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The nuclear order and emerging technologies

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Table of contents

Introduction	3
Technology’s challenges for disarmament and non-proliferation	4
A problem of politics	6
An emerging technology agenda for the NPT	8
References	10

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Introduction

Since its entry into force in 1970, the Nuclear Non-Proliferation Treaty (NPT) has been the foundation of the nuclear order in combatting nuclear proliferation, advancing disarmament, and promoting dialogue and transparency. It is now at risk of irrelevance, however, not because of some dramatic turn of events, but rather because of political stagnation and a failure to adapt to the rapidly changing technological landscape.¹

In short, the nuclear order has an emerging technologies problem. Technologies such as artificial intelligence (AI), additive manufacturing, space-based capabilities and hypersonic weapons could create incentives for nuclear arms racing by current nuclear possessors and undermine progress towards disarmament, while also creating unprecedented pathways for nuclear acquisition by new nuclear actors. Yet, there are no guardrails either in bilateral or multilateral nuclear agreements to manage many of these new risks. United Nations Under-Secretary-General and High Representative for Disarmament Affairs Izumi Nakamitsu described the problem as, ‘Rapid advances in science and technology, without guardrails and effective governance, exacerbate the risk of their (nuclear weapons) negative impacts on international peace and security.’²

The intersection of nuclear weapons and emerging technologies could create new nuclear risks and undermine existing nuclear institutions, but the NPT has been slow to take up the issue. For example, the 2022 NPT Review Conference (RevCon) draft Final Document referred to ‘technology’ twenty-seven times, but only one of these mentions how emerging technologies may impact the risks of nuclear use or pose challenges for nuclear disarmament.³ The draft statement committed the nuclear-weapons states (NWS), ‘To take steps to better understand and minimize vulnerabilities related to potentially disruptive new technologies and cyber capacities as they pertain to nuclear weapons; and to refrain from any actions related to those technologies and capacities that could increase nuclear risks.’⁴ With no elaboration on the modalities of these steps and Russia blocking consensus, it is unclear how States Parties will, both individually and collectively, ‘better understand and minimize vulnerabilities’ related to emerging technologies.

The goal of this report is to outline the ways in which emerging technologies could complicate implementation of the NPT and to offer an agenda for incorporating emerging technologies into NPT business, without distracting from the NPT’s main objectives and avoiding political pitfalls. Ultimately, this report recommends a combination of bridge-building initiatives, such as a Science and Technology Working Group within the NPT and risk reduction measures, such as initiatives within NPT groupings, to bring emerging technologies into the NPT and strengthen the Treaty. Bringing the NPT into the 21st century will require creative thinking, along with bureaucratic and political solutions. Above all, this will require engaging a more diverse group of actors, particularly from the private sector, the Global South and the next generation of nuclear leaders.

Technology's challenges for disarmament and non-proliferation

Emerging technologies can be defined as, 'those technologies, scientific discoveries, and technological applications that have not yet reached maturity or are not widely in use but are anticipated to have a major – perhaps disruptive – effect on international peace and security.'⁵ Some approaches to understanding the impact of emerging technologies on nuclear issues have focused on the impact of a specific technology or specific scenarios.⁶ James Acton, for example, has highlighted the potential for nuclear escalation due to the 'entanglement' of space-based nuclear and conventional command and control systems, which could be vulnerable to cyberattacks during a conventional crisis.⁷ Others have pointed to the potential for emerging technologies to strengthen nuclear stability, such as Jessica Cox and Heather Williams's suggestion that AI could improve situational awareness during crises, or to facilitate verification and monitoring activities, such as improved satellite technology facilitating open-source intelligence.⁸ An earlier tendency to render technologies 'good' or 'bad,' stabilising or destabilising, has started to give way to more nuanced appraisals about their potential.

Emerging technologies are already impacting NPT member states' abilities to make progress towards the NPT's three objectives – disarmament, non-proliferation and access to nuclear technology for peaceful uses. This paper will primarily focus on the impact on disarmament and non-proliferation, arguing that emerging technologies can impact the NPT in four ways.

