Deterrence, Disruptive Technology and Disarmament in the Third Nuclear Age

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Contents

Introduction: A global nuclear order in flux

We are living in an era of flux in the global nuclear order where nuclear risks are changing and the methods, mechanisms and frameworks that have been devised to manage the nuclear condition are under pressure. A perfect storm of rapid widespread technological innovation and the emergence of a global system of great power nuclear competition is calling into question how we prevent future nuclear use, and whether the traditional organization of global nuclear politics around a "managed" system of nuclear deterrence and mutual vulnerability, can continue to provide stability and peace in the ways that many believe it has in the past. At the same time, technological and geopolitical shifts are unfolding in a global normative nuclear environment where dominant hegemonic ideas of past control are being challenged – both theoretically by the emergence of the academic field of "critical nuclear studies" and practically through agreements such as the 2017 Nuclear Ban Treaty.[1] The result is pervasive, and has implications for how we think about nuclear weapons and the way that we keep ourselves safe (whether this be through better managed deterrence and stability, or by a renewed drive towards abolishing nuclear weapons entirely). This suggests that we may be at a pivotal moment in our nuclear history where political choices about the nature of our nuclear future, nuclear deterrence, and especially nuclear disarmament, will be fundamental to what lays ahead.

Of course, there have been periods of worrying technological and political change that have impacted global nuclear politics in the past; the development of long-range missiles, multi-megaton bombs, stealthy submarines, and maneuverable warheads, to name just a few, but the current challenge appears to be more pronounced. For one, most previous technological innovation largely served to enhance the perceived security of nuclear second-strike capabilities, and therefore as strengthening deterrence through mutual nuclear vulnerability between nuclear-armed countries. Technological change was also primarily limited to the two superpowers (the US and the Soviet Union/Russia) and to a lesser extent their allies and the non-great powers, in what was effectively a bipolar or dyadic world. But perhaps most fundamentally, the new capabilities or strategic missions that resulted from technological progress in the past were principally in *nuclear* weaponry and for *nuclear* missions and served to bolster the credibility of delivering *nuclear* warheads or bombs. Today the impact is quite different: technological innovation across a range of weapons and supporting capabilities has the potential to undermine nuclear weapons systems previously thought of as being relatively secure, this in turn may create the political space for greater risk taking, strategic coercion, or even facilitate pre-emptive or disarming *conventional* counterforce strikes; these capabilities are being developed by all leading

[1] For example, Benoit Pelopidas, "Power, luck and scholarly responsibility at the end of the world(s)", *International Theory*, 12:3, November 2020: 459-470.

nuclear-armed states, but most importantly by the nuclear "great powers" as part of an unfolding competitive multipolar nuclear world; and lastly, many new strategic military capabilities are non-nuclear, dual-capable (can be used for nuclear or conventional applications) and, in some cases, non-kinetic, and may augment or even replace the role and functions of nuclear weapons in the future.

This shift and challenge are slowly being recognized in academic, NGO and government forums and literature, but it remains fundamentally under-theorized and poorly understood as a general global phenomenon. This is partly because it is a complex – some would say "wicked"[2] – challenge with many different moving parts and dynamics, and something that is experienced differently by different stakeholders in different parts of the world. However, one way of seeking to develop a suitable framework of understanding and analyzing this transition in the strategic nuclear environment is as a move into a "Third Nuclear Age" and as something distinct from what has come before. It does not necessarily follow that everything we have established to manage nuclear risks in the past is wrong or defunct in this new era, or that a "Third" nuclear age means that the challenges and remedies of the past simply disappear or become anachronistic. But it does mean that we need to reassess what works and what needs to change in a world that is potentially going to be quite different to that of the Cold War when many aspects of what we might think of as "nuclear orthodoxy" were conceived, or the 1990s and 2000s when the focus and nature of nuclear risks appeared to shift again. Given this changing threat environment, the Third Nuclear Age is likely to be an era that will require genuine political engagement to ensure that we don't sleep walk into a world where nuclear use becomes more likely through accident, miscalculation or even deliberately. On the flip side, there is no reason why the Third Nuclear Age cannot become synonymous with a genuine and concerted move towards nuclear peace, possibly through nuclear disarmament.

This paper proceeds in four sections: the first outlines the current shift in global nuclear order and places it in historical context before explaining the significance and value of conceptualizing this transition as a move toward a new "nuclear age"; the second explains and unpacks the technological drivers of this shift in global nuclear politics, with particular focus on the emergence of a range of "disruptive technologies" that might be used for different strategic capabilities, missions and effects; section three puts these technological challenges into political and geopolitical perspective and shows how the return of nuclear great power competition is challenging and changing notions of deterrence, security, and regional and global stability between the US, Russia, China and India; section four begins to think about the different ways

[2] Patricia Lewis, *Nuclear weapons as a wicked problem in a complex world,* chapter in Bard Nikolas Vik Steen & Olav Njolstad, *Nuclear disarmament: A critical assessment,* (London, Routledge: 2019).

that nuclear politics might unfold in the Third Nuclear Age by contrasting alternative nuclear futures characterized by restraint and transformation; finally, the conclusion considers what the shift into a new nuclear age will mean for the idea of a sustainable and manageable "nuclear peace".

I. Conceptualizing a new nuclear age

Recent scholarly and professional literature, as well as some official government and military publications and speeches, have begun to refer the current period we are living in as a "new nuclear era" or "new nuclear age".[3] Often, but not always, this is linked with the challenges posed by "new", "emerging" or "disruptive" technologies and the impact that they might have on nuclear politics and international security and stability. But beyond this, there doesn't seem to be any great consensus on the nature and implications of this challenge, other than that is probably negative rather than positive for a global nuclear edifice based on nuclear deterrence, nuclear abstinence (of both use and acquisition), stability through mutual nuclear vulnerability, and an incremental approach to disarmament. To some extent this is understandable – there are a number of important dynamics shaping our current nuclear world that interact in complex and complicated ways. In addition to widespread technological change and innovation, these might include, but are by no means limited to: the agreement of the Treaty of the Prohibition of Nuclear Weapons (TPNW) in 2017; commitments to nuclear modernization and in some cases expansion by all of the nuclear-armed states; a global nuclear governance structure centered on the Non-Proliferation Treaty (NPT) that is under pressure; growing demand for access to nuclear technology for energy security, particularly from the "global south"; a more porous and complex nuclear information space; a return of great power nuclear competition and rhetoric in an progressively multipolar world; concerns about an "end of arms control"; and an increasingly disengaged general public and uninformed policy elite. Because there are so many moving pieces it is sometimes difficult to fully appreciate the nature of this challenge to nuclear life in a coordinated way, and therefore to think about what all of these dynamics really mean for the day-to-day management of nuclear weapons. At the same time, it is important not to let analysis become subject to the constraints and blinkers of a particular regional or ethnocentric approach, or simply to assume that how we have thought about nuclear order in the past can be automatically transplanted to the future.

[3] For example, Linton Brooks, Francis J. Gavin & Alexei Arbataov, *Meeting the challenges of the new nuclear age,* (American Academy of Arts & Sciences: 2018); Steven E. Miller, Robert Legvold & Lawrence D. Freedman, *Nuclear weapons in a changing global order,* (American Academy of Arts & Sciences: 2018); and the special issue of *Daedalus,* (Spring 2020), "Meeting the challenges of a new nuclear age", edited by Robert Legvold & Christopher F. Chyba.

