Will Emerging Technology Cause Nuclear War?: Bringing Geopolitics Back In

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In order to fully understand the link between nuclear stability and emerging technology, the current geopolitical situation must be accounted for. Incorporating emerging technologies into US, Ally, and partner militaries will likely reinforce the prevailing global strategic stability.

Will emerging technology cause nuclear war? For more than 70 years, the world has avoided major-power conflict, and many attribute this era of peace to nuclear weapons.[1] In situations of mutually assured destruction, neither side has an incentive to launch a nuclear first strike because doing so will only result in self-annihilation. Maintaining secure, second-strike capabilities—the ability to absorb an enemy nuclear attack and respond with a devastating counterattack—is the key to deterrence.[2] Recently, analysts have begun to worry, however, that new military technologies may call into question this model of global strategic stability.[3]

The world is experiencing a fourth industrial revolution (4IR) in which a wave of new and transformative technologies is being developed, including artificial intelligence (AI), additive manufacturing, quantum information technology, hypersonic missiles, biotechnology, and directed energy.[4] While these technologies are expected to have profound implications for societies and economies, most are dual use and will also affect national security, including nuclear strategic stability.

According to an emerging conventional wisdom, new technology may upset nuclear strategic stability by calling into question the survivability of nuclear forces.[5] The solution, according to some analysts, is for nuclear-armed states to eschew military applications of at least some of these technologies and lead an international effort to control their spread.[6] But these studies too often consider new technology and nuclear strategy in the abstract without adequately considering the prevailing geopolitical context into which these new technologies have been introduced.

This article argues understanding the link between new technology and nuclear stability must consider the prevailing geopolitical context. For the past several decades, the United States, its Allies, and like-minded part-

ners have formed the core of the existing international order.[7] They have benefited from this system and would like to see it strengthened, revitalized, and defended. If the new technologies of the 4IR are incorporated into US, Ally, and partner militaries, then any advantages they provide will likely reinforce the prevailing distribution of power and existing sources of strategic stability.

In contrast, China and Russia are revisionist powers intent on disrupting or displacing the US-led system, and they would likely employ new technological advantages to pursue revisionist aims. The greatest danger from emerging technology for nuclear stability, therefore, may result from the possibility that new technology provides Russia or China an enhanced military advantage over vulnerable US Allies and partners, leading to a regional conflict with a significant risk of nuclear escalation.

This article contributes to the growing literature on new technology and nuclear stability by emphasizing politics take precedence over technology.[8] Technology rarely transforms states. More commonly, states employ technologies to achieve preexisting ends. It is not simply the technologies themselves that are destabilizing but the geopolitical ambitions of the states that possess them.

In emphasizing the divergent positions of the United States of America and its nuclear-armed rivals in the international system, this article also contributes to a growing body of literature that takes seriously hierarchy in international relations theory.[9] The United States, the international system's leader for the past several decades, is likely to use new technology to reinforce its advantageous position within the existing international order. China and Russia will most likely employ new technology in bids to erode America's privileged position. Analyses not grounded in an understanding of these states' different positions in the prevailing international order risk overlooking this important source of variation in conflict behavior and nuclear-escalation dynamics.

This framing of the problem leads to a different set of policy implications. The United States and its Allies and partners must retain second-strike capabilities, preserve current power distributions, maintain an innovation edge, and prevent the proliferation of destabilizing military technologies to revisionist powers.

Emerging Technology and Nuclear Stability

A growing body of literature expresses concern that emerging technology could undermine nuclear strategic stability through its effect on nuclear second-strike capabilities or on dual-use systems, including nuclear com-

mand, control, and communications.[10] For example, cyberattacks and conventional hypersonic missiles might be combined to provide credible first-strike capabilities against an adversary's nuclear forces, and advanced, directed-energy missile defenses could be employed to absorb enemy nuclear retaliation.

By threatening an enemy's secure, second-strike capabilities, these new technologies might undermine nuclear strategic stability. If leaders believe they can disarm their opponents, they may be motivated to use nuclear weapons first in a crisis. Alternatively, leaders fearing a disarming attack may choose to use their nuclear weapons first before they lose them.

