

RESEARCH ARTICLE

Strategic non-nuclear weapons and the onset of a Third Nuclear Age

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Abstract

Three decades after what is widely referred to as the transition from a First to a Second Nuclear Age, the world stands on the cusp of a possible Third Nuclear Age where the way that we conceptualise the central dynamics of the nuclear game will change again. This paradigm shift is being driven by the growth and spread of non-nuclear technologies with strategic applications and by a shift in thinking about the sources of nuclear threats and how they should be addressed, primarily, but not solely, in the United States. Recent scholarship has rightly identified a new set of challenges posed by the development of strategic non-nuclear weaponry (SNNW). But the full implications of this transformation in policy, technology and thinking for the global nuclear order as a whole have so far been underexplored. To remedy this, we look further ahead to the ways in which current trends, if taken to their logical conclusion, have the capacity to usher in a new nuclear era. We argue that in the years ahead, SNNW will increasingly shape the nuclear order, particularly in relation to questions of stability and risk. In the Third Nuclear Age, nuclear deployments, postures, balances, arms control, non-proliferation policy, and the prospects for disarmament, will all be shaped as much by developments in SNNW capabilities as by nuclear weapons. Consequently, we advocate for an urgent reassessment of the way nuclear order and nuclear risks are conceptualised as we confront the challenges of a Third Nuclear Age.

Keywords: Third Nuclear Age; Deterrence; Arms Control; Emerging Technology; Nuclear Weapons; Escalation; Nuclear Risk; Strategic Stability; Nuclear Order

Introduction

We stand on the cusp of a Third Nuclear Age. If this new era comes to pass, the main characteristics of the global nuclear order are likely to see considerable challenge.¹ This shift is being driven by the development of a suite of strategic non-nuclear weaponry (SNNW)² and enabling technologies, in conjunction with a fundamental political shift relating to perceptions of nuclear

¹A growing literature is pointing to a ‘new’ or ‘third’ nuclear age. This includes: Rebecca Hersman, ‘Wormhole escalation in the new nuclear age’, *Texas National Security Review* (summer 2020); Nicholas L. Miller and Vipin Narang, ‘Is a new nuclear age upon us? Why we may look back on 2019 as the point of no return’, *Foreign Affairs* (December 2019), available at: <https://www.foreignaffairs.com/articles/2019-12-30/new-nuclear-age-upon-us>; Jenny L. Naylor, ‘The Third Nuclear Age’, *Comparative Strategy*, 38:4 (2019), pp. 246–88; Michael Smetana, ‘A nuclear posture review for the Third Nuclear Age’, *Washington Quarterly*, 41:3 (2018), pp. 137–57.

²Sometimes also referred to as strategic conventional weapons or advanced conventional weapons. See James Acton, ‘Russia and strategic conventional weapons: Concerns and response’, *Nonproliferation Review*, 22:2 (2015), pp. 141–54 and Andrew Futter and Benjamin Zala, ‘Advanced U.S. conventional weapons and nuclear disarmament: Why the Obama plan won’t work’, *Nonproliferation Review*, 20:1 (2013), pp. 107–22.

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threats and debates about how they should be addressed. Together, these trends fundamentally challenge the canon of academic and policy thinking about nuclear weapons and nuclear stability, and mean that decision-makers must contemplate new risks of inadvertent escalation, miscalculation, and nuclear use, and the possibility of counterforce missions unencumbered by the political and moral restraints associated with the nuclear taboo.³ Essentially, we are set to move from a global nuclear order based on the assumption that developments in nuclear weapons are the primary driver of stability and instability, to one in which non-nuclear capabilities play an equally, if not more important role. Thus, the defining feature of the Third Nuclear Age will be that nuclear geopolitics, risks, crises, deployments, postures, balances, arms control, and non-proliferation will all be shaped as much by developments in SNNW capabilities as by nuclear weapons.

We argue that a Third Nuclear Age will be a product of that which has preceded it: Second Nuclear Age thinking about the benefits of deploying SNNW combined with the return of the kind of major power competition associated with the First Nuclear Age, is likely to make the Third Nuclear Age a highly dangerous one. While we may only be on the cusp of this transition it could hardly be timelier to begin thinking about the impact of these dynamics on the management of the global nuclear order. This is important given that, as we argue further below, there is nothing preordained or irreversible about the onset of a Third Nuclear Age. This new era will be one of our own making.

This article builds on recent work by focusing on the strategic implications of the development of various SNNW systems and advances in sensing and reconnaissance but makes a more ambitious argument about the political and strategic impact of SNNW.⁴ We argue that five factors have been either ignored or underappreciated in the existing literature: First, while leading scholars have recognised the challenges posed by individual SNNW, the *combination* of these technologies and the considerable influence on policy has been largely overlooked in current analyses. Second, we go beyond recent arguments about *nuclear* counterforce options,⁵ to suggest that the *non-nuclear* components of these new capabilities are as important, if not more important, than developments in nuclear forces. Third, while much focus has rightly been placed on the United States, we suggest that the SNNW phenomenon is, or at least will become, truly global and is intrinsically tied-in with shifts in polarity, regional dyads, and interstate power balances. Fourth, the impact is more far-reaching than a challenge to secure second-strike nuclear forces, and instead will impact all aspects of the global nuclear order. This is because the challenge is not simply technological but is fundamentally co-constitutive with a change in how decision-makers and analysts think about the management of nuclear threats. Therefore, we should expect the politics of arms control and multilateral cooperation on nuclear issues to play out in new ways. Lastly, when it comes to the timing of the impacts of SNNW deployments, we argue that perceptions of what may be developed or deployed, or worst-case scenarios of how they might be used, are equally, if not more important than the purpose or the capability of the systems deployed today, when it comes to real-world policy impact.

³Nina Tannenwald, 'The nuclear taboo: The United States and the normative basis of nuclear non-use', *International Organization*, 53:3 (1999), pp. 433–68; Rebecca Davis Gibbons and Keir Lieber, 'How durable is the nuclear weapons taboo?', *Journal of Strategic Studies*, 42:1 (2019), pp. 29–54.

⁴James M. Acton, 'Escalation through entanglement: How the vulnerability of command-and-control systems raises the risks of an inadvertent nuclear war', *International Security*, 43:1 (2018), pp. 56–99; Charles L. Glaser and Steve Fetter, 'Should the United States reject MAD? Damage limitation and U.S. nuclear strategy toward China', *International Security*, 41:1 (2016), pp. 49–98; Kier Lieber and Daryl Press, 'The new era of counterforce: Technological change and the future of nuclear deterrence', *International Security*, 41:4 (2017), pp. 9–49; Erik Gartzke and Jon R. Lindsay, 'Thermonuclear cyberwar', *Journal of Cybersecurity*, 3:1 (2017), pp. 37–48.

⁵Lieber and Press, 'The new era of counterforce'; Vince A. Manzo and John K. Warden, 'After nuclear first use, what?', *Survival*, 60:3 (2018), pp. 133–60; Christopher Clary and Vipin Narang, 'India's counterforce temptations: Strategic dilemmas, doctrine, and capabilities', *International Security*, 43:3 (2018/19), pp. 7–52.

Thus, we face more than simply a ‘new era of counterforce’, or the impact of new ‘disruptive and emerging technologies’, but instead a transition to a new and deeply challenging period in the management of strategic stability and global order involving both nuclear and non-nuclear dangers. Our aim is to move beyond current debates about the efficacy of any one type of SNNW or the effects of recent trends on any one aspect of today’s nuclear arsenals. Instead, we aim push the conversation in the direction of interrogating different future scenarios based on the (at this stage still hypothetical) maturation of current trends. Our claim is that only by engaging in such an exercise can the potentially radical implications of a Third Nuclear Age be grappled with.

The concept of nuclear ages is contested, and we are not arguing that nuclear history neatly fits into distinct periods, but rather suggest that this is a useful lens through which to understand nuclear politics at a particular point in time. In reality, policy thinking and technological capabilities evolve and bleed into each other rather than neatly shifting at an easily identifiable moment. But the categorisation of a Third Nuclear Age is useful if we are to understand the main conceptual frameworks and thinking that define and shape particular moments in our nuclear history, and for how we seek to manage and reduce nuclear risks.

While it is impossible to predict exactly how nuclear politics will play out in the Third Nuclear Age, we outline four possible scenarios. The first, and arguably the most likely, is one where the deployment of SNNW drives *nuclear proliferation and arms racing* by all nuclear-armed states, increases the risks of misperception and escalation, and creates new challenges for crisis stability and the non-proliferation regime. The second is where one state (most likely, but not necessarily the United States) gains a *temporary strategic advantage* through the deployment of SNNW. The third, and perhaps the most desirable, is one characterised by *restraint in SNNW* development and deployment through new arms control, risk reduction, and other normative mechanisms and regimes. The fourth is where *SNNW proliferation undermines nuclear weapons*. In this scenario, the vulnerabilities of nuclear forces to SNNW make reliance on SNNW a more credible option for all states. In the short term, the impact of SNNW is likely to be felt most acutely by states with small, vulnerable nuclear arsenals, but in the medium to long term, as technology diffuses and spreads, the impact will be felt by all.

Our analysis proceeds in three sections. We begin by exploring the conceptualisation of nuclear history into distinct ‘nuclear ages’ and explaining the impact this has on policy. Next, we briefly review the combination of offensive, defensive, and enabling technological breakthroughs in the SNNW space that are reshaping the central tenets of nuclear order that, having been developed in the First Nuclear Age and survived into the Second, will be challenged by the onset of a Third. The final section unpacks four scenarios for the Third Nuclear Age and outlines what we see as the main dynamics and contours of the future research agenda in nuclear studies.