One way to think about the current period in our nuclear history is as the latest act or chapter in an ever-evolving nuclear story. In this story – or perhaps more correctly, historical narrative that begins in with the first nuclear explosion in 1945 – some dynamics remain fairly constant, some alter slowly and in a relatively linear, evolutionary and predictable manner, and some change or are perceived to change quickly and in ways not previously imagined possible or likely. For example, the physical destructive power of nuclear and thermonuclear weapons, and the science and physics that undergirds this, has been fairly well understood since the 1950s (if not earlier); the ways and means of delivering these weapons to their targets and those capable of building such weapons, has – in general[4] – changed slowly and evolved in a largely anticipated manner over time; and occasionally there are periods of political or technological change that challenge or shift the focus of where we think the major nuclear debates, fault-lines and risks of nuclear politics might be at any given moment. It is in this last category and the punctuated equilibria that it produces, that we can perhaps see the greatest differences over the seven and half decades of the nuclear era.

Viewing nuclear history in this way allows us to conceive of the global nuclear story – not entirely unproblematically – as split into different "ages". The concept of nuclear ages is contested, with different opinions about how many distinct "ages" there have been so far, where they started and finished, and what phenomenon each was linked with.[5] But a general consensus has arisen (at least in Western scholarship) around the notion of splitting nuclear history into a First Nuclear Age spanning roughly between 1945 and 1990 where attention focused on nuclear arms racing and the threat of nuclear war between the US/NATO and the Soviet Union, and a Second Nuclear Age where attention shifted to the challenges posed by other nuclear actors in different parts of the world.[6] These constructs clearly don't capture everything that happened during these periods but rather reflect the central risk and focus, or at least what policy elites, commentators and the public viewed as the main challenge to order, stability and peace, at any given time.

The key to using the notion of nuclear ages as a lens to understand nuclear history is therefore not so much in their historical accuracy – horizontal and regional proliferation challenges didn't start and the US-Russia nuclear relationship didn't disappear in the 1990s – but as a mechanism of understanding the nature of global nuclear order and the hierarchy of risks and dangers at any

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[4] There have been concerns of "proliferation cascades" in the past, but in general these have proved to be hyped. See, Benoit Pelopidas, "The oracles of proliferation: How experts maintain a biased historical reading that limits policy innovation", *The Nonproliferation Review*, 18:1 (2011), pp.297-314.

[5] See for example, Ariel E. Levite, "Heading for the Fourth Nuclear Age", *Proliferation Papers*, (Institut Français des Relations Internationales: 2009), https://inis.iaea.org/collection/NCLCollectionStore/_Public/42/050/42050140.pdf

[6] Colin Gray, *The Second Nuclear Age*, (London, Lynne Rienner Publishers: 1999); Paul Bracken, *The Second Nuclear Age: Strategy, Danger and the New Power Politics* (New York: Times Books, 2012); Keith Payne, *Deterrence in the Second Nuclear Age*, (University of Kentucky Press: 1996).

given time. Of course, this periodization makes more sense from a "Western viewpoint" and may even be conceived as having an inherently "post-colonial"[7] underpinning given that it largely fails to take into account the non-Euro-Atlantic, non-English-speaking experience. But this is to some extent understandable – if not necessarily excusable – given the unparalleled role that the United States has played in shaping international nuclear order (and nuclear thinking and scholarship) since 1945. That said, the importance of casting the analytical net beyond the United States and the Western developed world when seeking to understand the current strategic context is a fundamental component of the "Third Nuclear Age".

While there is little agreement on when it began (and in some ways assigning a particular start date to any thematic era always feels arbitrary) the idea of a Third Nuclear Age has nevertheless started to take hold (including a small literature that uses the term "Third Nuclear Age" specifically).[8] At best we can probably say that a gradual transition has unfolded over the past decade as the locus of global nuclear risk has slowly shifted away from nuclear terrorism and "rogue states" towards the nuclear dimensions of great power politics and rivalry. Slightly longer-term we can point to the impact of the deployment of new and enhanced types of military capabilities by the great powers to bolster or enhance deterrence (or coercion), ostensibly to deal with non-great power rival threats, and the impact this has on great power politics. While we don't know exactly what this new nuclear era will look like, not least because it will reflect political choices taken by the key players in the years ahead, we can begin to map out what the central tenets, characteristics and flashpoints of this Third Nuclear Age might be.

Three aspects in particular stand out: rapid technological change that is facilitating the creation of new or enhanced nuclear and non-nuclear weapons capabilities, transforming strategic missions, particularly for major nuclear-armed adversaries, and complicating the nuclear information space; renewed great power nuclear competition in an interconnected and increasingly multipolar world that will shape deterrence, arms racing and regional stability; and normative shifts in how global nuclear order, nuclear stability and nuclear governance are conceptualized, maintained and challenged. Taken together it is not unreasonable to suggest that we will see: challenges – real or perceived – to deterrence through mutual nuclear vulnerability; the growth of non-nuclear deterrence by denial capabilities; arms racing in both nuclear and non-nuclear strategic weapons (ostensibly to "restore" deterrence); reduced interest in strategic arms

[7] See Shampa Biswas, *Nuclear desire: Power and the postcolonial nuclear order,* (University of Minnesota Press: 2014).

[8] E.g., Andrew Futter & Benjamin Zala, "Strategic non-nuclear weapons and the onset of the Third Nuclear Age", *European Journal of International Security,* 41:4 (2021), pp.9-49; Jenny Naylor, "The third nuclear age", *Comparative Strategy,* 38:4 (2019), pp.276-288; David A. Cooper, *Arms Control for the Third Nuclear Age: Between disarmament and Armageddon,* (Georgetown University Press: 2021); Michael Smetana, "A nuclear posture review for the Third Nuclear Age", *The Washington Quarterly,* 41:3 (2018), pp.137-157.

control as fissures between perceived national interests and the benefits of restraint become more pronounced; complications for alliance management, extended deterrence and assurance as nuclear weapons play a prominent but possibly less well-defined role in strategy; and crises between major nuclear-armed states that escalate in new and unforeseen ways from an array of different flashpoints (particularly from the non-nuclear to nuclear domain). In this way, the Third Nuclear Age may reflect both the strategic competition, arms racing and threat of major power nuclear war that characterized the First Nuclear Age and the global nuclear proliferation focus and blurring of rational deterrence theory of the second, but also a challenge to the overarching "Western" orthodoxy and bounded nuclear debate which has underpinned both.

The value of thinking about the current nuclear order and the inherent complexity and flux that characterize it in this way is that it helps focus our attention on the most pressing challenges at any one point in time. Risks or dangers that dominated the nuclear past haven't necessarily disappeared – worries about nuclear brinksmanship, curtailing proliferation to recidivist regimes or preventing non-state actors from gaining access to nuclear material or device remains fundamentally important – but rather that we shift our analytical focus to a different hierarchy of nuclear dangers. Only by questioning the logic and lessons of our nuclear past, living in the realities of the nuclear present, and imagining the different nature of the nuclear future can we seek to keep the world safe from the threat of nuclear weapons.

II. Disruptive technologies, military capabilities and strategic missions

At the heart of the current challenge to the established nuclear order and the centerpiece of the transition into the "Third Nuclear Age" is technological innovation and transformation.[9] But this period of technological change should not be misunderstood as reflecting a certain technological determinism (the idea that technology drives social outcomes rather than the other way around), but rather as a phenomenon that is and will remain inherently political and fluid. Moreover, while there seems to be tendency to homogenize – and in some cases hype[10] – the challenges posed by technological change and "new" weapons systems and missions, it actually involves a number of different dynamics with different implications for different parts of nuclear order. This language also often masks or distorts the novelty of some technologies and their

[9] E.g., Christopher F. Chyba, "New technologies and strategic stability", *Daedalus*, 149:2 (2020), pp.15-170' Todd S. Sechser, Neil Narang & Caitlin Talmadge, "Emerging technologies and strategic stability in peacetime, crisis, and war," *Journal of Strategic Studies*, 42:6 (2019), pp.727-735; Rupal Mehta, "Extended deterrence and assurance in an emerging technology environment", *Journal of Strategic Studies*, 44:7 (2021), pp.958-982. See also, Gregory D. Koblentz, "Emerging technologies and the future of CBRN terrorism", *The Washington Quarterly*, 43:2 (2020), pp.177-196.