New technology may also contribute to accidental or inadvertent nuclear escalation by threatening dual-use command and control assets in space and cyberspace or by compressing time for leadership decisions. Leaders may choose to initiate a nuclear war under the mistaken belief that an enemy nuclear attack has already begun or is imminent.[11]

There are several limitations, however, to the existing analysis. First, the underlying theory of nuclear conflict this body of thought advances is debatable. It rests heavily on the "use it or lose it" cause of nuclear war, but use it or lose it is rooted in the logical fallacy of the false dilemma.[12] States have many options in a crisis other than suffering a disarming nuclear attack or launching one. Moreover, faced with a range of choices, the use-it-or-lose-it logic assumes a state will intentionally choose to initiate a nuclear war—the most risky and costly available option. The use-it-or-lose-it pathway to nuclear war, therefore, is in tension with mainstream nuclear deterrence theory that maintains states will be reluctant to conduct a deliberate attack on another nuclear-armed state.[13]

A second limitation of this approach is that theories of nuclear instability developed in the early days of the Cold War are in tension with current understandings of the causes of war in contemporary international relations theory. The nuclear stability framework rests on the notion that parity in the balance of power is associated with peace. The prevailing bargaining model of war, however, maintains that parity contributes to uncertainty about the balances of power and resolve, which hinders efforts to reach negotiated settlements short of armed conflict.[14] The empirical record supports this theory and demonstrates parity in the balance of power is associated with conflict, and uneven balances of power are associated with peace.[15] Situations of obvious strategic nuclear superiority, therefore, may be more stable than situations of strategic parity.

Perhaps the most important limitation of the existing debate is its tendency to theorize in the abstract, divorced from real-world geopolitical

conditions. Proper nouns are rarely used. States, in these analyses, are treated as black boxes endowed with nuclear weapons and new technology, facing off against a mirror-image rival. The question of interest to scholars is whether the new technology could incentivize a generic nuclear-armed state to launch a nuclear first strike. The varying geopolitical positions, foreign policy ambitions, or ongoing political conflicts of interests among the major nuclear powers in the world today—the United States, China, and Russia—are not of immediate interest.

New technology is not acquired by black boxes, however. Emerging technology is diffusing into an international system in which the United States has been the world's leading power for the past several decades. This system is increasingly being challenged by nuclear-armed competitors, including China and Russia. States will likely use the advantages provided by new technology in a bid to advance preexisting foreign policy objectives.

In short, scholars have devoted excessive attention to abstract conjectures about interactions among technologies and weapons systems. Missing from the literature is an examination of how the diffusion of new technology might affect the behavior of today's principal nuclear-armed powers and, in turn, the strategic stability of the contemporary international system.

The next section provides a novel framework, grounded in the prevailing geopolitical context, for understanding how new technology might affect nuclear strategic stability. Namely, the spread of new technology to the United States and its Allies and partners—status quo powers at the core of the existing international system—will tend to shore up sources of strategic stability. Conversely, the spread of new technology to revisionist powers China and Russia presents the greatest risk of conventional conflict that might escalate and threaten nuclear strategic stability.

Geopolitical Context

The United States has been the most powerful country in the international system by almost any measure since 1945.[16] In the aftermath of World War II, the United States and its Allies constructed the outlines of the world we inhabit to this day.[17] They attempted to construct a security order that would prevent the recurrence of major conflict. Alliances in Europe and Asia—and the extension of the US nuclear umbrella—deterred conflict in those geopolitical regions and contributed to peace and stability.[18] American nuclear security guarantees also dissuaded Allies from pursuing independent nuclear arsenals. The Treaty on the Non-Proliferation of Nuclear Weapons slowed the spread of nuclear weapons to additional states.

Throughout the Cold War, the United States and its Allies and partners in the free world competed with the Soviet Union for global preeminence. Through much of this competition, Moscow was a revisionist power with the explicit goal of exporting its Marxist-Leninist revolutionary model abroad.[19] It challenged the status quo repeatedly, including by initiating crises in Berlin, Cuba, and elsewhere.[20] Indeed, according to the International Crisis Behavior Project data set, Moscow initiated 13 of the 17 crises between the Soviet Union and its nuclear-armed opponents during the Cold War.[21] Many of these crises entailed a significant risk of nuclear escalation, and fears of nuclear instability featured prominently in the discussions of defense analysts during this time.[22]

Following the collapse of the Soviet Union, the United States remained a unipolar power.[23] Alongside its Allies and partners, Washington used this position to deepen and expand the US-led, rules-based international system. Countries previously locked behind the Iron Curtain in Europe rushed to join the West, adopting democratic forms of government and market-based economies and entering NATO and the European Union (EU). Some analysts predicted the "end of history," as there was no obvious competitor to the Western model of free politics and open markets.[24]

As great power competition receded into the background, so too did fears of nuclear instability. The 2010 US *National Security Strategy* mentions Russia and China more often as partners for cooperation to address shared challenges than as military threats. Indeed, the document states the risk of nuclear war with these powers was extremely remote, as "the specter of nuclear war has lifted."[25] Reducing the role and number of nuclear weapons became a central objective of US nuclear policy.