First, emerging technologies could produce new strategic asymmetries that cause states to increase reliance on nuclear weapons. Over time, this could further slow progress towards nuclear disarmament, which states are obligated to pursue under Article VI of the NPT as part of a 'cessation of the arms race' and 'general and complete disarmament.' Russia, for example, has increased reliance on

nuclear weapons due to a perceived conventional inferiority vis-à-vis NATO and the United States. While Russia has also invested heavily in recent years in advanced conventional capabilities, such as drones and hypersonic weapons, these have not led to a swift or decisive victory in the war in Ukraine. These technologies may have given Russia a 'false sense of supremacy' that motivated the invasion in February 2022.⁹ Instead, Russia has been forced to rely on nuclear bullying and nuclear threats since the start of the war in an attempt to signal its resolve and commitment to victory.¹⁰ With its conventional forces decimated, Russia will likely increase reliance on nuclear weapons in the face of a technologically superior adversary to pursue a strategy of regional aggression.

The second challenge of emerging technologies for the global nuclear order is that they could contribute to a qualitative arms race. One specific way in which emerging technologies could deepen debates about pathways towards disarmament is by driving nuclear build-ups. Many of these new technologies could undermine the survivability of nuclear arsenals, such as through disabling counterforce strikes.¹¹ As long as states rely on nuclear weapons, they will be committed to maintaining a survivable force and therefore may



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Paul Freisthler, Chief Scientist for Science and Technology at the US Defense Intelligence Agency



consider vertical proliferation – improving their existing nuclear forces qualitatively – as a means of reducing vulnerability. Russia and China, for example, are developing dual-capable hypersonic glide vehicles that can carry both conventional and nuclear weapons. China appears to be having more success than Russia in developing advanced capabilities that rely on many of these emerging technologies. Paul Freisthler, Chief Scientist for Science and Technology at the US Defense Intelligence Agency observed in 2023 that ‘Over the past two decades, China has dramatically advanced its development of conventional and nuclear-armed hypersonic missile technologies and capabilities through intense and focused investment, development, testing and deployment.’¹² In August 2021, China tested a Fractional Orbital Bombardment System (FOBS), which entailed launching a hypersonic glide vehicle into space, which then orbited the earth and re-entered on a glidepath to its target.¹³ This technology is not necessarily new, but does point to increasing competition among the NWS for improved nuclear delivery capabilities.¹⁴

The United States, Russia and China are entering an era of renewed great power competition and emerging technologies are a key area of that competition. The 2023 US Strategic Posture Commission raised a concern that, ‘emerging technologies could result in military capabilities that would rapidly and surprisingly shift the military balance between the United States and its Allies and potential adversaries.’¹⁵ Chinese President Xi Jinping acknowledged this in 2021, identifying technological innovation as ‘the main battlefield of the international strategic game,’¹⁶ unveiling major plans to place technology and innovation at the heart of China’s development strategy.¹⁷ These technologies have the potential to spark a vertical arms race and slow progress towards nuclear disarmament, along with increasing risks of escalation.

A third way in which emerging technologies could impact the NPT is by creating new pathways for nuclear proliferation, although this has not yet been realised. Additive manufacturing, for example, might expand and simplify nuclear acquisition pathways, potentially enabling nuclear proliferation.¹⁸ Tristan Volpe has examined the challenges additive manufacturing and other dual-



Emerging technologies could result in military capabilities that would rapidly and surprisingly shift the military balance between the United States and its Allies and potential adversaries

The 2023 US Strategic Posture Commission



use technologies pose to nuclear non-proliferation efforts, which ‘could create periods of intense competition making investments in energy infrastructure indistinguishable from weapons programmes.’¹⁹ Many of these technological advances are not limited to the nuclear possessors or Western states, but also impact on developing economies and/or countries that may want to develop a nuclear hedge in the event of greater geopolitical instability or proliferation.