[10] E.g., Ivan Oelrich, "Cool your jets: Some perspective on the hyping of hypersonic weapons", *Bulletin of the Atomic Scientists*, 76:1 (2020), pp.37-45.

applications and the challenges that they may or may not create and pose.[11] For example, technological change might be either incremental or revolutionary, have positive or negative aspects, and be considered as stabilizing or destabilizing, depending on how different capabilities are used and applied. It may also reflect new versions of older problems rather than something genuinely different.

In terms of real-world applications, technological progress might create the potential for new or improved military capabilities with different functions (e.g., weapons, various support systems, or both) or facilitate the conduct of particular strategic missions in different, enhanced or even new ways (e.g., non-nuclear counter-force or non-kinetic counter-space operations). As the next section explains, different actors may also have different applications for these technologies and therefore present different challenges (not all of which are strategic), which in turn requires different mechanisms for control or mitigation. Unfortunately, these nuances sometimes get lost under catch-all monikers such as "emerging" (which refers to a technology that hasn't been demonstrated), "new" (a technology that has been recently deployed) or "disruptive" (technologies that could impact deterrence and stability) technology – each of which highlight slightly different dynamics. Therefore, perhaps the best way to conceptualize the challenge is: *a range of new or enhanced military capabilities as a result of technological innovation that could be used for strategic missions, some of which might be considered disruptive to nuclear deterrence if utilized in certain ways, that are transforming the nature of strategic stability and global order.*

The recent period of technological change is not something that can easily be ascribed a "start date", and many of the ideas and applications that we associate with the current challenge to nuclear order can be traced back decades. Indeed, several of the technological applications that are at the heart of the Third Nuclear Age were developed originally by the US to meet the challenges of the second if not first nuclear ages (notably precision strike and BMD).[12] But most technological developments with strategic impact are the product of what is loosely termed as the "information revolution" or "fourth industrial age" that we are currently living in, and specifically of the massive advances in computing, microchips and microprocessors, data processing, communications and sensor capabilities that have occurred since the 1980s. These in turn have led to significant advances in engineering, electronics and other associated sciences that have then been applied to the military realm. This of course began in the developed "West" and specifically in places such as Silicon Valley in the US, and became synonyms with the "Revolution in Military Affairs" thesis of the 1990s, but has gradually diffused to other powerful international actors and

[11] See Andrew Futter, "Disruptive technology and nuclear risks: What's new and what matters", *Survival*, 64:1 (2022), 99-120.
[12] See Futter & Zala, "Strategic non-nuclear weapons and the onset of the Third Nuclear Age".

percolated up to the nuclear level over time.

While not "new" the computer revolution has facilitated the current re-interest in both maneuverable "hypersonic" glide and cruise missiles[13] as well as counterspace and anti-satellite weaponry (ASAT)[14], and continues to drive the pursuit of missile defenses through hit to kill interception.[15] But it has also opened up the potential for other capabilities and different missions, such as using very accurate conventionally-armed long-range ballistic and cruise missiles to destroy high-value targets thanks to enhanced data gathering and target tracking[16]; driven the development of autonomous platforms, sensors and weapons to support nuclear and strategic activities across all domains[17], notably augmenting and expanding the techniques for undersea warfare against nuclear-armed submarines[18]; created new challenges and opportunities for Computer Network Operations (or more colloquially "cyber-attacks") as states have modernized and digitized nuclear infrastructure and command and control systems[19]; spurred interest in applications of Artificial Intelligence (AI) across all parts of the nuclear and deterrence enterprise[20]; and led to renewed interest in the broader range of possible applications of Directed Energy Weapons (DEW) for both defensive and offensive operations.[21] Essentially these developments have allowed for faster, more accurate weapons that can perform types of strategic mission that were previously untenable, or at least thought of as impossible without using large yield nuclear weapons. As a result, it has also shifted or blurred the distinction between the need to use nuclear or non-nuclear weapons for certain strategic missions in a way unlike anything that has gone previously. It has also further blurred the distinction between tactical and strategic missions.

While the impact of technological change is of course ubiquitous and pervasive, there is already a very pronounced impact on three particular (albeit interlinked) strategic missions, all of which may have the potential to undermine deterrence and strategic stability:

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[13] Richard H, Speier, George Nacouzi, Carrie A. Lee & Richard Moore, "Hypersonic missile nonproliferation", (RAND Corporation: 2017), https://www.rand.org/pubs/research_reports/RR2137.html

[14] Brian Weeden & Victoria Samson, "Global counterspace capabilities: An open source assessment", *Secure World Foundation*, (April 2018), https://swfound.org/media/206118/swf_global_counterspace_april2018.pdf

[15] E.g., US Department of Defense, "Missile defense review", (January 2019), https://media.defense.gov/2019/Jan/17/2002080666/-1/-1/1/2019-MISSILE-DEFENSE-REVIEW.PDF

[16] Dennis Gormley, "US advanced conventional systems and conventional prompt global strike ambitions: Assessing the risks, benefits, and arms control implications", *The Nonproliferation Review*, 22:2 (2015), pp.123-139.

[17] Michael C. Horowitz, Paul Scharre & Alexander Velez-Green, "A stable nuclear future? The impact of autonomous systems and artificial intelligence", arXiv preprint, (2019), https://arxiv.org/pdf/1912.05291.pdf

[18] Bryan Clark, "The emerging era in undersea warfare", *Center for Strategic and Budgetary Assessments*, (January 2015), https://csbaonline.org/uploads/documents/CSBA6292_(Undersea_Warfare_Reprint)_web.pdf

[19] Andrew Futter, *Hacking the bomb*, (Georgetown University Press: 2018)

[20] Edward Geist & Andrew J. Lohn, "How might Artificial Intelligence affect the risk of nuclear war?", (The RAND Corporation: 2018), https://www.rand.org/pubs/perspectives/PE296.html.

[21] Henry Obering, "Directed Energy Weapons are real … and disruptive", *PRISM*, 8:3 (2019), pp.37-46.

First, counterforce. Advances in sensor capabilities, real time data processing, targeting, and very accurate "smart" weapons, are potentially making it easier to "find" previously stealthy or maneuverable nuclear weapons systems and potentially to compromise them. This is significant because very quiet nuclear-armed submarines able to lay hidden somewhere in the ocean or ballistic missile launchers that can be moved by road or rail and hide in different locations are essentially the bedrock of great-power nuclear deterrence strategy. The logic is that if these systems cannot be reliably destroyed in a pre-emptive attack, then an adversary won't risk striking first for fear of retaliation. But it is at least conceivable in the Third Nuclear Age that such systems; (i) become more vulnerable, and; (ii) could be targeted with non-nuclear weapons. This is important because it would create the potential to conduct strategic missions without resorting to the use of nuclear weapons, thus circumventing the normative restrictions on nuclear use (albeit the so-called nuclear taboo may be weakening as part of the transition into a Third Nuclear Age too).[22]

Second, undermining nuclear command, control and communications (NC3). It has always been theoretically possible to infiltrate and compromise an adversary's nuclear command and control and strategic support systems – that is the systems needed to detect incoming attacks, communicate with, control and authorize the firing of nuclear or other weapons – either through direct human, kinetic or nuclear attacks. But today the challenge is more pronounced. This is partly because more accurate weapons make targeting command facilities or conducting various counter-space missions against critical nuclear support infrastructure in orbit more credible, but also because of the potential to use non-kinetic weapons, especially Computer Network Operations against all aspects of NC3. The modernization and digitization of both weapons and support systems by all major nuclear-armed actors has made them potentially even-more attractive targets for a would-be adversary seeking to prevent nuclear weapons systems from being used. At the same time, a more porous real-time nuclear information space has exacerbated the potential for both state and non-state actors to complicate and undermine decision making through.[23] All of this potentially raises the stakes for leaders who fear that their most sensitive nuclear systems could be or have been compromised or that they may not be able to rely upon the information that support systems are providing. This may induce a certain level of restraint. But equally likely it will create escalatory pressures based on fear that deterrent forces could be undermined.