In recent years, however, great power competition has reemerged.[26] Russia is dissatisfied with the spread of the US alliance system to its sovereign borders. It has invaded its neighbors—Georgia in 2008 and Ukraine in 2014—with the goal of preventing them from joining Western institutions such as NATO and the EU. Putin has declared the collapse of the Soviet Union the "greatest geopolitical catastrophe of the 20th century" and aspires to recreate a greater Russia.[27] Russia desires the dismantlement of America's alliance architecture in Eastern Europe.[28] As Putin has said, he wants "new rules or no rules." US strategists fear Putin may use military power in a bid to force that objective.[29]

China has also become more assertive in recent years.[30] For decades, Chinese leaders followed former premier Deng Xiaoping's dictum that China should "hide its capabilities and bide its time." In recent years, however, Chinese president Xi Jinping has abandoned that doctrine. China

has expressed its dissatisfaction with the territorial status quo in Asia. Beijing regards Taiwan as a renegade province that will eventually be reincorporated into China. It has not ruled out the use of force to achieve this objective and has increased its military activities in the Taiwan Strait.[31]

Further, China has ongoing territorial and maritime disputes with several of its neighbors, including the land border with India, the Senkaku/Diaoyu Islands with Japan, and throughout the South China Sea with several claimants in Southeast Asia. These disputes have been sources of increased military contestation in recent years, and all are potential flashpoints for great power military conflict.

The unclassified *Summary of the 2018 National Defense Strategy of the United States of America: Sharpening the American Military's Competitive Edge* identifies the return of great power competition with Russia and China as the principal threat to US national security.[32] Of particular concern is the risk that Russia or China could attack a vulnerable US Ally in Eastern Europe or East Asia, respectively, presenting the United States with a fait accompli.[33]

Washington would be faced with a difficult decision. It could fight a major war with a nuclear-armed rival to liberate a beleaguered Ally. Alternatively, the United States could back down to avoid conflict, but at the risk of failing to protect a treaty ally. This path would allow Russian and Chinese aggression to stand, undermine US credibility, and call into question America's other formal alliance commitments. A congressionally mandated National Defense Strategy Commission report warns of the possibility of a major war with Russia or China—one that the United States and its Allies and partners might lose.[34]

This understanding of the geopolitical context provides the necessary baseline against which to assess the likely impact of new technology on global stability.

New Tech Arms Race

Many analysts believe the emerging technology of the 4IR could profoundly affect military capabilities and operational concepts.[35] New technology has had revolutionary effects on warfare and international politics throughout history from the Bronze Age to the gunpowder and nuclear revolutions.[36]

New technologies with direct military application are in development, including AI, quantum information technology, hypersonic missiles, directed energy, additive manufacturing, and biotechnology. How exactly these technologies will affect the future of warfare is still uncertain. The

National Defense Strategy Commission report charges that the United States lacks clear operational concepts for combat with Russia and China.[37] Still, there is reason to believe these new technologies could have meaningful military applications but perhaps not to the advantage of the United States and its Allies and partners. At present, Russia and especially China might transcend the United States and its Allies and partners in some key 4IR technologies.

Indeed, AI could transform the future of warfare, including through the development of lethal autonomous systems.[38] These "killer robots" may lower the threshold of conflict by allowing political leaders to take a country to war without risking the lives of human soldiers. When produced in large numbers, these drones could operate in swarms that overwhelm enemy military platforms and targets.[39]

Artificial intelligence could also be employed to rapidly sort through vast quantities of data, improving intelligence, surveillance, and reconnaissance and making it easier to track and target enemy forces. The United States retains important advantages in AI, including through its world-leading university system. But China, with its large population and surveillance tactics, has access to more data to train its AI algorithms.[40] Beijing is also less constrained by ethical and moral concerns and has the lead in some applications of AI, including facial-recognition technology.