Nuclear ages and strategic thinking

In both scholarly and policy discourse, particularly in the United States and ‘the West’, it has become commonplace to split nuclear history into two separate ‘ages’, defined by the factors that drive and shape the major debates and policy decisions relating to nuclear weapons at the global level.⁶ A First Nuclear Age is said to have spanned the years between 1945 and the end of the Cold War, while a Second ensued in the years since 1989–91 to the present time.

Nuclear ages begin in the mind. They are, at the outset, mental constructs. However, thinking in such ways has material ‘real world’ policy effects. When a particular construct becomes widely

⁶For a small but representative sample that illustrates this, see Gregory D. Koblentz, ‘Strategic Stability in the Second Nuclear Age’, Council Special Report No. 71 (New York: Council on Foreign Relations, November 2014); Michael Krepon, Travis Wheeler, and Shane Mason (eds), *The Lure & Pitfalls of MIRVs: From the First to the Second Nuclear Age* (Washington, DC: Stimson Center, May 2016); Zenel Garcia, ‘Strategic stability in the twenty-first century: The challenge of the Second Nuclear Age and the logic of stability interdependence’, *Comparative Strategy*, 36:4 (2017), pp. 354–65.

held it produces a ‘conventional wisdom’. This shift in conceptualising nuclear history in turn creates policy change – everything from investing in new technologies, to withdrawing from old agreements, to shifting the threat perceptions of decision-makers. At this point a genuinely distinct nuclear age can be said to have come into existence. In other words, distinct nuclear ages do exist but there is nothing natural or predetermined about this – actors think and act them into existence.⁷

Because the creation of new nuclear ages is an agent-driven (rather than structural) process, this plays out in particular national contexts. As is discussed further below, the idea of a distinction between the First and Second nuclear ages has been most prominent in the United States. One of the most interesting aspects of this is that this shift in thinking has never been fully accepted by other important nuclear-armed actors such as Russia and China. Yet the policy implications of this shift in American thinking have had very real impacts on Russian and Chinese defence policies, not least encouraging their embrace of SNNW as discussed further below.

For analysts, identifying distinct nuclear ages and, most importantly, the thinking that underpins (and precedes) them is extremely important. It allows us to identify the agents, ideas, and policies that drive these paradigm changes and therefore to critically analyse their strengths and weaknesses. It helps illuminate the fact that nuclear ages are not the result of structural forces but instead are constructed by real-world actors. We can choose not to create a new nuclear age. That is why in this article we have set ourselves the task of identifying the ideas and policies that are set to bring into existence an entirely avoidable Third Nuclear Age.

There are good reasons to be sceptical about the characterisation of one or other nuclear age. For example, a small but growing group of writers have recently begun to make the case for a revisionist history of the First Nuclear Age.⁸ Their position is that this period was never neatly synonymous with the restraining effects of the ‘nuclear revolution’ thesis.⁹ But the point of doing such work is to challenge conventional wisdoms, not to attempt to argue that those conventional wisdoms did not exist in the first place. One need not be an advocate of thinking in terms of distinct nuclear ages in order to understand the policy effects that this thinking has.

Both material and ideational factors (for example, technological developments and changes in threat perceptions) define and shape nuclear ages. Each reinforces the other. Changes in how we think about the management of nuclear dangers leads to increased resources being devoted to new technologies. These new technologies in turn help change the way we perceive the risks and opportunities of various policies.

The idea of the First Nuclear Age has come to be associated with superpower confrontation (and to a lesser extent, confrontation between their allies),¹⁰ vertical proliferation, and the

⁷While it is not our purpose here to fully explore the theoretical implications of this way of conceiving of distinct nuclear ages, it is worth noting the resonance of this ontological position with recent work on socially constructed orders such as Hendrik Spruyt, *The World Imagined: Collective Beliefs and Political Order in the Sinocentric, Islamic and Southeast Asian International Societies* (Cambridge: Cambridge University Press, 2020) and Emanuel Adler, *World Ordering: A Social Theory of Cognitive Evolution* (Cambridge: Cambridge University Press, 2019).

⁸See Keir A. Lieber and Daryl G. Press, *The Myth of the Nuclear Revolution: Power Politics in the Atomic Age* (London: Cornell University Press: 2020); Brendan Rittenhouse Green, *The Revolution that Failed: Nuclear Competition, Arms Control, and the Cold War* (Cambridge: Cambridge University Press, 2020); Timothy P. McDonnell, ‘The Terrible Swift Sword: US Nuclear Posture and Foreign Policy’ (PhD dissertation, Massachusetts Institute of Technology, 2019); Francis J. Gavin, ‘Rethinking the bomb: Nuclear weapons and American grand strategy’, *Texas National Security Review*, 2:1 (2019), pp. 74–100.

⁹Robert Jervis, *The Meaning of the Nuclear Revolution: Statecraft and the Prospect of Armageddon* (Ithaca, NY: Cornell University Press, 1989).

¹⁰Kenneth N. Waltz, ‘Nuclear myths and political realities’, *American Political Science Review*, 84:3 (1990), pp. 731–45; Lawrence Freedman, *The Evolution of Nuclear Strategy* (Basingstoke: Palgrave Macmillan, 2003); Francis J. Gavin, *Nuclear Statecraft: History and Strategy in America’s Atomic Age* (Ithaca, NY: Cornell University Press, 2012).

arms racing that were at the heart of the Cold War.¹¹ The main threat was perceived to be a large-scale war between East and West that could escalate to a full-scale nuclear exchange with globally catastrophic consequences. The key mechanisms of control for the First Nuclear Age would become deterrence based on a condition of Mutually Assured Destruction (MAD) underpinned by secure second-strike capabilities, and nuclear arms control. The standard account of the First Nuclear Age is based on the assumption that the existence of nuclear weapons played a major role in the absence of major power war during the Cold War, as mutual vulnerability to nuclear retaliation rendered both superpowers incapable of risking direct military confrontation.¹² At the same time, the goal of non-proliferation was conceived of and received significant attention during the First Nuclear Age (not least in the negotiation and signing of the Nuclear Non-Proliferation Treaty in 1968).¹³

The transition to a Second Nuclear Age is said to reflect a shift towards the threat of horizontal proliferation beyond the US, Russia, the UK, France, and China, particularly the acquisition of nuclear capabilities by regional nuclear powers and new 'rogue' actors, including terrorist groups.¹⁴ It has also seen nuclear threats become subsumed to some extent under a broader label of weapons of mass destruction. Consequently, the canon of nuclear studies shifted towards regional crises¹⁵ and the challenge posed by new nuclear actors. There is less focus on the two main nuclear players – the United States and Russia – despite their continued numerical superiority over all other nuclear-armed states. Instead, the Second Nuclear Age is associated with nuclear multipolarity,¹⁶ and for many the shift from West to East in the strategic centre of gravity of world politics.¹⁷ As a result, non-proliferation, counter-proliferation, normative taboos, and even coercive disarmament came to dominate the political discussion. While the centrality of MAD remained, it weakened as deterrence thinking became increasingly diversified towards 'new' types of threats.

This is a periodisation that of course makes more sense from the perspective of an American or Western policy-focused audience than it does from the perspective of the rest of the world. The hierarchical division between a small minority of nuclear-armed states and the clear majority of states who have eschewed such capabilities has not been fundamentally changed by the conceptual shift from a First to a Second Nuclear Age. However, we agree with Colin Gray that using the 'intellectual constructs' of nuclear ages is an imperfect but useful way to organise evidence that can guide theoretical or conceptual discussion on significant changes in the structure of the global nuclear order.¹⁸ It allows the strategic thinker to differentiate between causes and symptoms of

¹¹Charles L. Glaser, *Analyzing Strategic Nuclear Policy* (Princeton, NJ: Princeton University Press, 1990); Jervis, *The Meaning of the Nuclear Revolution*; John H. Herz, *International Politics in the Atomic Age* (New York: Columbia University Press, 1959).

¹²See, for example, John Lewis Gaddis, *The Long Peace: Inquiries into the History of the Cold War* (Oxford: Oxford University Press, 1989).

¹³Michael Krepon, *Better Safe Than Sorry: The Ironies of Living with the Bomb* (Stanford, CA: Stanford University Press, 2009), p. 43.

¹⁴Colin S. Gray, *The Second Nuclear Age* (Boulder, CO: Lynne Rienner, 1999); Paul Bracken, *Fire in the East: The Rise of Asian Military Power and the Second Nuclear Age* (New York: Harper Collins, 1999); Keith B. Payne, *Deterrence in the Second Nuclear Age* (Lexington, KY: University Press of Kentucky, 1996); Paul Bracken, 'The structure of the Second Nuclear Age', *Orbis*, 47:3 (2003), pp. 399–413; Vipin Narang, *Nuclear Strategy in the Modern Era: Regional Powers and International Conflict* (Princeton, NJ: Princeton University Press, 2014).

¹⁵Narang, *Nuclear Strategy in the Modern Era*.

¹⁶This view emphasises the polarisation of the Cold War period that aligns with the First Nuclear Age rather than the fact that nuclear multipolarity had technically existed since the first British nuclear test in 1952.

¹⁷Ashley J. Tellis, Abraham M. Denmark, and Travis Tanner (eds), *Strategic Asia 2013–14: Asia in the Second Nuclear Age* (Seattle, WA and Washington, DC: National Bureau of Asian Research, 2013); Yoshihara and Holmes, *Strategy in the Second Nuclear Age*; Paul Bracken, *The Second Nuclear Age: Strategy, Danger and the New Power Politics* (New York: Times Books, 2012).

¹⁸Gray, *Second Nuclear Age*, pp. 5–9, 154–5. As Gray puts it, ages reflect a transformation in the character not nature of the nuclear era. *Ibid.*, p. 21.

policy change. In so doing, it forces those of us in the business of analysis and scholarship rather than diplomacy and policymaking to ensure that our fundamental concepts, lines of debate and, where relevant, advocacy of particular policy prescriptions reflect an accurate understanding of contemporary nuclear dynamics. The alternative, thinking in terms of an undifferentiated nuclear history beginning in 1945 and lasting as long as the weapons themselves, risks treating all trends and phenomena as equally significant in shaping nuclear decision-making across time. Using the construct of nuclear ages allows us to think clearly and carefully about what is truly novel and important in terms of nuclear weapons policies, and about how best to respond.