Third, defense against missiles. Technological change is transforming the nature and capacity to

[22] Nina Tannenwald, "The vanishing nuclear taboo? How disarmament fell apart", *Foreign Affairs,* 97:6 (2018), pp.16-24.
[23] Harold A. Trinkunas, Herbert Lin & Benjamin Loehrke, "Three tweets to midnight: Effects of the global information ecosystem of the risk of nuclear war", (Hoover Institution Press: 2020).

defend against different types of (nuclear) missile attack. Of course, BMD is not new: but the various methods of interception/prevention and the support infrastructure to achieve this mission has and is changing and are diffusing to more actors.[24] In fact, we can now split the missile defense mission into two components. *Right* of launch missile defense – that is seeking to shoot down missiles once they have been launched, has been improved by enhanced sensors, tracking and guidance/interception capabilities (and by the replacement of nuclear blasts with non-nuclear hit-to-kill interception, including with DEW). This may even apply to future interception of maneuverable missiles travelling at different trajectories (such hypersonic glide and cruise missiles).[25] *Left* of launch missile defense – seeking to prevent missiles being fired at all through interference with their electronic or computer systems – is something new and novel (albeit something that can perhaps be characterized as the latest iteration of pre-emption, but by other means).[26] We can think of these two dynamics as facilitating the move toward a full-spectrum missile defense capability of different types of anti-missile systems for different purposes. This is significant because an effective missile defense, or even just the perception that such a system could become effective, is a major threat to deterrence through nuclear retaliation (and may increase strategic risk-taking by the country that believes it has a credible defense).

But the concern is not just about deliberate or planned uses of these capabilities for political and strategic gain, but also about how the interaction between new, enhanced and existing capabilities might create pathways for unintended and inadvertent escalation. Of course, fears of inadvertent nuclear escalation are not new[27], but these fears and associated pathways may look different in the Third Nuclear Age. One concern is that nuclear and non-nuclear capabilities become "entangled" in a way that increases the chances of tactical conventional operations and warfighting being misperceived as strategic, or even part of disarming strike.[28] A related worry is that a crisis between the great powers might escalate rapidly from the "sub-conventional" to nuclear domain given the complex interaction between digital technologies and dual use military capabilities.[29]

Concerns about the disruptive and transformative impact of technological change in the nuclear

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[24] Catherine McArdle Kelleher & Peter Domrowski, *Regional missile defense from a global perspective,* (Stanford University Press: 2015).
[25] Aaron Kennedy, Jacob Allen, Jonathan Balakumar, Mark Hutchings & Daniel Cook, "Hypersonic missile defence, stopping the unstoppable", *UK Project on Nuclear Issues Papers,* (RUSI: 2020).
[26] Andrew Futter, "The dangers of using cyberattacks to counter nuclear threats", *Arms Control Today,* (July/August 2016), https://www.armscontrol.org/act/2016-07/features/dangers-using-cyberattacks-counter-nuclear-threats
[27] Barry R. Posen, *Inadvertent escalation: Conventional and nuclear war risks,* (London, Cornell University Press: 1991).
[28] James Acton, "Escalation through entanglement: How the vulnerability of command-and-control systems raises risks of an inadvertent nuclear war", *International Security,* 43:1 (2018), pp.56-99.
[29] Rebecca Hersman, "Wormhole escalation in the new nuclear age", *Texas National Security Review,* 3:3 (2020).

realm aren't new,[30] but the fact that so-many of the capabilities and missions are non-nuclear and even non-kinetic does present a genuinely novel set of pressures. These range from the theoretical possibility of conducting non-nuclear disarming strikes against an adversary's nuclear systems, reducing confidence in mutual vulnerability as a stabilizing mechanism, and the potential to use these capabilities for strategic coercion, deliberate escalation, and risk taking. It also involves the different pressures of a global nuclear environment and information space far removed from that of the past. This does not mean that developments directly in nuclear technology and nuclear weapons systems aren't important (indeed, the recent return of nuclear-powered missiles and orbital bombardment systems, along with commitments to nuclear modernization and in some cases expansion by major nuclear powers, show this), but that they are no longer the main or perhaps the only dynamic that needs to be addressed when it comes to managing nuclear risks.

Technology is not in and of itself changing the global nuclear order, undermining deterrence, and creating new problems and dangers, but rather it is the *political* decisions about this technology how it is applied, and what it can be used for that will define the Third Nuclear Age.

III: Great power competition, nuclear deterrence and strategic stability

Technological innovation and change are not happening in a political vacuum but are instead reflective of and co-constitutive with a re-emergence of great power nuclear competition.[31] If the First Nuclear Age can be thought of as broadly synonymous with the bilateral nature of the Cold War and the Second Nuclear Age with US unipolarity and primacy, then the Third Nuclear Age seems destined to be one of *multi*polarity, with the four nuclear "poles" of power residing in the US, Russia, China, and to a slightly lesser extent India.[32] In fact, it is arguably the ambitions and thinking of these four main players in the global nuclear order that are responsible for driving the interest in "disruptive" technological innovation, enhanced weapons systems and new types of strategic thinking and missions. This in turn is having significant bilateral, multilateral and regional impact, not least on nuclear deterrence, nuclear risk reduction, and the maintenance of strategic stability.

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[30] For example, B.T. Feld, T. Greenwood, GW Rathjens, S Weinberg (eds), *Impact of new technologies on the arms race*, (London, The MIT Press: 1971), J.J. Gertler, *Emerging technologies in the strategic arena: A primer*, (RAND Corporation: March 1987) and Carl Builder, *Strategic conflict without nuclear weapons*, (RAND Corporation: April 1983).

[31] See for example, Peter Rudolf, "US geopolitics and nuclear deterrence in the era of great power competitions", *Political Science Quarterly*, 136:1 (2021), pp.129-153; Elbridge A. Colby & A. Wess Mitchell, "The age of great power competition", *Foreign Affairs*, 99:1 (2020), pp.118-130. Or as others would have it, the "persistence" of great power politics: https://tnsr.org/roundtable/the-persistence-of-great-power-politics/

[32] Most accounts suggest that the new era of competition is about the US-China rivalry and to a lesser extent Russia. But India should be included because it will play a central role in a multipolar nuclear world.

For the best part of a generation, the global nuclear order has been dominated by the United States. While other nuclear-armed actors clearly existed during this period, and the US and Russia retained rough parity as the most heavily armed nuclear states, the major fault lines and risks in the international system were to some extent determined and framed by the United States and its allies, and by the most prominent nuclear challenges that they perceived. Consequently, the notion of a Second Nuclear Age was always bound up with a particular Western nuclear-ethnocentrism rather than reflecting a genuinely global expression of nuclear politics. As a result, and especially after the terrorist attacks of 11th September 2001, the canon of government, academic and professional attention in the "West" shifted to the dangers posed by nuclear terrorism, nuclear proliferation to "rogue states", and "loose" nuclear material, and away from arms racing and the threat of a nuclear exchange between major nuclear powers.