Quantum computing promises information advantages including the ability to have secure, encrypted communications and to decode enemy communications. In its 2021 *Military Balance* report, the International Institute for Strategic Studies states, "the integration of quantum technologies currently represents one of the most anticipated advances for armed forces. . . . There is little doubt that they will have disruptive effect when they are employed at scale."[41] China may have the edge in this area, as it was the first country to conduct a successful test of a quantum satellite.[42]

Space and cyber are increasingly important military domains. Space-based weapons, sensors, defensive interceptors, and the diffusion of counterspace capabilities will make space an increasingly contested military environment.[43] The United States is relatively more dependent on space-based assets and computers than its rivals, and the US Department of Defense warns Russia and China will likely employ cyber and counterspace attacks in the early stage of any conflict with the United States in a bid to disrupt US command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR).[44]

Hypersonic missiles, maneuverable and able to travel at over five times the speed of sound, could allow states to conduct low- or no-warning at-

tacks and to evade missile defenses.[45] These weapons could also execute large-scale, nonnuclear strategic attacks, the rate of speed compressing the decision-making time leaders have to respond to such attacks. Although the United States developed the initial concepts for these weapons, Russia and China have prioritized their production, testing, and deployment. China has conducted more hypersonic tests than any other nation, and Moscow and Beijing have deployed hypersonic weapons.[46]

Many other emerging technologies have military applications. Directed-energy microwaves and lasers could allow states to develop more effective integrated air and missile defense systems or to degrade an enemy's command and control.[47] Additive manufacturing could greatly reduce the cost of producing component parts of military platforms and creates the potential for large and rapid quantitative increases in weapons systems, from drones and tanks to submarines and nuclear weapons.[48]

Biotechnology could be exploited to produce "super soldiers." China has genetically engineered beagles with three times the muscle mass of a typical canine, a technology that could possibly be applied to humans.[49] Exoskeletons could provide soldiers with superhuman strength, and brain implants promise superior cognitive performance. China employed exoskeletons in combat in its 2020 border conflict with India.[50]

It is not yet clear how these new technologies, when combined with novel operational concepts, will affect the future of warfare, but it is likely they will. A future state may, for example, be able to use additive manufacturing to produce masses of inexpensive drones directed by new AI algorithms to swarm and overwhelm adversaries.[51] The attack might be preceded by cyber and counterspace attacks that blind an adversary and disrupt its command and control.

Following a successful advance, the country could then employ directed-energy weapons, autonomous mines, and other advanced defenses to lock in territorial gains and thwart enemy attempts to roll back its aggression. It is possible that the first state to hone these technologies and devise effective operational concepts will have a military edge over its opponents.

Novel Applications

How will states use such a newfound advantage? Technology rarely fundamentally changes the nature or objectives of states. More often, states use technology to advance preexisting geopolitical aims. Moreover, enhanced power can result in greater ambition. Given the geopolitical landscape described, it is likely the United States and its Allies and partners at the core

of the international system will behave differently with new military technologies than will revisionist powers, such as Russia and China.

The spread of new technology to the United States and its Allies and partners would likely serve, on balance, to reinforce the existing sources of stability in the prevailing international system. At the end of the Cold War, the United States and its Allies and partners achieved a technological-military advantage over its great power rivals, with the US using its unipolar position to deepen and expand a rules-based system. They also employed their military dominance to counter perceived threats from rogue states and terrorist networks. The United States, its Allies, and partners did not, however, engage in military aggression against great power, nuclear-armed rivals or their allies.

In the future, these status quo powers are apt to use military advantages to reinforce their position in the international system and to deter attacks against Allies and partners in Europe and the Indo-Pacific. These states might also employ military power to deal with threats posed by terrorist networks or by regional revisionist powers such as Iran and North Korea. But it is extremely difficult to imagine scenarios in which Washington or its Allies or partners would use newfound military advantages provided by emerging technology to conduct an armed attack against Russia or China.

Similarly, Moscow and Beijing would likely use any newfound military strength to advance their preexisting geopolitical aims. Given their very different positions in the international system, however, these states are likely to employ new military technologies in ways that are destabilizing. These states have made clear their dissatisfaction with the existing international system and their desire to revise it. Both countries have ongoing border disputes with multiple neighboring countries.

If Moscow developed new military technologies and operational concepts that shifted the balance of power in its favor, it would likely use this advantage to pursue revisionist aims. If Moscow acquired a newfound ability to more easily invade and occupy territory in Eastern Europe, for example (or if Putin believed Russia had such a capability), it is more likely Russia would be tempted to engage in aggression.

Likewise, if China acquired an enhanced ability through new technology to invade and occupy Taiwan or contested islands in the East or South China Seas, Beijing's leaders might also find this opportunity tempting. If new technology enhances either power's anti-access, area-denial network, then its leaders may be more confident in their ability to achieve a fait accompli attack against a neighbor and then block a US-led liberation.

These are precisely the types of shifts in the balance of power that can lead to war. As mentioned previously, the predominant scholarly theory on the causes of war—the bargaining model—maintains that imperfect information on the balance of power and the balance of resolve and credible commitment problems result in international conflict.[52] New technology can exacerbate these causal mechanisms by increasing uncertainty about, or causing rapid shifts in, the balance of power. Indeed as noted above, new military technology and the development of new operational concepts have shifted the balance of power and resulted in military conflict throughout history.