And finally, thus far, the majority of emerging technologies have defied attempts at arms control and remain largely unregulated, as noted by Under-Secretary Nakamitsu. There are numerous reasons for the lack of guardrails around many of these technologies. In an era of renewed competition, states may be reluctant to impose unilateral restraint and resist any limitations on emerging technologies until they reach maturity and their military applications are better understood. But also, many of these technologies present new challenges for monitoring and verification, which historically relied heavily on counting rules. Digital capabilities cannot be so easily ‘counted.’

In recent years, the United Kingdom, United States and others have taken a new approach to arms control for emerging technologies by launching initiatives to promote responsible behaviours that evolve into multilateral commitments.²⁰ In 2020–2021, the United Kingdom led a UN resolution on ‘Responsible Behaviors in Space’ to reduce risks of misperception and accidents. In 2022, the United States committed to a ban of direct ascent anti-satellite testing which became a UN resolution with the support of 154 states. While these behaviour-based approaches to arms control are a worthwhile first step, existing institutions such as the NPT have not incorporated similar efforts.

A problem of politics

While the technological landscape is rapidly evolving, nuclear institutions are slow to change, for better and for worse. On the one hand, the consistency provided by nuclear institutions brings a sense of stability. On the other hand, failure to change could lead to irrelevance, particularly when it is a small number of hold-outs that are reluctant to engage in cooperative efforts such as agreeing to an NPT consensus statement or discussing risk reduction and arms control opportunities. Many of these technologies could undermine NPT States Parties' ability to fulfill their obligations under the treaty, including non-nuclear weapon states (NNWS) that also have a commitment to advancing disarmament and non-proliferation. But the NPT remains mired in stagnation and there are practical limits to what States Parties can achieve.

The causes for this stagnation are bureaucratic and political. The NPT agenda is already full. Focusing on emerging technologies could distract from important work on nuclear disarmament and non-proliferation. Further, work on emerging technologies could worsen existing polarisation within the NPT. The NPT operates by consensus, prioritising collective buy-in over speed and radical change. But many other NPT practices further slow the Treaty's ability to adapt. Member States meet annually for Preparatory Committee (PrepCom) and every five years for RevCons. The majority of NPT work is done outside of these meetings, however, through intercessional work often led by regional groupings or like-minded states such as from the Non-Proliferation and Disarmament Initiative (NPDI). The challenge, therefore, is how to incorporate emerging technologies into the NPT, without overloading the states' agendas, exacerbating distrust, and adding pressure – both in terms of capacity and expectations.

Aside from the procedural and bureaucratic challenges, there are at least two major political divisions within the NPT. First and foremost is the debate between NWS and a large number of NNWS, many of whom are members of the Treaty on the Prohibition of Nuclear Weapons (TPNW).

Many of the states supporting the TPNW are disappointed that nuclear possessors continue to maintain and rely on their nuclear forces, and in most cases are expanding their arsenals. For them, this undermines the spirit, if not the letter, of the NPT. Representatives from some NNWS, such as Indonesia and others, have alleged a 'lack of sincere engagement of nuclear Powers on the issue of disarmament.'²¹ One of the objectives of the TPNW is to advance an alternative approach to disarmament, based not on the security environment but rather on humanitarian grounds. For example, former Director of the International Campaign to Abolish Nuclear Weapons Beatrice Fihn argued that the goal of the TPNW was to 'change the landscape,' and envisioned the TPNW as 'a tool to express their (States Parties) condemnation of a system that gives a handful of nations a monopoly on nuclear weapons while the rest will only bear their consequences.'²²

There are also legal drivers behind the TPNW. The TPNW is perceived by its supporters as filling a legal gap, as expressed in the First Meeting of States Parties:

Nuclear weapons are now explicitly and comprehensively prohibited by international law, as has long been the case for biological and chemical weapons. We welcome that the Treaty fills this gap in the international legal regime against weapons of mass destruction and reaffirm the need for all States to comply at all times with applicable international law, including international humanitarian law.²³