But today this balance is shifting. This is because of the re-emergence of Russia as a major competitor to the United States, particularly in Europe, and because of the "rise" of both China and India as significant regional nuclear powers with strategic aspirations in Asia. But it is also because the "nuclear" aspects of great power competition have become more pronounced in what some have framed as an emerging multi-polar world. Each of these actors has cited "great power competition" and its inherent nuclear dimension as a major security challenge, and have taken steps to modernize, expand or otherwise enhance their nuclear and strategic non-nuclear capabilities. While nuclear and strategic non-nuclear weapons play a slightly different role for each of these actors, the net effect is a challenge to a generation of progress on arms control and a change in the contours of regional and global nuclear order.

At the heart of this great power competition is a system of deterrence (and in some cases extended deterrence) relationships based on mutual nuclear vulnerability: between the US (and NATO) and Russia; between the US its regional allies in Asia-Pacific and China; between Russia and China; and between India and China. Each of these relationships are different, not least due to the different mix of strategic capabilities and geopolitical priorities and aspirations between actors, but all are driven by the perceived necessities of "deterrence". But they are also interlinked, in that developments in one "dyad" or region necessarily impacts the actions of the other great powers, and their actions in turn impacts other regional actors (and vis-versa). This is what makes the challenge truly global and complex. The problem with deterrence in a competitive global environment is that it is not a fixed concept and deterrence relationships evolve as each party seeks to "retain" parity or perhaps some sort of strategic advantage. This means that each of the great powers are constantly updating the capabilities and doctrine that they think is required to achieve this. But in the Third Nuclear Age this is no longer simply about nuclear weapons.

The logical place to start is with an analysis of the United States. The US has been at the forefront

of the development of nuclear and non-nuclear strategic weapons systems for at least a generation, and arguably since the 1940s. But during the past three decades, US posture has moved explicitly towards building a more diverse range of capabilities for strategic missions and deterrence.[33] This has been driven – or at least justified[34] – by a perceived diversification in nuclear threats between those posed by great powers and those posed by rogue and non-state actors, and a concomitant range of pressures to assure the security of allies, particularly in Europe and Northeast Asia. The most conspicuous expression of this is the deployment of various missile defense systems, but it is also reflected in aspects of the non-nuclear precision strike mission. But the issue for the US is that it has been difficult in reality to separate deterrence and assurance missions between different types of adversary/competitors.

For example, deploying BMD and precision strike systems in conjunction with regional allies in order to deter North Korea will by implication have some capability against China, or at least may be perceived as such. The same is true for capabilities designed to meet future nuclear challenges from the Middle East (e.g., Iran) for Russia. A direct effect has been a growing a concern for Moscow and Beijing about whether technological change, including the incorporation of high-accuracy long-range weapons alongside an expanding system of missile defenses into US strategy, while ostensibly for deterring non-great power threats, has ushered in the specter of a new era of "counterforce"[35] against their nuclear arsenals. Elites in Russia and China certainly believe this could be the case (if not now then certainly in the future), and both have explicitly linked nuclear modernization and expansion, and in the case of Russia, nuclear warfighting rhetoric (not to be confused with the debate about a possible "escalate to de-escalate" policy[36]), with the need to restore deterrence stability in the face of these technological changes. This is significant because such moves would appear to undermine US goals of nuclear reductions through arms control, and make further bi- or even trilateral cuts to nuclear weapons numbers beyond the now extended New START treaty unlikely.[37] Over the past few years US deterrence thinking has slowly been realigning to (re)prioritize "great power" deterrence (most recently alluded to in the 2018 Nuclear Posture Review),[38] and to develop both nuclear and non-nuclear options to achieve this.

Russia's nuclear arsenal is smaller today than at any point since the early Cold War, but nuclear

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[33] David McDonough, *Nuclear superiority: The 'New Triad' and the evolution if American nuclear strategy,* Adelphi Paper 383, (Routledge for The International Institute for Strategic Studies: 2006).
[34] Justifications of nuclear and strategic weapons procurement are not necessarily causes. Procurement often has internal and domestic drivers too.
[35] Keir Lieber & Daryl Press, "The new era of counterforce: Technological change and the future of nuclear deterrence", *International Security*, 41:4 (2017), pp.9-49.
[36] E.g., Bruno Tertrais, "Russia's nuclear policy: Worrying for the wrong reasons", *Survival*, 60:2 (2018), pp.33-44.
[37] See for example, Andrew Futter & Benjamin Zala, "Advanced US conventional weapons and nuclear disarmament", *The Nonproliferation Review*, 20:1 (2013), pp.107-122.
[38] "Nuclear posture review", US Department of Defense, (February 2018), https://media.defense.gov/2018/Feb/02/2001872877/-1/-1/1/EXECUTIVE-SUMMARY.PDF

weapons have never lost their political significance and central role in great power deterrence.[39] While Russian nuclear weapons didn't disappear physically as a major factor in international politics during the last three decades, the fears about US-Russia arms racing and strategic competition that characterized the Cold War did. But Russian nuclear weapons have become a more conspicuous component of statecraft in the past two decades, and nuclear rhetoric and threats have played a particularly prominent role in the 2022 war in Ukraine.[40] This Russian nuclear renaissance can probably be traced back to the decision by the George W Bush administration to abrogate the Anti-Ballistic Missile Treaty in the early 2000s and consequent concerns about NATO expansion, but also to a resurgence in Russian great power aspirations under President Vladimir Putin in the years since. More concretely we have seen it in the announcement of a raft of new strategic weapons systems[41] specifically slated to counteract US and NATO missile defense deployments and "restore" stability, including a nuclear-powered cruise missile, nuclear and non-nuclear hypersonic weapons, and the Status 6 underwater nuclear torpedo, alongside revamped interest in Russian missile defense and ASAT capabilities.[42] The return of "nuclear" has also been linked with a need to counteract the weakness of Russia's conventional forces,[43] and at the same time send a political message about Russia's continued importance as a "great power", especially in Europe. This is all significant because it suggests that nuclear weapons and other advanced strategic capabilities are becoming more rather than less important for Russia. This in turn could have implications for stability and arms control in the Euro-Atlantic space (especially what – if anything – will follow the New START treaty if it is left to expire in 2026), and specifically for NATO-Russia relations in a region that is becoming increasingly polarized again between "east" and "west" following the 2022 Russian invasion of Ukraine. On top of this, the significance of the Russia-China nuclear relationship remains a moot point: one fear is that Russia and China may unite to undermine US global interests, but at the same time, Russia retains at least some tactical nuclear weapons for fear of a Chinese invasion along their shared border.

The nuclear component of Chinese strategic thinking has traditionally taken a back-seat role, and

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[39] See, Anya Loukianova Fink & Olga Oliker, "Russia's nuclear weapons in a multipolar world: Guarantors of sovereignty, great power status and more", *Daedalus*, 149:2 (2020), pp.37-55.
[40] E.g., Olga Oliker, "Putin's nuclear bluff: How the west can make sure Russia's threats stay hollow", *Foreign Affairs*, (11 March 2022), https://www.foreignaffairs.com/articles/ukraine/2022-03-11/putins-nuclear-bluff
[41] Edward Geist & Dara Massicot, "Understanding Putin's nuclear 'superweapons'", *SAIS Review of International Affairs*, 39:2 (2019), pp.103-177.
[42] Samuel Bendett, Mathieu Boulegue, Richard Connolly, Margarita Konaev, Pavel Podvig & Katarzyna Zysk, "Advanced military technology in Russia: Capabilities and implications", *Chatham House Research Paper*, (September 2021), https://www.chathamhouse.org/sites/default/files/2021-09/2021-09-23-advanced-military-technology-in-russia-bendett-et-al.pdf ; Deganit Paikowsky, "Why Russia tested its anti-satellite weapon", *Foreign Policy*, (26 December 2021), https://foreignpolicy.com/2021/12/26/putin-russia-tested-space-asat-satellite-weapon/
[43] Kristen Ven Bruusgard, "Russian nuclear strategy and conventional inferiority", *Journal of Strategic Studies*, 44:1 (2021), pp.3-35.