Indeed, it is clear that scholarship and analysis that utilises the concept of nuclear ages have been extremely influential in policy terms, especially in the United States. The discussion about recent advances in SNNW and their impact on nuclear stability in the sections that follow, suggests that it was distinctly Second Nuclear Age thinking that drove the political and financial investment in the technologies that are creating a Third Nuclear Age. The prominent voices advocating for the need to think carefully about the nature of the Second Nuclear Age were unsurprisingly keen advocates for loosening the commitment to First Nuclear Age concepts such as MAD in relation to strategic competitors in favour of countering the asymmetric advantages of 'rogue states'.

For sure, the acceptance of MAD had always met resistance in US policy circles, but its centrality to nuclear strategy had remained firm for decades.¹⁹ Yet, the notion of a fundamental shift in the factors contributing to nuclear dangers offered a window for transforming this debate. The combination of regional challengers and rogue states led Cold War strategists to argue in the 1990s for abandoning the Anti-Ballistic Missile Treaty and to pursue both theatre and national ballistic missile defence (BMD) systems. For Gray, the challenge was for the United States to avoid being constrained in its power projection by the missile capabilities of small recalcitrant states.²⁰ The sense that 'regional nuclear competitions' would define the Second Nuclear Age became increasingly widespread and calls for analysts and policymakers alike to 'question, modify, or even jettison the models they inherited from the Cold War predecessors' grew in number and prominence.²¹ By 2012, Paul Bracken was making the argument that the new multipolar nuclear dynamics of the Second Nuclear Age meant that 'the circuit breakers have been pulled out of the global wiring system for nuclear peace and war'.²² For Brad Roberts, the Second Nuclear Age required the United States to develop a whole new theory of victory. This theory would need to embrace a 'synergistic integration of the deterrence benefits of multiple tools of deterrence, both nuclear and non-nuclear'.²³

The notion of a shift from a First to a Second Nuclear Age was never simply an analytical move. It was intimately wrapped up with policy advocacy that we can refer to as 'Second Nuclear Age thinking', the technological products of which are now driving the move towards a Third Nuclear Age. Such advocacy was largely confined to scholars and commentators in or writing about the United States. It emphasised the spread of ballistic (and to a lesser extent cruise) missile technologies to an ever-growing list of states, many of which were assumed to be hostile to US interests around the world.²⁴ This was coupled with a decreasing faith in the ability of legal

¹⁹Charles L. Glaser and Steve Fetter, 'National missile defense and the future of U.S. nuclear weapons policy', *International Security*, 26:1 (2001), pp. 40–92 (p. 61). Our purpose here is not to weigh in on arguments about whether decision-makers and analysts were correct in assuming that the logic of MAD had played the central role in keeping the Cold War from turning hot during the First Nuclear Age. On this, see Green, *The Revolution that Failed*.

²⁰Gray, *Second Nuclear Age*, p. 99.

²¹Devin T. Hagerty, 'Nuclear deterrence in South Asia: The 1990 Indo-Pakistani crisis', *International Security*, 20:3 (1995/96), pp. 79–114 (p. 114). See also Marc Dean Millot, 'Facing the emerging reality of regional nuclear adversaries', *Washington Quarterly*, 17:3 (1994), pp. 41–71.

²²Bracken, *The Second Nuclear Age*, p. 11.

²³Brad Roberts, *The Case for U.S. Nuclear Weapons in the 21st Century* (Stanford, CA: Stanford University Press, 2016), p. 246.

²⁴See, for example, 'Report of the Commission to Assess the Ballistic Missile Threat to the United States' (15 July 1998), available at: <https://fas.org/irp/threat/bm-threat.htm>.

regimes and treaties to stop the spread of missiles to US adversaries, and a concomitant willingness to consider pre-emptive counterforce strikes as a more effective alternative to relying on multilateral initiatives established late in the First Nuclear Age. This became particularly pronounced after the terrorist attacks against the United States of 11 September 2001. Second Nuclear Age thinking was premised on a perception of US primacy in world politics and a concern that Washington's freedom of action could be curtailed by the kind of vulnerability that had become accepted as being necessary for strategic stability during the First Nuclear Age. According to adherents of Second Nuclear Age thinking, this situation was made particularly dangerous by the fact that nuclear weapons were now in the possession of very different types of actors. These were states whose willingness to be deterred was hindered by the fact that they were 'pseudo- or illiberal democracies',²⁵ separated from the United States by 'cultural differences',²⁶ or even that they 'may not understand the 'rules' of Cold War-style deterrence and could well blunder into nuclear conflict'.²⁷

Second Nuclear Age thinking has been evident in policy advocacy and policymaking since the mid-1990s. It informed the strategy of 'deterrence by denial' championed by important US decision-makers in the aftermath of the 1991 Gulf War.²⁸ Deterrence by denial has long been associated with the development of BMD but it also has a long association with various counterforce options as well.²⁹ As early as 1993, Brad Roberts foreshadowed what we describe below as the main currents of the Third Nuclear Age, by arguing for the deployment of a mixture of missile defence alongside 'stand-off attack and stealthiness; shallow-water anti-submarine warfare capabilities; and the ability to apply conventional firepower early, massively, and with precision'.³⁰ By 1997, the Pentagon was stating publicly that 'BMD can strengthen the credibility of U.S. deterrent forces and provide an essential hedge against the failure of deterrence'.³¹ The enthusiasm among American scholars and practitioners for a posture of deterrence by denial was not only driven by nuclear concerns but also by increased attention to the threats posed by biological and chemical weapons throughout the 1990s and early 2000s.³² Over time, the greater focus on deterrence by denial rather than by punishment during this period gave rise to a new language of nuclear deterrence with calls for policy approaches to deterring threats that were 'nuanced',³³ 'complex',³⁴ and 'tailored'.³⁵ All of these had in common a rejection of what was perceived (by their advocates) as being out-dated homogeneous approaches to managing nuclear dangers through a reliance on nuclear postures geared towards deterrence by punishment. In essence, the Second Nuclear Age ushered in a period in mainly US scholarship,

²⁵Keith B. Payne, 'Post-Cold War requirements for U.S. nuclear deterrence policy', *Comparative Strategy*, 17:3 (1998), pp. 227-77 (p. 235).

²⁶Josiane Gabel, 'The role of U.S. nuclear weapons after September 11', *Washington Quarterly*, 28:1 (2004), pp. 179-95 (p. 184).

²⁷James Jay Carafano, 'Nuclear Deterrence: A Defensible Defense', The Heritage Foundation (13 January 2009), available at: {<https://www.heritage.org/defense/commentary/nuclear-deterrence-defensible-defense>}.

²⁸Les Aspin, 'The Defense Department's New Nuclear Counterproliferation Initiative', address to the National Academy of Sciences, Washington, DC, 7 December 1993.

²⁹See, for example, 'U.S. military options against emerging nuclear threats: The challenge of a denial strategy', *IISS Strategic Comments*, 12:3 (April 2006).

³⁰Brad Roberts, 'From nonproliferation to antiproliferation', *International Security*, 18:1 (1993), pp. 139-73 (p. 171). It is interesting to note that at the time, Roberts thought that the Second Nuclear Age had produced 'a strong case for mobile and inexpensive theater missile defenses, although a less immediate case for strategic defences', a position that would change over time.

³¹US Department of Defense, *Proliferation: Threat and Response* (Washington, DC: Office of the Secretary of Defense, November 1997), p. 17.

³²Robert G. Joseph, 'Nuclear deterrence and regional proliferators', *Washington Quarterly*, 20:3 (1997), pp. 167-75.

³³Daniel Gouré, 'Nuclear deterrence, then and now', *Policy Review* (December 2002/January 2003), pp. 43-56.

³⁴Payne, 'Post-Cold War requirements'; T. V. Paul, Patrick M. Morgan, and James J. Wirtz (eds), *Complex Deterrence: Strategy in the Global Age* (Chicago, IL: University of Chicago Press, 2009).

³⁵M. Elaine Bunn, 'Can deterrence be tailored?', *Strategic Forum*, 225 (January 2007), pp. 1-9.

public commentary, and eventually policymaking, which recognised that deterrence by punishment would endure in a basic sense due to the long tail of First Nuclear Age policies and force structures (especially in deterrence relationships with peer competitors), but had an aspiration for a posture defined by deterrence by denial.

The realisation of this aspiration due to technological advances has now created the prospect of a Third Nuclear Age. In contrast to the First and Second Nuclear Ages, in which the development and deployment of nuclear weapons themselves (by the superpowers in the First and by non-great powers in the Second) drove major debates and policies, in the Third Nuclear Age SNNW will play the defining role. A Third Nuclear Age will be one in which the possession of a range of SNNW by an adversary would be as, if not more, important than their nuclear capabilities in shaping state decision-making on nuclear force structure, doctrines, and deployments as well as policies on arms control and non-proliferation. Thus, the Third Nuclear Age can be thought of as a complex and potentially dangerous mix of aspects of the preceding two ages: the major power competition of the First, combined with the more diffuse spread of high-tech weaponry associated with the Second.

The central fear motivating the policy choices of nuclear-armed actors in the Third Nuclear Age would be a non-nuclear first strike (or coercion) by an adversary that believed it could degrade any retaliatory strike through offensive and defensive forces. It is important to remember that this is a fear of a worst-case scenario. It is not necessarily our central argument that the Third Nuclear Age will see states regularly, if ever, engaging in non-nuclear pre-emptive strikes. But it is the genuine anxiety of this possibility at some point in the future, and the associated (and perhaps more immediate) dangers from a state believing it had to use nuclear weapons first for fear of a disarming non-nuclear strike that will underlie most of the major decisions taken by nuclear-armed actors across a range of issues. Decision-makers need not believe that a non-nuclear counterforce strike is likely for the threat to play a decisive role in shaping policy and stability.