States disagree, in particular, about the legally-binding nature of 'past commitments' under the NPT. In the 2000 and 2010 RevCons, NPT States Parties reached consensus on Final Documents outlining steps they would pursue in fulfilling their NPT obligations. In 2000, this included a testing moratorium, negotiations on a Fissile Material Cutoff Treaty (FMCT), and irreversible nuclear reductions, among other steps.²⁴ The 2010 Final Document was even more ambitious to include a 64-point Action Plan, with items such as reducing

the role and significance of nuclear weapons, respecting existing commitments with regards to security assurances, and ratifying nuclear weapon free zone agreements.²⁵

With the worsening security environment, however, many nuclear possessors and their allies continue to rely on nuclear weapons for security reasons, which may slow momentum towards disarmament. For example, the NATO communique following the 2023 Vilnius Summit stated, ‘The strategic nuclear forces of the Alliance, particularly those of the United States, are the supreme guarantee of the security of the Alliance. The independent strategic nuclear forces of the United Kingdom and France have a deterrent role of their own and contribute significantly to the overall security of the Alliance.’²⁶ The result is a disarmament polarisation that permeates nearly all NPT business and would likely complicate attempts to address the risks posed by emerging technologies, as well.

The second major political divide is among the NWS themselves, in what is known as the ‘P5 process.’ The P5 are the five recognized nuclear possessor states under the NPT who are also the five permanent members of the UN Security Council. The P5 process was established in 2009 with the intention of demonstrating NWS commitment to their NPT disarmament obligations, and providing a unique forum for them to develop confidence-building measures and lay the groundwork for future cooperation on nuclear reductions.²⁷ The P5’s agenda historically has included a diverse range of issues, including an FMCT, the Bangkok Treaty, along with discussions about transparency of nuclear doctrines.

But the P5 is particularly sensitive to shifts in geopolitics. In 2018, for example, the P5 process came to a standstill following the poisoning of the Skripals at the behest of the Russian government,

resulting in the death of one British citizen. Additionally, P5 discussions are often mired by asymmetric engagement on issues of transparency and nuclear risk reduction. The United States, United Kingdom, and France, have historically provided greater transparency into their nuclear arsenals through a regular reporting process. The United Kingdom, for example, hosted a conference in September 2019 to go through its reporting form in detail with government and non-governmental partners.²⁸ But this transparency, along with initiatives for risk reduction, have not been consistent across all five countries.

The United States has made attempts to incorporate discussion of emerging technologies into the P5 process in the context of risk reduction. In March 2023, for example, US Deputy Assistant Secretary of State Alexandra Bell noted:

Military applications of artificial intelligence could enable new kinds of weapon systems and change how states make decisions in crisis or conflict. The possible use of AI in an irresponsible manner by states to inform or support nuclear operations raises serious concerns about how AI systems might affect nuclear risks. This is something that we want to avoid. We need to manage potential challenges at the intersection between emerging technologies and nuclear risks.²⁹

The P5 has a full agenda. Not all states are ready to discuss sensitive issues around emerging technologies. And geopolitical tensions, particularly Russia’s ongoing war in Ukraine, may preclude meaningful engagement and progress on the topic.

With these political constraints in mind, there are limited options for the NPT to address the challenges of emerging technologies, but a number of opportunities exist that point to an emerging technology agenda for the NPT.



The strategic nuclear forces of the Alliance, particularly those of the United States, are the supreme guarantee of the security of the Alliance. The independent strategic nuclear forces of the United Kingdom and France have a deterrent role of their own and contribute significantly to the overall security of the Alliance.

