—and can be used together with—general purpose forces and weapons." Even more worryingly, entanglement might lead Russia

to conduct "limited strategic strikes" in an effort "to thwart U.S. naval and air forces that were engaged in a conventional conflict and perceived as conducting a conventional counterforce offensive by launching attacks against airfields, naval bases, and their C3I [command, control, communication, and information] facilities." Limited strategic strikes, it should be emphasized, are not part of Russia's official declaratory policy, but they are openly advocated by government-affiliated experts, and Western analysts (or at least those without access to classified information) do not appear to have picked up on these discussions.

China has a much smaller and less diversified nuclear force than Russia, and has pledged not to use nuclear weapons first. While alleviating some risks of entanglement, this posture may simultaneously exacerbate others. For example, because China's nuclear force is much smaller than Russia's, Beijing may be even more concerned about the possibility of conventional counterforce—even if it is vanishingly unlikely that China would use nuclear weapons to attack the U.S. non-nuclear forces that Beijing believed were threatening its nuclear deterrent. Importantly, Zhao and Li point out that because of mistrust between the United States and China, the potential benefits of China's nuclear posture are less marked than they might otherwise be. In particular, Chinese experts generally have "complete faith" in their country's no-first-use commitment. As a result, they tend to believe that Washington would not interpret ambiguous Chinese actions, such as attacks against early-warning satellites, as preparations for nuclear use. Recognizing that many Western experts "challenge the unconditionality of China's no-first-use commitment," Li and Zhao believe that there is significantly greater scope for misunderstanding.

The character of the escalation risks that might arise in a conflict is further shaped by the strategic geography of the theater of operations. Naval operations, which would be an important adjunct to a land war in Europe, would be at the very center of a U.S.-China conflict.[1] In this context, dangerous interactions could arise between U.S. unmanned underwater vehicles (UUVs) and China's nascent force of ballistic missile submarines (SSBNs). Zhao and Li note Chinese concerns that, in the near future, "UUVs could be deployed at the entrance to an enemy's submarine base or near a maritime chokepoint to track and trail submarines." Not only might such operations threaten both Chinese SSBNs and attack submarines, but "even if the United States wanted to threaten only China's attack submarines and not its SSBNs, there would be a real risk that China would nonetheless suspect that its sea-based nuclear deterrent capabilities were in danger." This form of entanglement may not be unique to UUVs; U.S. attack submarines could also threaten both Chinese SSBNs and attack submarines. However, UUVs compound the problem—not least because they could potentially be deployed in much larger numbers than attack submarines, and because, without a crew to worry about, UUVs could be tasked with more aggressive but riskier operations than attack submarines generally undertake.

One important—and difficult to explain—difference between Russian and Chinese perceptions concerns the plausibility of cyber attacks against nuclear and dual-use C3I systems. Zhao and Li observe that "Chinese analysts have demonstrated an acute awareness of the potential vulnerabilities of the country's nuclear C3I system, particularly against cyber infiltrations." They explore how, in light of this perceived vulnerability, the discovery that a nuclear C3I network had been penetrated could be highly escalatory—even if the attacker's goal was no more malign than espionage. By contrast, Arbatov, Dvorkin, and Topychkanov are less concerned about the escalation implications of cyber weapons (though they do caution that secrecy in this area makes it impossible to draw "even remotely specific" conclusions). In particular, they argue that while certain components of a state's nuclear C3I system, including early-warning satellites, may be vulnerable to cyber interference, the systems for communicating directly with strategic nuclear forces "are isolated and highly protected" and "in all probability, not vulnerable to cyber attacks." If the absence of Russian writing on this subject is anything to go by, the Russian analytical community shares this perspective. Of course, in an effort to assess escalation risks, the most critical views are those of the Russian government and military, and it is unclear whether they are consonant with the perspective of nongovernment analysts.

In addressing these escalation risks, unilateral actions are the most realistic option, at least in the first instance. Some such actions, including revised war planning, would inevitably have to be kept secret, making progress difficult to gauge from the outside, but could prove quite effective nonetheless. After all, the escalation risks resulting from entanglement depend critically on which weapon systems a state procures, and on how these capabilities are deployed in peacetime and employed in wartime, as well as on political and military leaders' understanding of how their actions are likely to be perceived by an adversary and their recognition of the challenges of correctly interpreting an adversary's actions. Raising awareness of inadvertent escalation risks among the individuals responsible for strategic-level decisionmaking in a crisis, and factoring these risks into acquisition policy and war planning could, therefore, be a powerful approach to risk mitigation. To be clear, "factoring" escalation risks into policy and planning does not mean that they should always trump warfighting considerations. It simply means that they should be weighed up as part of the process of deciding whether a new weapon system or operational concept is in a state's interest.

Ideally, China, Russia, and the United States would all embark on this process, and each should do so irrespective of whether the others do. Of course, given Chinese and Russian views that inadvertent escalation is unlikely, it is highly questionable whether Beijing or Moscow will do so—and there is only slightly more room for optimism that the current U.S. administration will devote much time or attention to this problem. However, all three governments should realize that they have nothing at all to lose from unilateral and

secretive processes, and potentially much to gain. Nongovernmental analysts in all three countries could play a role by engaging with their governments—publicly or privately, as appropriate—to highlight the potential severity of the escalation risks.