The combined effects of SNNW and the implications for the Third Nuclear Age

The move towards a Third Nuclear Age has four significant technological developments, each facilitated by the latest information technology revolution and by enormous shifts in computing, processing, and sensing power. Taken together, these dynamics are continuing to push the policy focus away from nuclear punishment towards non-nuclear denial, blurring the distinction between offence and defence, and creating a more fluid, complex, and potentially dangerous nuclear order.

The first key component of the Third Nuclear Age is the *growing perception that strategic forces and population centres could be protected against nuclear attacks with missile defences*. While the pursuit of missile defences can be traced back to the 1940s, it has only really been in the last twenty years that the technology has matured to a point whereby interception by conventional hit-to-kill technologies might credibly be deployed against certain types of threats, and that the political debate that surrounds the use of anti-missile defences has become normalised.³⁶ The US, Russia, China and India have all deployed or are in the process of deploying ballistic missile defences.³⁷

³⁶Andrew Futter, *Ballistic Missile Defence and U.S. National Security Policy: Normalisation and Acceptance after the Cold War* (Abingdon: Routledge, 2013). See also Catherine McArdle Kelleher and Peter Dombrowski (eds), *Regional Missile Defense from a Global Perspective* (Stanford, CA: Stanford University Press, 2015).

³⁷See Office of the Secretary of Defense, *2019 Missile Defense Review* (Washington, DC: Office of the Secretary of Defense, 2019); Keir Giles, *Russian Ballistic Missile Defense: Rhetoric and Reality* (Strategic Studies Institute, US Army War College: 2015); Bruce W. MacDonald and Charles D. Ferguson, 'Chinese strategic missile defense: Will it happen, and what would it mean?', *Arms Control Today* (November 2015); Zafar Khan, 'India's ballistic missile defense: Implications for South Asian deterrence stability', *The Washington Quarterly*, 40:3 (2017), pp. 187–202.

The second set of dynamics is the *maturation and spread of non-nuclear weapons that might be used to threaten an adversary's nuclear and associated systems*. Historically this was a mission that could only be carried out – or at least was most efficiently carried out – through the use of nuclear weapons. But major advances in precision, tracking, sensing, and processing power has meant that these tasks can now potentially be undertaken with non-nuclear weaponry. In the short term, this raises the possibility of a state conducting, threatening (or at least being misperceived as threatening), a *non-nuclear* disarming first strike against another, especially against states with smaller and less sophisticated nuclear arsenals (for example, North Korea). It also creates greater chances for states to misperceive that such an attack is imminent. In the medium to long term, it could include all nuclear-armed states. These systems include: various conventional precision/prompt strike weapons, including cruise and boost-glide hypersonic weapons,³⁸ some of which might be capable of targeting mobile missiles;³⁹ new methods of tracking and attacking nuclear-armed submarines,⁴⁰ long seen as one of the least vulnerable nuclear delivery systems due to their ability to hide in the ocean and remain undetected⁴¹ (whereas silo-based missiles and aircraft can normally be located); and counter-space and kinetic and non-kinetic anti-satellite (ASAT) technologies⁴² (while ASAT are not direct counterforce weapon they pose an indirect threat to nuclear relations, particularly given the reliance of leading nuclear powers on space for early warning, communications, and intelligence surveillance and reconnaissance).⁴³

The third technological driver of the Third Nuclear Age is the *emergence of unconventional capabilities that provide new means of defending against or attacking an adversary's nuclear systems*. These include various types of computer network operations (CNOs), or what are often loosely refer to as 'cyber-attacks'. The challenges posed by CNOs are diverse, and include compromising sensitive nuclear secrets, exaggerating the risks associated with disruption of the nuclear-supply chain, the possibility of interfering with early warning and communications, and the danger that hackers might break into nuclear command and control systems directly.⁴⁴

³⁸See James Acton, *Silver Bullet? Asking the Right Questions About Conventional Prompt Global Strike* (Washington, DC: Carnegie Endowment for International Peace, 2013), available at: {<https://carnegieendowment.org/files/cpgs.pdf>}; Richard H. Speier, George Nacouzi, Carrie A. Lee, and Richard Moore, *Hypersonic Missile Nonproliferation: Hindering the Spread of a New Class of Weapons* (Santa Monica, CA: RAND Corporation, 2017); Dennis M. Gormley, 'U.S. advanced conventional systems and conventional prompt global strike ambitions: Assessing the risks, benefits, and arms control implications', *Nonproliferation Review*, 22:2 (2015), pp. 123–39. For some of the earliest work on precision-guided missiles and their effect on (in this case conventional) deterrence, see John J. Mearsheimer, 'Precision-guided munitions and conventional deterrence', *Survival*, 21:2 (1979), pp. 68–76.

³⁹See Lieber and Press, 'The new era of counterforce'; Paul Bracken, *The Hunt for Mobile Missiles: Nuclear Weapons, AI, and the New Arms Race* (Philadelphia, PA: Foreign Policy Research Institute, 2020); Kelley M. Saylor, 'Hypersonic Weapons: Background and Issues for Congress', Congressional Research Service Report (Washington, DC: Congressional Research Service, 23 November 2020), p. 2, available at: {<https://fas.org/sgp/crs/weapons/R45811.pdf>}.

⁴⁰Rory Medcalf, Katherine Mansted, Stephan Frühling, and James Goldrick (eds), *The Future of the Undersea Deterrent: A Global Survey* (Canberra: Australian National University, 2020), available at: {https://nsc.crawford.anu.edu.au/sites/default/files/publication/nsc_crawford_anu_edu_au/2020-02/the_future_of_the_undersea_deterrent.pdf}.

⁴¹Although this faith may have been misplaced in the past, see Austin Long and Brendan Rittenhouse Green, 'Stalking the secure second strike: Intelligence, counterforce, and nuclear strategy', *Journal of Strategic Studies*, 38:1–2 (2015), pp. 38–73.

⁴²See Brian Weeden and Victoria Samson, 'Global Counterspace Capabilities: An Open Assessment', Secure World Foundation (April 2020).

⁴³See Todd Harrison, Kaitlyn Johnson, and Thomas G. Roberts, 'Space Threat Assessment 2018', Report of the CSIS Aerospace Security Project (Washington, DC: Center for Strategic & International Studies, April 2018), available at: {https://aerospace.csis.org/wp-content/uploads/2018/04/Harrison_SpaceThreatAssessment_FULL_WEB.pdf} and Forest E. Morgan, *Deterrence and First-Strike Stability in Space: A Preliminary Assessment* (Santa Monica, CA: RAND Corporation, 2002).

⁴⁴See Andrew Futter, *Hacking the Bomb* (Washington, DC: Georgetown University Press, 2018); US Department of Defense, Defense Science Board, 'Task Force Report: Resilient Military Systems and the Advanced Cyber Threat' (January 2013), available at: {<https://nsarchive2.gwu.edu/NSAEBB/NSAEBB424/docs/Cyber-081.pdf>}. See also Gartzke and Lindsay, 'Thermonuclear cyberwar'; and Stephen J. Cimbala, *Nuclear Weapons in the Information Age* (London: Continuum, 2012).

But while much of the more popular concern about cyber-attacks and nuclear weapons focus on those that would seek to *enable* nuclear systems – that is, cause a launch/ explosion – of primary interest to us here are those which seek to *disable* them – that is, prevent nuclear weapons from being used or reduce confidence that these systems will work as intended when required. These attacks might be carried out *directly* against nuclear systems – through hacking into command-and-control apparatus and preventing launch orders – or *indirectly* by interfering with or spoofing early warning systems so that they either see nothing or are bombarded with false attack information. While nuclear weapons systems have always been vulnerable to attackers, as well as open to computer-induced mistakes, these challenges are expanding in the current digital age. In fact, the US has begun planning for the use of cyber-attack capabilities against enemy missile and nuclear systems as part of a full spectrum missile defence or ‘left of launch’ programme.⁴⁵ Given the intangible nature of these capabilities, they are a grave concern for all nuclear-armed states. In particular, the belief that some systems may not work when needed severely undermines the notion of a secure, second-strike capability.

The fourth element is a new *real-time digitised environment in which global nuclear politics will play out, characterised by improvements in the ability to target, track, and monitor an adversary’s nuclear capabilities*, increasingly driven by artificial intelligence (AI). Essentially, the latest information technology revolution is changing both the methods and the context within which nuclear operations are managed, and a greater reliance on sophisticated technologies is creating more challenges and risks that must be understood and addressed. The major change here is in the technology available to support non-nuclear operations against nuclear weapons.⁴⁶ Perhaps most notably the potential to incorporate AI into both weapons platforms and remote sensing for reconnaissance and tracking of enemy nuclear forces or in managing more autonomous weapons systems.⁴⁷ While AI remains in its infancy, it could be used to help track, locate, and target enemy forces in a way not possible before, and to facilitate greater autonomy in nuclear/SNNW systems and provide better situational awareness.⁴⁸ More broadly, an ever more pervasive and complex digital context-or ecosystem⁴⁹-within which nuclear operations are carried out also increases the chances of accidents, miscalculation, and possible inadvertent escalation in the Third Nuclear Age.⁵⁰ This in turn means that current moves towards nuclear modernisation and greater incorporation of AI are likely to create more problems in the years ahead,⁵¹ albeit that the challenge will be different for different actors and systems.

⁴⁵Brian McKeon, ‘Statement before the Senate Armed Services Subcommittee on Strategic Forces’ (13 April 2016), available at: {https://www.armed-services.senate.gov/imo/media/doc/McKeon_04-13-16.pdf}.