Beijing still adheres to a policy of not using nuclear weapons first in a conflict, although China's nuclear stockpile and the range of strategic delivery vehicles for these weapons have slowly increased over time.[44] But China too seems to have gone through a period of change when it comes to nuclear strategy, and particularly its link with Chinese influence and power in Asia, and much hype has been generated by the possibility of a rapid expansion of the Chinese nuclear ballistic missile fleet alongside various other "exotic" weapons such as the fractional orbital bombardment system tested in 2021,[45] and a nascent BMD program.[46] Like Russia, China is concerned about the deployment of US non-nuclear strategic weaponry (especially BMD, but also precision conventional strike weapons) and what these might mean for deterrence, and particularly how to ensure that its land-based missiles and nuclear-armed submarines are protected from disarming attacks.[47] But China's expanding strategic capabilities are also seen as a challenge to the US-led alliance system in the region, which includes Japan, South Korea, and Taiwan, and the ability for the US to control China's immediate neighborhood. One way that China has sought to achieve this is by intermingling nuclear and non-nuclear forces (and their NC3) in order to complicate adversary decision-making in a future crisis. This is because it raises the risks of direct escalation as a result of tactical operations or missions that accidentally compromise or undermine strategic and nuclear capabilities, something which could have direct implications for the shape of any future conflict (e.g., over Taiwan) in the region.[48] Chinese fears about US BMD and precision strike capabilities are not new,[49] but a growing sense of a "new Cold War"[50] has made this risk more acute and driven what appears to be a classical realpolitik response. An often-overlooked factor regarding changes in Chinese capabilities and posture is that they not only impact the regional security architecture in Northeast Asia and the Asia-Pacific, challenging US regional alliances and dominance, but also have a direct impact on Indian deterrence thinking and by extension South Asia, as well as on Russia.

Nuclear weapons play a less prominent role in Indian aspirations to great power status, though acquiring a nuclear capability does seem to have been important to national prestige, domestic

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[44] Eric Heginbotham, Michael S. Chase, Jacob Heim & Bonny Lin, "China's evolving nuclear deterrent", *The RAND Corporation,* (2017), https://www.rand.org/pubs/research_reports/RR1628.html

[45] Bleddyn Bowen & Cameron Hunter, "Chinese Fractional Orbital Bombardment", *Asia Pacific Leadership Network Policy Brief No.78,* (1 November 2021), https://www.apln.network/analysis/policy-briefs/chinese-fractional-orbital-bombardment

[46] Bruce W. MacDonald and Charles D. Ferguson, "Chinese strategic missile defense: Will it happen, and what would it mean? *Arms Control Today,* (November 2015), https://www.armscontrol.org/act/2015-11/features/chinese-strategic-missile-defense-happen-what-mean

[47] Tong Zhou, "What's driving China's nuclear build-up? *Carnegie Endowment for International Peace,* (5 August 2021), https://carnegieendowment.org/2021/08/05/what-s-driving-china-s-nuclear-buildup-pub-85106

[48] Caitlin Talmadge, "Beijing's nuclear option", *Foreign Affairs,* 97:6 (2018), pp.44-51.

[49] M. Taylor Fravel & Evan S. Medeiros, "China's search for assured retaliation: The evolution of Chinese nuclear strategy and force structure", *International Security,* 35:2 (2010), pp.48-87.

[50] Hal Brands & John Lewis Gaddis, "The new Cold War: America, China, and the echoes of history", *Foreign Affairs,* 100:6 (2021), pp.10-21.

politics, and identity. Like China, India has only slowly increased the size of its nuclear arsenal and retains a nuclear no-first use declaration, but at the same time has worked hard to develop more secure and longer-range means of delivering these weapons.[51] India has also begun developing a range of strategic non-nuclear weapons for various deterrence purposes, notably a multi-layered ballistic missile defense system,[52] various precision strike capabilities, and in 2019 conducted its first ASAT test.[53] These advances have even led one scholar to suggest that India might be developing – consciously or not – a counterforce capability that could be used against its immediate regional rival, Pakistan.[54] But India's deterrence requirements are mixed: to the east the challenge is deterring tactical aggression and border conflicts (such as over Kashmir) by a nuclear-armed but conventionally inferior Pakistan, and to the west (and at sea) matching an increasingly powerful nuclear-armed and conventionally superior China as a major peer competitor in Asia. But keeping these two deterrence "missions" separate in practice may be difficult, and it is possible that Indian non-nuclear capabilities (particularly the combination of BMD and precision strike weapons) become a security concern for China in the future. India also appears to be trying to balance the benefits of closer relationships with both the US (e.g., the civilian nuclear deal in 2006 and membership of "The Quad")[55] and Russia (e.g., weapons cooperation on the Brahmos II missile and the S400 missile defense system)[56] with a desire to avoid formal alliances with either. Given the proxy links between China and Pakistan, South Asia is also likely to be one of the main theatres where nuclear great power competition will play out in the years ahead.[57]

What this suggests is that we are entering an era where established notions of nuclear arms control, prospects of nuclear reductions, and stability through mutual nuclear vulnerability are under threat. It is also potentially an era where the locus and geography of nuclear risks is shifting and the threat of great power conflict could be increasing. While some of the return of great power nuclear

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[51] For an interesting discussion if this, see Harsh V. Pant & Yogesh Joshi, "Is India overturning decades of nuclear doctrine", *Foreign Policy*, (23 October 2020), https://foreignpolicy.com/2020/10/23/india-nuclear-no-first-use-strike-china-pakistan/

[52] See, Zafar Khan, "India's ballistic missile defense: Implications for South Asian deterrence stability", *The Washington Quarterly*, 40:3 (2017), pp.187-202.

[53] Ashley Tellis, "India's ASAT test: An incomplete success", *Carnegie Endowment for International Peace*, (15 April 2019), https://carnegieendowment.org/2019/04/15/india-s-asat-test-incomplete-success-pub-78884

[54] Christopher Clary & Vipin Narang, "India's counterforce temptations: Strategic dilemmas, doctrine, and capabilities", *International Security*, 43:3 (2019), pp.7-52. For an alternate view see, Rajesh Rajagopalan, "India and counterforce: A question of evidence," *ORF Occasional Paper No. 247*, (May 2020), https://www.orfonline.org/research/india-and-counterforce-a-question-of-evidence-66126/

[55] Sameer Lalwani & Heather Byrne, "Great expectations: Asking too much of the US-India strategic partnership", *The Washington Quarterly*, 42:3 (2019), p..41-64.

[56] Nivedita Kapoor, "India-Russia ties in a changing world order: In pursuit of a 'special strategic partnership'", *Observer Research Foundation Occasional Paper*, (October 2019), https://www.orfonline.org/wp-content/uploads/2019/10/ORF_OccasionalPaper_218_India-Russia.pdf

[57] See, Andrew Futter & Francesca Silvestri, "A new nuclear age for South Asia?", *Observer Research Foundation*, (7 January 2022), https://www.orfonline.org/expert-speak/a-new-nuclear-age-in-south-asia/

competition is about prestige, posturing and domestic politics, there is unquestionably an underlying realpolitik angle as these different actors develop new and enhanced weapons systems to meet new deterrence challenges. But it is not just specific relationships but the interaction between them and the impact this has on other actors that is important, which is why the challenge must be seen as global.