A second step, which could run concurrently with these internal processes, would be intergovernmental discussions. Initially, the main purpose of a dialogue might simply be to assess escalation risks more accurately by better understanding a potential adversary's perspectives. Given how important context is in shaping escalation risks, it would make sense to have separate U.S.-China and U.S.-Russia dialogues rather than a single trilateral process.

Reciprocity—each party feeling that a dialogue has actually enhanced its understanding of the other—will be key to sustainability. In this context, Zhao and Li break new ground by identifying specific areas on which China could explain its thinking to the United States. They argue that if Washington conveys "to Chinese leaders its recognition that mutual vulnerability is a fact, and that the United States will plan and posture its strategic forces on that basis," Beijing should be willing to "explain its thinking on whether future hypersonic weapons would be armed with conventional or nuclear warheads, and on what space-based assets might be considered legitimate targets and under what conditions." Arbatov, Dvorkin, and Topychkanov's work suggests that these two issues—advanced conventional weapons and the survivability of space-based nuclear C3I assets—could also be fruitfully discussed in a U.S.-Russia dialogue. Interactions between cyber weapons and nuclear C3I systems could be a third potential focus for both U.S.-China and U.S.-Russia discussions. In the case of Russia, discussions might need to start with the very basic question of whether Moscow perceives there to be a "there there" at all.

The United States and Russia have agreed to discussions on strategic stability, and it is possible that the escalation consequences of entanglement could be discussed during these talks. Although the first round took place in September 2017, it is difficult to be optimistic that a substantive and productive dialogue will result. U.S.-China talks are likely to prove even more challenging to initiate for all the reasons explained by Li and Zhao. In the interim, track 2 discussions involving non-official participants could help fill the gap and hopefully pave the way for intergovernmental dialogues.

Over the long term, cooperative confidence building and even formal arms control could play an important role in risk mitigation—though their prospects are currently bleak (indeed, a prerequisite to such measures is intergovernmental discussions, and even they seem like a bridge too far right now). Nonetheless, governments can and should start their homework to develop and assess proposals.

For the United States and Russia, a good starting point would be three concrete proposals suggested by Arbatov, Dvorkin, and Topychkanov: transparency agreements that

would preclude the "tacit massing" of platforms for delivering air- and sea-launched cruise missiles within range of the other's "strategic targets"; an agreement to prohibit the testing and deployment of dedicated anti-satellite weapons; and the inclusion of intercontinental boost-glide systems under the central limits of a successor to the New Strategic Arms Reduction Treaty. Washington and Moscow should assess whether each of these proposals would be acceptable and, if not, whether it could be modified to make it acceptable. For example, Washington has long expressed concerns that a ban on anti-satellite weapons would be unverifiable. But, more focused confidence-building measures designed to protect satellites in geostationary or highly elliptical orbits (where key space-based nuclear C3I assets are located) may be more achievable. Washington and Moscow should also ask themselves which confidence-building concepts were sufficiently mutually beneficial to be negotiated on a stand-alone basis, and which would only make sense as part of a package that was balanced overall. Again, nongovernmental analysts could start to address these questions if governments do not.

Some of the challenges to taking these steps are all too evident; others are less so. Zhao and Li identify one challenge that has been frequently overlooked but is potentially serious: the question of blame. They note how many Chinese experts argue that it is the United States that is responsible for generating escalation risks and, therefore, that it is Washington that should take corrective measures. In a similar vein, some U.S. officials argue that because it was China's choice to use some C3I capabilities to support both nuclear and non-nuclear operations, it is up to China to manage the consequences of this decision. It is all too easy to imagine a similar blame game being played by U.S. and Russian officials.

In the nuclear era, however, the concept of blame is moot. Given that the risks of inadvertent escalation are shared, so too should be the responsibility for managing them. It took the extraordinary dangers of the Cuban Missile Crisis, in 1962, for the United States and the Soviet Union to reach this realization and commence even a stop-start process of risk reduction. Unfortunately, leaders in Washington and Moscow seem to have forgotten this lesson. Meanwhile, given China has only very limited experience with serious nuclear crises, leaders in Beijing may never have learned it. Whatever real and serious U.S.-Russian and U.S.-Chinese disagreements exist, none of these states should want to reach the brink of a nuclear war—or go beyond it—before seeing the value of efforts to mitigate the risks of inadvertent escalation.

NOTES

1. For this and other reasons, the escalation risks resulting from unmanned underwater vehicles seem—intuitively at least—as if they would be substantially more serious in a U.S.-China conflict than a U.S.-Russia conflict. Russia's SSBN force is larger than China's and spread over two oceans. Russia's SSBNs appear to be substantially quieter than China's. And, the naval chokepoints in the West Pacific are generally more restrictive than in the North Atlantic Ocean. However, more research is warranted to determine whether this intuition is correct. In particular, there is a very narrow waterway between the White Sea (where Russia's Northern Fleet is based) and the Barents Sea, and the impact of potential U.S. UUV operations there deserves particular attention.

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