⁴⁶Lieber and Press, ‘The new era of counterforce’, p. 9.

⁴⁷Vincent Boulanin (ed.), *The Impact of Artificial Intelligence on Strategic Stability and Nuclear Risk, Volume I: Euro-Atlantic Perspectives* (Stockholm: Stockholm International Peace Research Institute, May 2019).

⁴⁸Edward Geist and Andrew J. Lohn, ‘How Might Artificial Intelligence Affect the Risk of Nuclear War?’, Perspective 296 (Santa Monica, CA: RAND Corporation, 2018), p. 11, available at: {https://www.rand.org/content/dam/rand/pubs/perspectives/PE200/PE296/RAND_PE296.pdf}; Phil Stewart, ‘Deep in the Pentagon, a secret AI program to find hidden nuclear missiles’, *Reuters* (5 June 2018), available at: {<https://www.reuters.com/article/us-usa-pentagon-missiles-ai-insight/deep-in-the-pentagon-a-secret-ai-program-to-find-hidden-nuclear-missiles-idUSKCN1J114J>}. See also Michael Horowitz, Paul Sharre, and Alexander Valez-Green, ‘A Stable Nuclear Future? The Impact of Autonomous Systems and Artificial Intelligence’ (December 2019), available at: {<https://arxiv.org/pdf/1912.05291.pdf>}.

⁴⁹Harold A. Trinkunas, Herbert Lin, and Benjamin Loehrke, *Three Tweets to Midnight: Effects of the Global Information Ecosystem on the Risk of Nuclear Conflict* (Stanford, CA: Hoover Institution Press: 2020).

⁵⁰See, for example, Heather Williams and Alexi Drew, ‘Escalation by Tweet: Managing the New Nuclear Diplomacy’, Kings College London Centre for Science & Security Studies (July 2020), available at: {<https://www.kcl.ac.uk/csss/assets/10957•twitterconflictreport-15july.pdf>}.

⁵¹Andrew Futter, ‘The double-edged sword: U.S. nuclear command and nuclear modernization’, *Bulletin of the Atomic Scientists* (29 June 2016), available at: {<http://thebulletin.org/double-edged-sword-us-nuclear-command-and-control-modernization9593>}.

Notwithstanding the possibilities of different countermeasures that might be deployed (and possible limitations),⁵² the implications of these technological developments are considerable, especially when they are viewed in combination, or as force multipliers for each other. The most worrying implications of SNNW is that they raise serious concerns about inadvertent escalation and miscalculation, increase the risks of nuclear use, and present the possibility of conducting a non-nuclear first strike against a nuclear-armed opponent.⁵³ While inadvertent escalation and the option of using nuclear weapons first in a crisis is not new,⁵⁴ the recognition of mutual vulnerability between the superpowers during the Cold War brought a limited degree of caution to nuclear relations. Others have replicated this since (even to some extent in South Asia, arguably the least stable nuclear region).

SNNW are creating both a new set of fears and risks resulting from 'strategic indistinguishability' and at the same time challenging existing understandings of nuclear first-strike stability. The fear is that advanced monitoring capabilities could be used to locate nuclear assets and find sensitive information about how they function. Non-nuclear precision strike and other offensive capabilities would then be used to attack nuclear and supporting systems, destroying them or at least preventing them from working. Missile defences would then be used to nullify and minimise any residual retaliation. This kind of counterforce attack is limited only to forms of SNNW that are currently either deployed or in development, and purely to the military domain, but the strategic picture will almost certainly shift in the future.⁵⁵

Analysing SNNW on an individual basis is therefore only ever likely to provide limited clues to the next nuclear age. For example, the interaction between offensive and defensive SNNW means that placing limits on the deployment of ballistic missile defence is only meaningful in the context of the possessor state's offensive counterforce capabilities.⁵⁶ The strategic impact of a BMD system can still be significant if it is only required to defend against a small force that has been seriously degraded by a first strike.⁵⁷ The combined effects of SNNW will also clearly have implications for coercion, compellence, and other foreign policy strategies affected by the existence of nuclear capabilities.⁵⁸

The danger of escalation is also likely to increase over time as SNNW mature and new capabilities are added to the mix. As Barry Posen's work on this issue (in the context of the First Nuclear Age) highlights, the greater the counterforce capabilities and commitment to counterforce strategies, the greater the chances of inadvertent nuclear escalation in the event of conflict.⁵⁹ The difference in the Third Nuclear Age will be that the commitment to counterforce strategies are likely to be significantly higher when the capabilities needed for this mission do not require crossing the nuclear threshold. Moreover, it will be far more difficult to distinguish the intended

⁵²See, for example, Ryan Snyder, Benoit Pelopidas, Keir Lieber, and Daryl Press, 'Correspondence: New era or new error? Technology and the future of deterrence', *International Security*, 43:3 (2018/2019), pp. 190–3.

⁵³See Greg Austin and Pavel Sharikov, "'Pre-emption is victory': Aggravated nuclear instability of the information age', *Nonproliferation Review*, 23:5–6 (2016), pp. 691–704 (p. 691).

⁵⁴See Freedman, *The Evolution of Nuclear Strategy*.

⁵⁵It is possible that pre-emptive, non-nuclear attacks might involve compromising non-military targets to cause confusion or further complicate a response. A denial-of-service attack on key infrastructure or attacking power grids would be a good example.

⁵⁶This relationship between offensive and defensive strategic forces was explicitly acknowledged in the preamble to the 2010 New START (Strategic Arms Reduction Treaty). See 'Treaty Between the United States of America and the Russian Federation on Measures for the Further Reduction and Limitation of Strategic Offensive Arms' (2010).

⁵⁷Despite this, the 2019 Missile Defense Review announced that the US would no longer accept any kinds of limits on future BMD deployments (albeit while still claiming to rely upon deterrence *vis-à-vis* Russia and China). See Office of the Secretary of Defense, *2019 Missile Defense Review*, p. vii.

⁵⁸Mark S. Bell, 'Beyond emboldenment: How acquiring nuclear weapons can change foreign policy', *International Security*, 40:1 (2015), pp. 87–119.

⁵⁹Barry Posen, *Inadvertent Escalation: Conventional War and Nuclear Risk* (Ithaca, NY: Cornell University Press, 1991), p. 9.

use of SNNW given their dual use nature; essentially, it is entirely possible to see the use of SNNW for a limited purpose interpreted as a much more serious attack.⁶⁰

If there is anything to the notion of the nuclear taboo, the prospect of being able to conduct a first strike without employing nuclear weapons logically makes such strikes (or the perception of such strikes) more likely.⁶¹ The important point for thinking about the effect of the widespread deployment of SNNW is that the prospect of such a strike (and possible misperception linked with it) only needs to become more likely in the near future for it to shape policies today.

Bolt out of the blue attacks will remain unlikely given the risks involved in one or other SNNW being less effective than envisaged. However, in a situation in which a state armed with a mix of offensive and defensive SNNW is already involved in armed conflict with a nuclear-armed state in which escalation seems likely, the temptation to engage in a SNNW counterforce strike will, at the very least, be present (as will the possibility of miscalculation). That temptation and risk looms as the worst-case scenario in the Third Nuclear Age. Once we take seriously the possibility (or at least the perception) of a combination of SNNW being used in a pre-emptive counterforce strike, we can begin to think through how different, but clearly worst-case scenarios, might play out. States investing in SNNW today could potentially give themselves the option to consider pre-emptive strikes that knock-out an adversary's nuclear capabilities, thereby completely altering the military dynamics of a conflict in the future.

Despite the fact that few advocates for any of the SNNW platforms discussed here consider the cumulative effects of these separate technologies on strategic nuclear stability, the connection was actually made by some of the earliest advocates of Second Nuclear Age thinking.⁶² This found its most potent form in the arguments for a 'new triad' of both nuclear and conventional, offensive and defensive capabilities in the 2002 US Nuclear Posture Review,⁶³ and in the more recent moves towards 'left of launch' cyber operations.⁶⁴ Proponents of Second Nuclear Age thinking about the conventional counterforce potential of these technologies always maintained that they were to be aimed only at 'rogue states' and would therefore not replace MAD as a doctrine *vis-à-vis* major powers like Russia. However, little attention was given to how this two-tiered system based on Washington's threat assessments would actually work in practice when the SNNW capabilities could, in principle, be used to threaten any nuclear stockpile if these SNNW capabilities were not kept to a minimum. This is especially true for those states whose deterrence stance is based on a 'minimum deterrent' deployment.⁶⁵

Of course, current trends may not hold, and the role of SNNW could in time be reduced in the postures of the nuclear-armed states, or as we discuss later on, we may see the emergence of restraint in SNNW deployment. But we suggest that current approaches to these technological areas will continue to push us into a Third Nuclear Age. First, due to the strategic implications of the interactive effects of SNNW, proliferation will continue across all four fields outlined above. Second, given its crucial role as a defensive backstop that can hedge against less effective offensive capabilities, the testing record in missile defence programmes will continue to be funded and therefore improve, even if only at slow rates. The United States, the country with the most well developed missile defence system to date has managed slow but more or less continual pro-

⁶⁰See Caitlin Talmadge, 'Would China go nuclear? Assessing the risk of Chinese nuclear escalation in a conventional war with the United States', *International Security*, 41:4 (2017), pp. 50–92.

⁶¹One need not believe that a nuclear first strike was as unlikely in the past as proponents of the 'nuclear revolution' thesis maintain to agree that strategic non-nuclear first strike would be even more likely than a nuclear one in the event of a major crisis.

⁶²Gray, *Second Nuclear Age*, pp. 100, 153.

⁶³David S. McDonough, 'Nuclear Superiority: The "New Triad" and the Evolution of Nuclear Strategy', Adelphi Paper 383 (London: IISS, 2006).

⁶⁴Riki Ellison, 'Left of Launch', Missile Defense Advocacy Alliance (16 March 2015), available at: {<https://missiledefenseadvocacy.org/alert/3132/>}.