IV. Building the nuclear future: Restraint, transformation and disarmament

The shape of our nuclear future is not preordained. On the one hand this is a good thing because it means that some of the most worrying technological and geopolitical aspects of the Third Nuclear Age discussed above won't automatically come to pass. But on the other hand, it also means that stability and peace are not guaranteed unless there is engagement by all stakeholders and the political willingness to take difficult decisions.

As I have argued elsewhere with Benjamin Zala[58], we might conceive of four different possible scenarios in the Third Nuclear Age: (i) a world where all major powers develop and deploy enhanced and new strategic capabilities that challenge current deterrence balances and drive instability and arms racing; (ii) a world where one of the major powers achieves a temporary strategic advantage – or at least is perceived to have done so – that might be exploited against another great power adversary or against a regional nuclear-armed adversary; (iii) a world where new arms control and risk reduction measures are combined with restraint in nuclear and non-nuclear deployment that provides a level of stability through management of the current nuclear deterrence status quo; (iv) a world where non-nuclear strategic capabilities achieve a level of utility that means that they replace nuclear weapons as the currency for the security of the major powers, potentially leading to nuclear disarmament.

From the current standpoint, especially in the wake of the war in Ukraine, the most *likely* scenario seems to be proliferation and instability caused by continued nuclear and strategic non-nuclear weapon proliferation by the US, Russia, China and India, possibly with periods where one of these states acquires temporary strategic advantage (bilaterally or regionally) that might increase strategic risk taking. The most *desirable* approach essentially depends upon the type of nuclear future we imagine as possible: more stable great power nuclear deterrence and regional stability (including the possibility of nuclear reductions) through *restraint*, or great power nuclear disarmament through *transformation* via non-nuclear technological developments and normative challenges to the established order.

[58] Futter & Zala, "Strategic non-nuclear weapons and the onset of the Third Nuclear Age".

The most traditional and conservative approach to managing the technological and political challenges of the Third Nuclear Age is by utilizing established methods of arms control, restraint, norm and confidence building mechanisms between the major nuclear powers. The aim of this approach would be to avoid the instability, risks and significant associated costs of moving to a new deterrence paradigm based on rapid expansion of strategic capabilities, by manufacturing and molding the frameworks needed to essentially minimize changes to the current system and strengthen current deterrent nuclear balances. The key here would be in finding political ways to encourage the major nuclear powers to constrain the development and deployment of disruptive and novel technologies and forego any pursuit of strategic advantage. This would represent the pragmatic middle way between armament and disarmament in an effective and legitimate way[59], but it would by no means be a panacea.

Arms control would clearly have a role to play in this approach, although the challenges of the Third Nuclear Age may require an expanded conceptualization and toolkit beyond what has been employed in the past. Arms control isn't "dead" as some have suggested[60], but we will need to assess what we currently have that can be used to control the risks posed to stability by technological and geopolitical changes, and which risks require something new to keep us safe.[61] At a minimum, current frameworks will need to be broadened or extended (certain hypersonic delivery vehicles and long-range non-nuclear precision missiles should be covered by New START (though at the moment this only impacts the US and Russia), and agreements such as the Missile Technology Control Regime might be used to limit the spread of certain capabilities to other actors). Some apparatus might even conceivably need to be regenerated – such as a new multiparty anti-ballistic missile agreement based on the ABM Treaty that limited US and Russian missile defenses between 1972 and 2002, or an agreement that recaptures the spirit of the more recently defunct Intermediate-range Nuclear Forces Treaty which banned an entire class of destabilizing weapons between 1987 and 2019.

But forging the regulatory frameworks for restraint will also almost certainly require new mechanisms to limit actions and deployments that might be deemed destabilizing. This might involve limitations upon the number of specific weapons systems, where and how they are deployed, codes of conduct in specific military domains, which in turn might be bolstered by data

[59] William Walker, *A perpetual menace: Nuclear weapons and international order",* (London, Routledge: 2012), p.5.
[60] Alexandra Bell & Andrew Futter, "Reports of the death of arms control have been greatly exaggerated", *War on the Rocks*, (4 October 2018), https://warontherocks.com/2018/10/reports-of-the-death-of-arms-control-have-been-greatly-exaggerated/
[61] See for example, Nina Tannenwald, "Life beyond arms control: Moving toward a global regime of nuclear restraint and responsibility", *Daedalus*, 149:2 (2020), pp.171-189.

exchanges, transparency, or launch/training exercise notifications.[62] Such measures might be unilateral, bilateral or multilateral, be formal and legally binding or informal and based on implicit understanding, or involve combinations of different nuclear and non-nuclear systems in *asymmetric* agreements.[63] It might also involve normative and declaratory initiatives, such as the recent announcement by the US, Russia, UK, France and China rejecting the idea of fighting a nuclear war.[64] In this way, these mechanisms wouldn't necessarily have to mirror the main nuclear arms control frameworks of the past.[65] The major hurdle at the time of writing is how to bring the major powers together in a meaningful way: the recent exploration of "trilateral" US-Russia-China nuclear reduction talks shows that this won't be straightforward,[66] and of course India resides outside the formal mechanism of global order (based on its non-membership of the NPT). Above all the restraint approach involves a tacit acceptance that the Third Nuclear Age will be broadly business as usual, and that nuclear weapons, nuclear deterrence and strategic competition amongst the nuclear great powers will remain at the heart of global nuclear order, albeit in a modified form. In this vision of the nuclear future, even if agreement cannot be reached on thorny political differences, a commitment to a broadly predictable and stable nuclear world would seem to benefit all.

A more revolutionary approach would be to view the transformative potential of technological innovation and new nuclear dangers inherent in the Third Nuclear Age as part of a genuine pathway to disarmament. There are two components to this: first, the potential for strategic non-nuclear weapons to replace nuclear weapons for deterrence, security and stability functions; and second, the challenge from outside the formal nuclear weapons order embodied in the Treaty on the Prohibition of Nuclear Weapons (or nuclear ban treaty) but also encapsulated in the rise of critical approaches to nuclear order. Together these dynamics might challenge the notion of "nuclear eternity" that appears to underpin much of how we think about nuclear weapons, deterrence and order.[67]

It may not seem likely from our current vantage point, but it is at least conceivable that advances

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[62] James M. Acton, Thomas D. MacDonald, Pranay Vaddi, *Reimagining nuclear arms control: A comprehensive approach*, (Carnegie Endowment for International Peace: 2021)

[63] E.g., Heather Williams, "Asymmetric arms control and strategic stability: Scenarios for limiting hypersonic glide vehicles", *Journal of Strategic Studies*, 42:6 (2019), pp.789-813.

[64] "Joint Statement of the Leaders of the Five Nuclear-Weapon States on Preventing Nuclear War and Avoiding Arms Races", (3 January 2022), **https://www.whitehouse.gov/briefing-room/statements-releases/2022/01/03/p5-statement-on-preventing-nuclear-war-and-avoiding-arms-races/**

[65] Arms control can be a diverse toolkit. See, Thomas Schelling & Morton Halperin, *Strategy and arms control*, (Martino Publishing: 2014).