Vilnius Summit



An emerging technology agenda for the NPT

An emerging technology agenda should focus on three priorities: bridge-building between NWS and NNWS, involving a more diverse group of actors, and building guardrails and risk reduction measures. By focusing on bridge-building, States Parties can provide a platform for NNWS, particularly states from the Global South, to have a louder voice on issues often constrained to Western states or NWS. Work on emerging technologies could therefore play both a political, as well as practical, function of easing, rather than exacerbating, the divide between NWS and NNWS. Incorporating a wider set of actors will be essential for efforts to discuss emerging technologies within the NPT. Many of these technological developments are taking place in the private sector and will require experts with science and technology backgrounds and from industry who may be unfamiliar with the NPT. It is also an opportunity to incorporate a younger generation of experts, as many of these technology experts are Millennials or Generation Z. To pursue these priorities, a future agenda for the NPT to address emerging technologies could include the following:

Recommendation 1:

All States Parties jointly acknowledge the challenges emerging technologies pose to the implementation of the NPT. This may seem like a largely symbolic gesture, but a joint statement by a diverse group of states or a series of national statements would lay the groundwork for meaningful work towards addressing the risks associated with emerging technologies. Nuclear issues can no longer be treated in a silo.

Recommendation 2:

A group of NWS and NNWS form a Science and Technology Working Group within the NPT, co-chaired by at least one NWS and one NNWS, such as the United Kingdom and Mexico, or the United States and South Africa. In past initiatives, the United Kingdom and Norway have demonstrated the value of NWS and NNWS partnership on practical challenges, such as verification and irreversibility, and offered a valuable model for others to emulate. The Working Group could focus on three priorities, as outlined in the draft 2022 Final Document: 1) better understand risks posed by emerging technologies; 2) develop risk mitigation strategies to identify risks posed by emerging technologies to nuclear use; and 3) identify potential beneficial applications of emerging technologies. This group would be an important opportunity to engage the Global South on a wider set of nuclear issues, in particular.

Recommendation 3:

Existing forums address the issue of emerging technologies. One example would be the Stockholm Initiative, a multilateral effort established in 2019 to advance disarmament diplomacy, which could take up the issue of emerging technologies. The Initiative encourages States Parties to pursue research and dialogue on the relationship between emerging technologies and nuclear risks, further pressing the P5 to collectively explore how to mitigate the likelihood of emerging technologies, ‘leading to new nuclear risks and exacerbating existing ones.’³⁰ The group could engage with technology and non-governmental experts to identify risks and opportunities of emerging technologies across the three pillars, along with staying abreast of rapid technological changes.

Another opportunity to address emerging technologies is the Creating an Environment for Nuclear Disarmament (CEND) initiative, which recently designated a subgroup to focus specifically on emerging technologies. The CEND subgroup might request members to provide reports on how individual technologies could impact their NPT obligations, to capture a diversity of perspective in a collaborative and inclusive forum. Other initiatives such as the International Partnership for Nuclear Disarmament Verification (IPNDV) and IND could also explicitly address risks and opportunities posed by emerging technologies by inviting in external experts. These efforts would serve an additional benefit of raising the technological IQ within the NPT.

Recommendation 4:

The P5 immediately incorporate emerging technologies into discussions. This could take various forms. One option would be to discuss emerging technologies in the context of transparency of nuclear doctrines, such as exploring how states would plan to respond in the event of non-nuclear strategic attacks, such as a large-scale conventional conflict involving sophisticated technologies or non-kinetic attacks on critical infrastructure. Another option would be to discuss the risks posed by emerging technologies to crisis escalation. This could involve expert presentations on entanglement, threats to nuclear command and control, risks of misperception, or the potential applications of AI to nuclear systems. A final option for consideration, though this is by no means exhaustive, would be a joint P5 commitment to keep a 'human in the loop' in nuclear decision-making. Four of the P5 have already made such a commitment either unilaterally or jointly.

The NPT is essential to nuclear stability and risk reduction, and strengthening it to respond to these developments should be a priority for all members. Bringing the NPT into the 21st century will require new initiatives and energy, creative solutions for addressing the risks of emerging technologies without losing sight of the NPT's original objectives and political cooperation that transcends current divides.

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