⁶⁵Glaser and Fetter, 'Should the United States reject MAD?'; Fravel and Medeiros, 'China's search for assured retaliation'.

gress in successful BMD testing.⁶⁶ This will need to continue and be replicated in other states over time. Third, increased spending on conventional precision-strike systems of different varieties will continue given that such systems require relatively large-scale deployment. Current trends indicate that this is likely.⁶⁷ Fourth, various ‘cyber’ technologies, AI and Autonomous systems will play an ever greater role in nuclear and SNNW planning and operations for all major powers.

A pre-emptive counterforce strike relying solely on SNNW is not yet technically feasible and this may even remain the case throughout the Third Nuclear Age. Much of the technology is still unproven and unreliable – the mission at this stage is simply too difficult to achieve given current capabilities. But this should not lead us to conclude that the prospect of an adversary achieving significant technological breakthroughs at some point will not be extremely influential on decision-making. It is this influence that will be one of the defining characteristics of the Third Nuclear Age. States do not – and cannot – plan for their own survival based solely on current capabilities or best-case thinking. It is, instead, the possibility of an adversary achieving significant breakthroughs in the SNNW sphere that will shape decision-making and threat perceptions. As President John F. Kennedy’s defence secretary, Robert McNamara, put it:

While serving as Secretary, I was repeatedly forced to make decisions about the forces we would begin to build today to balance Soviet forces that we believed might exist tomorrow. Such decisions were speculative, based on incomplete, often contradictory, and constantly changing information ... We had a limited knowledge of Soviet capabilities to develop and produce missiles and bombers – we had no information on how they intended to use those capabilities. We assumed, in other words, the Soviets would maximize the use of their resources.⁶⁸

The world therefore stands at a technological and policy crossroads with regard to future thinking about SNNW and its impact on nuclear order. Indeed, it is possible to foresee an emerging strategic environment where nuclear forces might be compromised (or at least confidence in them is reduced); stable deterrence relationships become more challenging than they have been in decades; crises have the potential to quickly escalate out of control; the threshold of nuclear use is lowered; nuclear coercion backed by SNNW threats intensifies, and both nuclear and SNNW arms racing ensues. This is not to say that the Third Nuclear Age will be characterised by constant conflict, or that the next crisis will be unmanageable; rather, we need to think through the plausible scenarios that a Third Nuclear Age is likely to produce. Only then can we begin to design new strategies for the peaceful management of nuclear dangers for such an era.

Four possible scenarios for the Third Nuclear Age

Since the Second World War, the US has been at the forefront in the development of military technology, both quantitatively and qualitatively, but it is not preordained that this will remain the case in the years ahead. The financial and technological gap between the United States and the other nuclear-armed states that encouraged Washington’s pursuit of ‘full spectrum dominance’⁶⁹ in military affairs during the Second Nuclear Age is narrowing as Russia, China, and

⁶⁶Matt Korda and Hans M. Kristensen, ‘US ballistic missile defenses, 2019’, *Bulletin of the Atomic Scientists*, 75:6 (2019), pp. 295–306.

⁶⁷Amy Woolf, ‘Conventional Prompt Global Strike and Long-Range Ballistic Missiles: Background and Issues’, Congressional Research Service Report (Washington, DC: Congressional Research Service, 14 February 2020), available at: <https://fas.org/sgp/crs/nuke/R41464.pdf>.

⁶⁸Robert S. McNamara, *Blundering into Disaster: Surviving the First Century of the Nuclear Age* (New York: Pantheon Books, 1986), p. 53.

⁶⁹US Department of Defense, *Joint Vision 2020* (Washington, DC: US Government Printing Office, June 2000), available at: <https://apps.dtic.mil/dtic/tr/fulltext/u2/a377926.pdf>.

now India slowly catch up. While this does not mean that primacy in the SNNW sphere is impossible, neither is it a foregone conclusion. Therefore, multiple pathways for the Third Nuclear Age need to be anticipated. While the strategic effects of SNNW are likely to be experienced differently by different actors in different regions, and vary depending on doctrine, capabilities, systems, and perceived requirements, it will necessitate a rethinking of the role of nuclear forces in military planning for all actors – from nuclear aspirants to established nuclear powers.

While our purpose so far in this article has been to map the emergence of an empirical trend and provide some degree of conceptual clarity in order to better understand it, this section aims to explore the different ways this trend may play out in the future. This necessarily requires moving from the empirical to the theoretical in our analysis. Therefore it is important to note that the scenarios below are based on the following five core theoretical assumptions: First, the uncertainty generated by an anarchical international system means that decisions on nuclear and SNNW forces will be made based on assessments of an adversary's likely future capabilities as well as the capabilities already at their disposal.⁷⁰ Second, while it is possible in theory to neatly distinguish between offensive and defensive SNNW, in practice this is extremely difficult – at least in a way that is widely accepted – and therefore, the logic of the security dilemma is likely to prevail in specific dyads.⁷¹ Third, that the primary driver of crises and instability in nuclear-armed relationships is the existence (perceived or otherwise) of an incentive or ability to strike first on the part of one or more actors.⁷² Fourth, notwithstanding these assumptions, through mutual restraint and effective signalling it is possible (if not always likely) for states to mitigate security dilemma dynamics and therefore increase relative stability.⁷³ Fifth, as in previous periods, wider trends in the global order – not least the levels of direct competition or cooperation among the major powers as well as the relative distribution of power and status among those states – will continually interact with material conditions such as technological breakthroughs.

There appear to be four possible future trajectories for this phenomenon in the short to medium term: SNNW and nuclear proliferation; SNNW creates strategic advantage; restraint in SNNW; and stability through SNNW. These are explained below.

SNNW and nuclear proliferation

The first scenario is one where the deployment of SNNW drives vertical *nuclear proliferation and arms racing*, heightens tensions, and creates new challenges for crisis stability and arms control. In this scenario, it is likely that we see periods of stalemate, where no one state gains absolute advantage from the development and deployment of SNNW, but where all are engaged in a

⁷⁰Charles L. Glaser, *Rational Theory of International Politics: The Logic of Competition and Cooperation* (Princeton, NJ: Princeton University Press, 2010), pp. 110–11.

⁷¹John J. Mearsheimer, 'Conversations in *International Relations*: Interview with John J. Mearsheimer (Part II)', *International Relations*, 20:2 (2006), pp. 231–43 (p. 234); Charles L. Glaser and Chaim Kaufmann, 'What is the offense-defense balance and how can we measure it?', *International Security*, 22:4 (1998), pp. 44–82 (pp. 56–7); Keir A. Lieber, 'Grasping the technological peace: The offense-defense balance and international security', *International Security*, 25:1 (2000), pp. 71–104 (p. 78). We do not argue that this distinction is impossible *per se* but instead that history shows us that finding unanimous agreement on the distinction among decision-makers over extended periods of time is extremely difficult.

⁷²Thomas C. Schelling, *The Strategy of Conflict* (Cambridge, MA: Harvard University Press, 1960), pp. 207–29; Richard Ned Lebow, *Nuclear Crisis Management: A Dangerous Illusion* (Ithaca, NY: Cornell University Press, 1987), pp. 31–74. While recognising that some types of crisis might be more dangerous than others. See Mark S. Bell and Julia MacDonald, 'How to think about nuclear crisis', *Texas National Security Review*, 2:2 (February 2019), pp. 40–64. We also agree with Brendan Rittenhouse Green and Austin Long that analytically they are intrinsically hard to interpret. See Brendan Rittenhouse Green and Austin Long, 'Contrasting views on how to code a nuclear crisis: In response to "How to Think About Nuclear Crises"', *Texas National Security Review*, 2:4 (2019), pp. 130–5.

⁷³Glaser, *Rational Theory of International Politics*, p. 107; Ken Booth and Nicholas J. Wheeler, *The Security Dilemma: Fear, Cooperation and Trust in World Politics* (Basingstoke: Palgrave Macmillan, 2008); Nicholas J. Wheeler, *Trusting Enemies: Interpersonal Relationships in International Conflict* (Oxford: Oxford University Press, 2018).

constant process of nuclear modernisation and enhancement. Nuclear weapons would remain the currency of deterrence policy, but ensuring credible deterrence becomes consistently more difficult. States would have to frequently upgrade their strategic forces, but a secure second-strike capability, and therefore deterrence, while fragile, would likely be retained, albeit at much higher levels than currently. Stability would, however, be predominantly reliant upon quantitative and qualitative advances in *nuclear* arsenals. This scenario may bear some political resemblance to the nuclear world of the 1950s and 1960s, as the US and the Soviet Union raced to outdo one another in more powerful and diverse weaponry in order to seek strategic advantage, or at least to guard against any perceived vulnerability. SNNW would therefore principally reinforce and augment the role played by nuclear weapons and the power balances that they create but undermine the post-Cold War trend of decreasing numbers of nuclear weapons worldwide.

From the current vantage point, this appears to be the most likely regional and global scenario. SNNW developments by the United States over the past decades – ostensibly driven by a need to meet perceived deterrence requirements of the Second Nuclear Age – are now being matched by peer competitors, notably Russia and China (with India making considerable gains as well).⁷⁴ This has already driven SNNW proliferation as well as aspects of nuclear modernisation programmes.⁷⁵ This in turn is shaping the way that the US, and others, views nuclear weapons and the possibility of future nuclear reductions.⁷⁶ The *proliferation scenario* would in some respects see a return to the problems that characterised the start of the First Nuclear Age, only this time with more players and a more complex strategic picture.