[66] For a more optimistic view see, Ulrich Kuhn, Alexey Arbatov, David Santoro, Tong Zhao, "Trilateral arms control? Perspectives from Washington, Moscow, and Beijing", *IFSH Report #002*, (March 2020), https://ifsh.de/file/publication/Research_Report/002/20200224_IFSH_Research_Report_002_final.pdf

[67] Benoit Pelopidas, "The birth of nuclear eternity", chapter in Sandra Kemp & Jenny Andersson (eds.), *Futures*, (Oxford University Press: 2021).

in non-nuclear strategic weaponry creates a pathway to nuclear disarmament through technological innovation. This could be a world of deterrence through non-nuclear capabilities and where non-nuclear weapons become the central currency of international politics and even prestige and status. This might come about in a number of different ways.

First, incremental developments in strategic non-nuclear capabilities by the major powers are deemed more "useable" or "credible" for strategic missions and gradually replace nuclear weapons for these roles. This would then facilitate *unilateral* nuclear reductions as the perceived value of these forces for the strategic deterrence mission erodes. Second, developments in strategic non-nuclear weaponry by the major powers could make the nuclear forces that adversaries and competitors previously viewed as secure more vulnerable to attack or to being compromised, potentially undermining confidence in their ability to act as a deterrent. This could shift the cost benefit analysis for some states of continuing to rely on nuclear weapons for deterrence. Finally, developments in strategic non-nuclear weaponry – especially those that might be used for conventional counterforce missions or coercion – could raise the barriers to new nuclear entrants because it would become more difficult to establish a credible nuclear capability and retain it. Future would-be proliferators may also begin to see the development and deployment of non-nuclear capabilities as a better way to meet their immediate deterrence and security needs. A good example of this is South Korea's interest in conventional counterforce deterrence against North Korea,[68] and others may also be interested in pursuing non-nuclear deterrence capabilities for particular strategic missions too.[69]

Of course, how this approach can be pursued in a pragmatic and safe manner is not straightforward. Moving from a world of multipolar nuclear competition to great power non-nuclear stability is unlikely to be easy, or necessarily peaceful. Moreover, there is also no guarantee that a world characterized by the use of strategic non-nuclear weapons capabilities for deterrence and statecraft would be less conflict-prone than a world with nuclear weapons.

The final strand that could come to dominate the shape of the Third Nuclear Age is a renewed interest and pressure for nuclear abolition. Alongside a revival in ethical and moral pressure for disarmament embodied by the Humanitarian Impacts Initiative[70], this renewed interest has been driven by enhanced concerns about the risk of nuclear use and nuclear war, not least as a result of technological and geopolitical change and complexity. Its most prominent manifestation is the

[68] Ian Bowers, Henrik Stalhane Hiim, "Conventional counterforce dilemmas: South Korea's deterrence strategic and stability on the Korean peninsula", *International Security*, 45:3 (2021), pp.7-39.
[69] David Blagden, "Strategic stability and the proliferation of conventional precision strike: A (bounded) case for optimism", *The Nonproliferation Review*, 27:1-3, (2020), pp.123-136.
[70] Elizabeth Minor, "Changing the discourse on nuclear weapons: The humanitarian initiative", *International Review of the Red Cross*, 97 (September 2015), pp.711-730.

2017 nuclear ban treaty, which came into force in 2021, that seeks to criminalize the possession and use of nuclear weapons. This marks a notable departure from for example the NPT, which tacitly accepts a role for nuclear weapons in deterrence while working ostensibly towards abolition.[71] While the ban treaty may not be the disarmament panacea that some hope (none of the nuclear-armed states have signed it or seem likely to), its political symbolism is important. This is because it represents a genuine attempt by those outside of the formal nuclear order to put pressure on the nuclear-armed states and the dominant narrative used by these states that nuclear deterrence is a central and legitimate ordering mechanism in international politics.[72] The ban treaty is also reflective of a growing sub-set of scholarship that might be termed as "critical nuclear studies", which has at its core a desire to challenge the prevailing narratives and ideas that sustain the nuclear condition.[73] This tentatively suggests that the Third Nuclear Age may be characterized by sustained pressure on the "nuclear control order" and the centrality of great power relations based on nuclear deterrence.[74]

Consequently, the shape of the Third Nuclear Age and the role that technological innovation, great power competition and nuclear risks will play within it, will be intrinsically linked with political decisions about the nature of nuclear politics and the art of the possible.

Conclusion: Nuclear peace in the Third Nuclear Age

Global nuclear order, nuclear risks and nuclear governance are in a period of modification and perhaps transformation. This is being driven by a complex amalgam of technological change and innovation, the emergence of a global system of great power nuclear competition, and a global political conscience increasingly challenging the centrality of nuclear weapons to world politics. The result is a broad array of potentially "disruptive" dynamics and pressures, many of which will be different from the past, that will be intrinsic to the move into what we might term as a Third Nuclear Age. Meeting the challenges of this new nuclear epoch will require urgent attention and action from all key stakeholders if we are to ensure that the horrifying consequences of nuclear use are not experienced again more than three quarters of a century after the nuclear bombings of Hiroshima and Nagasaki.

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[71] The extent to which the TPNW will undermine or complement the NPT remains a source of debate. But the important thing is that it is a challenge to the established practices and decision-making fora of global nuclear order.
[72] Nick Ritchie, "A hegemonic nuclear order: Understanding the Ban Treaty and the power politics of nuclear weapons", *Contemporary Security Policy*, 40:4 (2019), pp.409-434.
[73] E.g., Nick Ritchie, "Inventing nuclear disarmament", *Critical Studies on Security*, 7:1 (2019), pp.73-77 and Columba Peoples, "Redemption and Nutopia: The scope of nuclear critique in International Studies", *Millennium: Journal of International Studies,* 44:2 (2016), pp.216-235
[74] See Kjolv Egeland, "The ideology of nuclear order", *New Political Science*, 43:2 (2021), pp.208-230.

But there is no exact roadmap to achieving "nuclear peace", or indeed, much agreement about what this might look like in the Third Nuclear Age. For some, nuclear peace is fundamentally bound-up with a continuation of a system based on nuclear deterrence where conflict is ultimately deterred through the threat of nuclear punishment. While this vision is supposedly linked with an "incremental" approach to disarmament, it tacitly accepts that nuclear weapons are here to stay for the time being and have a role to play in preventing nuclear use and ensuring stability (at least between nuclear-armed actors). For others, nuclear peace can only be synonymous with nuclear disarmament and the eradication, proscription and delegitimization of the possession and use of nuclear weapons. This approach embodies the enthusiasm and belief in human progress that has always been part of the nuclear condition, and fundamentally challenges the accepted wisdom of nuclear weapons and nuclear deterrence as permanent features of international politics. Neither of these approaches are necessarily panaceas: a world with nuclear weapons will always contain the risk of nuclear use; a world without nuclear weapons won't necessarily mean less conflict. Choosing the correct pathway for our nuclear future was hard enough in the past and there is no suggestion it will become any easier as we move into a new, potentially more complex and dynamic chapter in the nuclear story.

Policy proposals to manage the challenges of the Third Nuclear Age are therefore inherently bound by whether one believes the best approach is to take our nuclear world as it is and seek to manage it (through restraint, arms control, and norms,), or whether it is possible to transition to a world where nuclear weapons no longer exist (through sustained moral, ethical, legal and perhaps technological pressure). Unfortunately, these two positions are not synonymous or complementary. As a result, and rather than advocating any particular pathway, perhaps the most useful thing is to advocate engagement, education and understanding so that we can all make informed choices based on accurate information about nuclear weapons. The nuclear future is not preordained: on the one hand this means we should guard against overconfidence and romanticizing the nuclear past[75], but on the other hand it means challenging and expanding the nature of nuclear critique to test what is and might be possible for our nuclear future.

[75] E.g., Kjolv Egeland, "Who stole disarmament: History and nostalgia in nuclear abolition discourse", *International Affairs*, 96:5 (2020), pp.1387-1403.