Some may argue emerging military technology is more likely to result in a new tech arms race than in conflict. This is possible. But Moscow and Beijing may come to believe (correctly or not) that new technology provides them a usable military advantage over the United States and its Allies and partners. In so doing, they may underestimate Washington.

If Moscow or Beijing attacked a vulnerable US Ally or partner in their near abroad, therefore, there would be a risk of major war with the potential for nuclear escalation. The United States has formal treaty commitments with several frontline states as well as an ambiguous defense obligation to Taiwan. If Russia or China were to attack these states, it is likely, or at least possible, that the United States would come to the defense of the victims. While many question the wisdom or credibility of America's global commitments, it would be difficult for the United States to simply back down. Abandoning a treaty ally could cause fears that America's global commitments would unravel. Any US president, therefore, would feel great pressure to come to an Ally's defense and expel Russian or Chinese forces.

Once the United States and Russia or China are at war, there would be a risk of nuclear escalation. As noted previously, experts assess the greatest risk of nuclear war today does not come from a bolt-out-of-the-blue strike but from nuclear escalation in a regional, conventional conflict.[53] Russian leaders may believe it is in their interest to use nuclear weapons early in a conflict with the United States and NATO.[54] Russia possesses a large and diverse arsenal, including thousands of nonstrategic nuclear weapons, to support this nuclear strategy.

In the 2018 *Nuclear Posture Review*, Washington indicates it could retaliate against any Russian nuclear "de-escalation" strikes with limited nuclear strikes of its own using low-yield nuclear weapons.[55] The purpose of US strategy is to deter Russian strikes. If deterrence fails, however, there is a clear pathway to nuclear war between the United States and Russia.

As Henry Kissinger pointed out decades ago, there is no guarantee that, once begun, a limited nuclear war stays limited.[56]

There are similar risks of nuclear escalation in the event of a US-China conflict. China has traditionally possessed a relaxed nuclear posture with a small "lean and effective" deterrent and a formal "no first use" policy. But China is relying more on its strategic forces. It is projected to double—if not triple or quadruple—the size of its nuclear arsenal in the coming decade.[57]

Chinese experts have acknowledged there is a narrow range of contingencies in which China might use nuclear weapons first.[58] As in the case of Russia, the US *Nuclear Posture Review* recognizes the possibility of limited Chinese nuclear attacks and also holds out the potential of a limited US reprisal with low-yield nuclear weapons as a deterrent.[59] If the nuclear threshold is breached in a conflict between the United States and China, the risk of nuclear exchange is real.

In short, if a coming revolution in military affairs provides a real or perceived battlefield advantage for Russia or China, such a development raises the likelihood of armed aggression against US regional allies, major power war, and an increased risk of nuclear escalation.

Implications

Future scholarship should incorporate geopolitical conditions and the related foreign policy goals of the states in question when theorizing the effects of technology on international politics. Often scholars attempt to conceptualize the effects of weapons systems in isolation from the political context in which they are embedded.

Studies treat technology as disembodied from geopolitics and as exerting independent effects on the international system. But technology does not float freely. Technology is a tool different actors can use in different ways. Bakers and arsonists employ fire in their crafts to strikingly different ends. In the current international environment, Russia and China would tend to employ technology toward advancing revisionist aims. Technological advances in these countries are therefore much more likely to disrupt the prevailing international order and nuclear strategic stability.

This approach also suggests the potential threat new technology poses to nuclear strategic stability is more pervasive than previously understood. To undermine strategic stability, new technology need not directly impact strategic capabilities. Rather, any technology that promises to shift the local balance of power in Eastern Europe or the Indo-Pacific has the potential to threaten nuclear strategic stability.

This understanding of this issue leads to different policy prescriptions. If the technology itself is the problem, then it must be controlled and should not be allowed to spread to any states. In contrast, the framework outlined here suggests a different recommendation: preserve the prevailing balance of power in Europe and Asia. Technological change that, on balance, reinforces the prevailing international system should strengthen stability.

Leading democracies, therefore, should increase investments in emerging technology to maintain a technological edge over their adversaries. Export control and nonproliferation measures should be designed to deny emerging military technology to Russia and China. Arms control should be negotiated with the primary objective of sustaining the current international distribution of power. Making progress in these areas will be difficult. But the consequences of failure could be shifts in the international balance of power, conflict among great powers, and an increased risk of nuclear war. SSQ

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