As with the development of various nuclear balances in the First Nuclear Age, this will play out in specific dyads and contexts rather than individual states responding to larger global trends in technological development. While this presently includes nuclear counterforce options, the analysis above suggests that SNNW may play a more significant role in this than nuclear forces over time. While this scenario would be characterised by vertical nuclear proliferation and both vertical and horizontal SNNW proliferation, it would potentially see less horizontal nuclear proliferation. Given that the threat of a disarming first strike using SNNW would be greatest for a new nuclear power with a small arsenal, there may possibly be a disincentive to proliferate. In this scenario, the prospect of even a small nuclear arsenal acting as a ‘great equalizer’ in strategic relations may no longer be achievable.

SNNW strategic advantage

The second scenario is where one state achieves and retains a qualitative and quantitative advantage in SNNW, however short-lived, that creates a strategic advantage by undermining, or at least challenging, the secure second-strike capabilities of its opponent(s). At the current time, this seems most likely to be the United States, but it is conceivable that another great power achieves dominance in the future. Like the first scenario, this is also a world of nuclear and non-nuclear proliferation, arms racing, and probably periods of instability. It does not have to be the case that the state looking to maintain an SNNW ‘edge’ rather than parity necessarily does so as part of a larger bid for military hegemony. As is the case with the United States at present, it is possible for policymakers to assume that others do not find their actions hostile if they themselves believe in their own defensive intentions.⁷⁷

⁷⁴See, for example, Clary and Narang, ‘India’s counterforce temptations’.

⁷⁵Benjamin Zala, ‘How the next nuclear arms race will be different from the last one’, *Bulletin of the Atomic Scientists*, 75:1 (2019), pp. 36–43.

⁷⁶US Department of Defense, ‘Nuclear Posture Review’ (Washington, DC: US Department of Defense, February 2018), available at: {<https://media.defense.gov/2018/Feb/02/2001872886/-1/-1/1/2018-NUCLEAR-POSTURE-REVIEW-FINAL-REPORT.PDF>}.

⁷⁷Robert Jervis, *Perception and Misperception in International Politics* (Princeton, NJ: Princeton University Press, 1976), pp. 354–5.

In this scenario, SNNW are also likely to create new and little-understood dynamics for nuclear crisis management, signalling, and (unintended) escalation,⁷⁸ possibly even creating ‘use it or lose it’ dynamics and pressures. SNNW may make it increasingly risky to adopt a policy of waiting to strike second. That said, it could induce postures of restraint for fear of being attacked. Stable nuclear balances and crisis management will be further complicated by the perceived requirement to keep nuclear forces at high levels of alert for fear of surprise attack, and by a current tendency to co-mingle nuclear and conventional weapons and command-and-control systems.⁷⁹ It would also drive high investments in countermeasures as well as create intense pressures to deploy these countermeasures quickly regardless of their proven effectiveness. Deploying anything is better than nothing in this scenario from the perspective of a state with a vulnerable nuclear arsenal. This in turn would raise the risks of accidents, mistakes, and inadvertent outcomes. Concerns about nuclear vulnerability will also probably curtail any efforts at further nuclear arms control.

A state with an SNNW-based strategic advantage at any point in time under this scenario might accept higher strategic risks due both to the capability of the SNNW technologies and the belief that others will view their intentions as defensive and benign. It might also increase the possibilities and veracity of a state seeking to carry out nuclear or SNNW coercion.⁸⁰ The discussion of risk by American policymakers during Washington’s brief period of nuclear monopoly between 1945 and 1949 suggests that, as the US secretary of defense at the time, James Forrestal, put it, ‘we can assume certain risks otherwise unacceptable’.⁸¹ The likelihood of taking greater risks in order to ensure one’s own survival is compounded by the fact that, as mentioned above, a disarming strike employing SNNW could be undertaken without crossing the nuclear threshold with all the historical and moral implications that this would have. Of course, this assumes that the *technical* ability is matched by the requisite *political* will to do so.

SNNW restraint

The third scenario is characterised by *restraint in SNNW development and deployment* through new arms control, risk reduction, and other normative mechanisms and regimes. This would be the closest to our current Second Nuclear Age, as it would mean limiting, or at least attempting to mitigate, the most destabilising effects of SNNW. This scenario would also appear to be the most politically (and economically) attractive from our current vantage point, although perhaps not the most likely. The restraint scenario would mean continuing to prioritise nuclear risk reduction and disarmament through diplomatic and normative mechanisms, but also possibly an acceptance that nuclear weapons will remain the central currency of international politics for some time to come.

Theoretically, the SNNW restraint scenario would minimise the risks of both nuclear and non-nuclear arms racing, limit the proliferation of SNNW to new actors (or at least slow it down), reduce the destabilising impact of SNNW in nuclear crises, and keep open the possibility of a norms-based international nuclear order. However, the restraint scenario is premised on two essential features. First, that there is a political willingness by key players to act with restraint and forego the possible advantages provided by SNNW. Second, that the requisite frameworks and normative global structures can be created and maintained to sustain this. This may well

⁷⁸Lawrence Kavaola, David Gompert, and Martin Libicki, ‘Cyber house rules: On war, retaliation and escalation’, *Survival*, 57:1 (2015), pp. 81–104.

⁷⁹Joshua Pollack, ‘Emerging strategic dilemmas in U.S.–Chinese relations’, *Bulletin of the Atomic Scientists*, 65:4 (2009), pp. 53–63 (p. 59); Acton, ‘Escalation through entanglement’.

⁸⁰See Todd Sechser and Matthew Fuhrmann, *Nuclear Weapons and Coercive Diplomacy* (Cambridge: Cambridge University Press, 2017).

⁸¹Quoted in Melvyn P. Leffler, *A Preponderance of Power: National Security, the Truman Administration, and the Cold War* (Stanford, CA: Stanford University Press, 1992), p. 17.

require a new global arms control edifice. Even in this restraint scenario, there would be constant concerns about cheating, hedging, or one state seeking strategic advantage, or breakout, through rapid technological development. If this scenario becomes entrenched over the longer term, then it will likely require a replay of the concerted thinking that brought about the arms control architecture of the First Nuclear Age in order to provide some sort of recognised stability.

It is possible that we see periods of restraint in the Third Nuclear Age. After all, it is entirely conceivable that the thinking and strategy of the major powers will shift over time. Thus, it may be more likely that we see the evolution of nuclear order as a punctuated equilibrium; periods of restraint following a period of arms racing, rather than moving straight to a stable order characterised by restraint right away. This would then mirror the experience (and enormous associated costs) of previous periods of nuclear history where arms control tends to follow development and deployment. From the current vantage point it is difficult to see how restraint in SNNW development and deployment can be permanent and enduring.

SNNW stability

The fourth scenario is where *SNNW proliferation undermines nuclear weapons*, MAD, and secure second-strike capabilities (but no one state gains a significant strategic advantage), and the vulnerabilities of nuclear forces to SNNW make reliance on SNNW a more credible option for all states. This could involve SNNW arms racing whereby developments in non-nuclear weaponry are perceived as being most effectively neutralised, or balanced, by SNNW themselves, and perhaps a return to more regular episodes of conventional conflict. It is possible that in the long term a certain degree of parity is achieved in SNNW (following either the first or second scenarios), whereby non-nuclear forces effectively cancel each other out and we return in principle to a world of deterrence based on strategic stability. Nuclear second-strike capabilities would therefore be undermined, but a balance may yet still be achieved.

This could potentially come about through models of restraint shown by the current dominant power (the United States) or may be the product of an unintended gradual power shift away from the US to other competitors and advanced military powers. It is possible that we see periods of relative balance and stability that punctuate a broader fluctuation between non-nuclear balances. This would be the kind of environment associated with the 'arms dynamic' rather than 'arms racing',⁸² characterised by deterrence by *non-nuclear denial* rather than *nuclear punishment*, and would be truly ground-breaking for the way we think about nuclear weapons and the nuclear revolution.⁸³ It could even conceivably create the possibility of a technologically driven nuclear-disarmed world.

For sure, SNNW are unlikely to ever have the same sheer destructive capability as nuclear weapons, at least from the current vantage point, and there may always be the risk that a state being coerced or fearful of being attacked may attempt to use nuclear weapons first. Indeed, a small number of nuclear weapons may still exist in this hypothetical world but wouldn't necessarily be deployed, ready for use or able to overcome defences and other SNNW countermeasures with confidence. More broadly, we should not expect that such a scenario, where no state holds a decisive advantage in SNNW, would be entirely free of destabilising tendencies. In fact, such a scenario still fits with precisely the interactive dynamic that Thomas Schelling outlined almost sixty years ago:

A modest temptation on each side to sneak in a first blow – a temptation too small by itself to motivate an attack – might become compounded through a process of interacting

⁸²Barry Buzan and Eric Herring, *The Arms Dynamic in World Politics* (Boulder, CO: Lynne Rienner, 1998).

⁸³See Jervis, *The Meaning of the Nuclear Revolution*. Although in this case nuclear stalemate could be replaced by non-nuclear stalemate. See Lieber and Press, *The Myth of the Nuclear Revolution*.

expectations, with additional motive for attack being produced by successive cycles of “he thinks we think he thinks we think ... he thinks we think he’ll attack; so he thinks we shall; so he will; so we must.”⁸⁴

It is possible that a degree of parity may be achieved in the SNNW sphere without parity among those actors in nuclear terms (for example, the United States and China with today’s nuclear arsenals but with rough SNNW parity). This will make matching SNNW and nuclear arms control efforts exceedingly difficult. It is also likely in this scenario that SNNW would spread beyond the nuclear-armed states and become a key component of all states’ security strategies.⁸⁵ It is also possible that this could be the pathway to a disarmed world and the end of the nuclear era, as SNNW cancel out any perceived advantages of nuclear weapons and increase the risks and trade-offs of relying upon them;⁸⁶ disarmament through technological change rather than moral, political, economic, or diplomatic pressure. This scenario could see non-nuclear capabilities replacing nuclear weapons as the go-to technology for security and power, and states relying on conventional and unconventional weapons for deterrence rather than nuclear: SNNW would provide general security. As in the proliferation scenario, horizontal nuclear proliferation or breakout would be highly unlikely given the SNNW threat to small nuclear arsenals.

In the short term, the political impact of SNNW is likely to be felt most acutely by states with small, vulnerable nuclear arsenals, but in the medium to long term, as technology diffuses, the impact will be felt by all. The question then becomes which is the more likely pathway, and whether anything can be done to influence policy in the longer term that might help move us towards a more stable global order, perhaps even one with less nuclear weapons or even complete nuclear disarmament. While the fourth scenario (SNNW creates stability) would probably be of most interest to those seeking nuclear disarmament and a new paradigm of global security, getting to an international system where security is based on non-nuclear weapons is unlikely to be easy (or a panacea). As a result, the best possible course of action may be restraint (the third scenario) in SNNW and an acceptance that nuclear weapons will continue to play a central role in the Third Nuclear Age.

Conclusion: Political choices in the Third Nuclear Age

Much has been made of the idea of a transition from a First to Second Nuclear Age with the end of the Cold War. We have explored the ways that this primarily US-driven conceptual shift has had material impacts on policies, technological changes, and strategic relationships. Central to this has been the political choices of agents in creating structural trends. Viewing the global nuclear order as having entered a Second Nuclear Age downplayed the importance of managing the ‘central balance’, elevated ‘rogue’ and ‘regional’ threats, and legitimised the development and deployment of SNNW. But evidence suggests that we may well now be on the cusp of a Third Nuclear Age, where the challenges, central dynamics, and threats will shift again. A return to major power competition and strategic rivalry is evident but with new opportunities for conflict and nuclear crises driven by SNNW. Somewhat simplistically, this might be characterised as First Nuclear Age politics with Second Nuclear Age technology.

While we cannot know exactly how this will pan out, it is important to begin thinking through the kinds of scenarios that we have outlined above now. Amid the different possible futures for the Third Nuclear Age, three key features stand out that are likely to underpin this new nuclear epoch:

⁸⁴Schelling, *The Strategy of Conflict*, p. 207.

⁸⁵This is already happening to some extent, see Speier et al., *Hypersonic Missile Nonproliferation*.

⁸⁶See Andrew Futter and Benjamin Zala, ‘Emerging technology and the future of nuclear order’, in Bård Nikolas Vik Steen and Olav Njølstad (eds), *Nuclear Disarmament: A Critical Assessment* (Abingdon: Routledge, 2019); Rod Lyon, ‘A new nuclear pessimism’, *The Strategist* (19 December 2017), available at: <https://www.aspistrategist.org.au/new-nuclear-pessimism/>.

- (i) Political developments and technological breakthroughs relating to the SNNW realm will be of central importance to the task of avoiding nuclear war.
- (ii) The ordering value of mutual vulnerability will come under greater pressure, especially the invulnerability of secure second-strike forces, and deterrence by denial will appear increasingly attractive to technologically advanced nuclear-armed powers. The combined effects of SNNW will raise the prospect of counterforce first strikes in times of crisis authorised by leaders unencumbered by the nuclear taboo.
- (iii) The dual-use nature of SNNW will create new dynamics and pathways for misperception and miscalculation, increasing the chances of inadvertent escalation between nuclear armed states. The cutting-edge nature of much of the technology and supporting systems is likely to make crises more common but less predictable.

This does not automatically mean that ‘traditional’ frameworks of nuclear governance are obsolete,⁸⁷ rather we must now search for new mechanisms and novel ideas to meet the challenges of a new nuclear age. We did this in the past, and we can do so again.

As outlined above, given current trends, the least dangerous path for the Third Nuclear Age appears to be restraint (the third scenario). While this would mean that nuclear weapons remain central in the Third Nuclear Age, it would potentially mitigate some of the most worrying dynamics of SNNW proliferation. That said, it would appear to rule out the possibility of moving to a world order based on non-nuclear rather than nuclear weapons through technological shifts (although not necessarily through ethical, financial, legal, or political means). This environment would be most conducive to confidence-building measures and relatively stable nuclear balances. The first and second scenarios will be costly, dangerous, and, especially in the case of the second scenario, highly destabilising. Whether SNNW restraint is achievable politically remains to be seen given deteriorating relations between the US and Russia, the US and China, and between India and China. Scenario four, where SNNW undermine nuclear systems and become the go-to currency of international politics, is the least likely, but also the most potentially transformative in how we conceptualise the nuclear condition.

What might be done to bring about this environment? There are no easy answers to the challenges posed by SNNW and the embryonic Third Nuclear Age. But we must look at politics as much as technology. For sure, some type of limitation on each of these systems, perhaps individually, needs to be at least discussed. It may be that Second Nuclear Age thinking has produced a techno-military environment that seems to be inevitably pushing the global nuclear order towards a Third Nuclear Age. Yet both the political and technological landscape of that age will be decided by political decisions. This is not an irresistible structural process, agency matters.

For some technologies, it may require more of a management strategy, but some type of pre-emptive arms control (that is seeking to regulate systems before they are widely deployed), asymmetric agreements across different domains, or the establishment of general norms around the non-use of these capabilities (such as clarity of purpose or greater transparency), might be possible for the others. But ultimately, the fate and shape of the Third Nuclear Age will be driven by policy choices taken by policy elites in Washington, Moscow, Beijing, New Delhi, and elsewhere, based on perceptions of their security environment and of each other.

Timing will be all-important, as indeed, will an approximate co-equivalence in systems development and deployment. It might also make sense to consider how the alert status of weapons might be reduced, how confidence in early warning could be enhanced, and whether some type of nuclear-hotline for all nuclear-armed states could be established. The aim would be to buy more time for the pre-strike phase of nuclear operations. We may also need to shift our focus towards pathways to nuclear use as a model for arms control – thinking through the most dangerous

⁸⁷Alexey Arbatov, ‘An Unnoticed Crisis: The End of History for Nuclear Arms Control?’ (Moscow: Carnegie Moscow Center, June 2015), available at: https://carnegieendowment.org/files/CP_Arbatov2015_n_web_Eng.pdf.

scenarios and working to minimise the associated risks rather than focusing on specific technologies – especially given the problems of dual use and indistinguishability posed by SNNW. War gaming, simulations, and red teaming, perhaps jointly, may also help to provide new insights into how these technologies will play out and interact, and perhaps assist in identifying processes, thinking, and procedures that no longer fully apply.⁸⁸ In the Third Nuclear Age, it may no longer make sense to treat nuclear weapons issues in isolation, no matter how much more difficult this makes things in practice. While the danger of nuclear war remains a unique threat, a new generation of scholars, practitioners, and activists will need to become more adept at dealing directly with the linkages between SNNW and nuclear weapons.

It may be possible to move to a world of relative stability based on non-nuclear deterrence by denial rather than nuclear punishment, but this would require nuclear-armed adversaries to move in lockstep in terms of testing and deployment. Fundamentally, this requires the mutual recognition of ‘special responsibilities’ among the major powers for avoiding dangerous crises in order to take such steps.⁸⁹ The problem from a stability perspective is that (at least for the time being), the US has a decisive lead in this area (and no obvious political willingness to engage). The logical solution to this is a unilateral freeze on the part of Washington. But a freeze of some sort motivated by a desire to let others catch up is extremely unlikely. However, a freeze motivated by the desire to reduce the incentives for adversaries to try and overcome the current systems (that is, to avoid a costly and risky arms race before it fully gets underway), is at least thinkable.⁹⁰ Hence there may be avenues for harnessing concerns in Washington about ‘falling behind’ certain other powers in areas such as hypersonic missile technology and AI.⁹¹ While this may be so, it will require strong political leadership in Washington to convince a sceptical domestic audience of the benefits of this. In essence, it requires a complete abandonment of Second Nuclear Age ideas about invulnerability and a return to a commitment to mutual vulnerability that has not been seen in policy circles since the First Nuclear Age. Such a decision would not need to be couched in these terms when explained to a domestic audience. The reality is, however, that in an era of increasing populism, the kind of leadership that eschews short-term domestic popularity for the sake of long-term global stability appears to be in short supply in many parts of the world.

Mitigating the worst dangers of a Third Nuclear Age will require breaking out of the Second Nuclear Age mind-set that has characterised mainstream nuclear policy debates for the last quarter century. Moving towards the restraint scenario outlined above will require the kind of thinking that led to the severe limits on BMD imposed by the 1972 ABM Treaty of the First Nuclear Age rather than moves that resemble the abrogation of this treaty in the Second Nuclear Age. A return to the fundamental questions that animated the First Nuclear Age will almost certainly be part of this – perhaps best captured by Schelling’s question to his readers in 1966: ‘What happens tomorrow and the day after as a result of the steps we take today? If we make ourselves less vulnerable today is it at the expense of tomorrow?’⁹² If tomorrow is to be less dangerous than the scenarios for the Third Nuclear Age described above, answering this question has now become unavoidable.

⁸⁸For recent work on war gaming and the prospects of nuclear use during the First Nuclear Age, see Reid B. C. Pauly, ‘Would U.S. leaders push the button? Wargames and the sources of nuclear restraint’, *International Security*, 43:2 (2018), pp. 151–92.

⁸⁹Hedley Bull, ‘The great irresponsibles? The United States, the Soviet Union, and world order’, *International Journal*, 35:3 (1980), pp. 437–47.

⁹⁰On this point, Schelling wrote of the American reaction to the Soviet missile defense deployments in the 1960s of signalling its own intention to build such a system ‘would take the profit out of it’ for Moscow and ‘only make the arms race more expensive and more vigorous, not only in ballistic missile defenses but in the kinds and numbers of offensive missiles that would be procured’. Thomas C. Schelling, *Arms and Influence* (New Haven, CT: Yale University Press, 1966), p. 268.

⁹¹Regardless of how well founded those fears are.

⁹²*Ibid.*, p. 236.

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