NATO PARLIAMENTARY ASSEMBLY

DEFENCE AND SECURITY COMMITTEE (DSC)

INTERNATIONAL ARMS CONTROL: CHALLENGES AHEAD

Preliminary Draft General Report

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EXECUTIVE SUMMARY

Over the past two decades, the United States, Russia, and China's have developed diverging perceptions of the international security environment, perceptions that have inadvertently motivated the successive abrogation of multiple arms control agreements. In February 2021, the final nuclear arms control agreement between the US and Russia, New START, was rescued just two days before its expiration. To strengthen arms control as an instrument of Allied security beyond New START, NATO member states must confront the forces militating against arms control and foster a shared perspective on the mutual security benefits it offers.

NATO Allies face three principal challenges to future arms control agreements. First, nuclear weapons states outside the Alliance – especially Russia and China – are developing new, destabilising nuclear weapons systems. Second, the risk of uncontrolled nuclear proliferation is greater now than it has been at any point since the Nuclear Non-Proliferation Treaty (NPT) was signed in 1968, with proliferation cascades looming in two particularly volatile security regions, East Asia and the Middle East. Finally, emerging and disruptive technologies (EDT) like Artificial Intelligence (AI) and autonomous systems impose significant uncertainty regarding the fundamentals of nuclear deterrence. These challenges increase the complexity of future negotiations, significantly undercutting the mutual trust required for effective arms control.

Still, parliamentarians possess powerful tools to combat these challenges and reorient the international community's focus toward arms control once again. As legislators across the Alliance's 30 nations, parliamentarians can advocate for arms control negotiations, build public support, and help enact effective legal frameworks to help ensure implementation. As the custodians of their respective nations' finances, parliamentarians – and especially those representing the Alliance's nuclear powers – can moderate the intensity of deleterious arms racing. Finally, as delegates to international institutions, NATO parliamentarians can work together for the establishment of norms and standards for the implementation of EDTs like AI in nuclear systems – and especially in the emerging domains of cyber and space.

I. INTRODUCTION

1. Just two days prior to its expiration on February 5, 2021, the United States extended the New Strategic Arms Reduction Treaty (New START) with Russia for five years. Had New START expired, the last remaining restrictions on the world's two largest nuclear arsenals would have lapsed, with both sides free to deploy new weapons without limitations for the first time since the 1970s. In the absence of this pillar of the global arms control architecture, other elements of the arms control architecture would likely have collapsed with it.

2. Today's challenges to arms control stem from the global great powers' diverging perceptions and strategies relating to the international security environment. Strategic stability between the United States, Russia, and, increasingly, China is complicated by widespread nuclear force modernisation and the development of emerging and disruptive technologies (EDTs). The potential spread of nuclear weapons in the Middle East and Asia remains an equally palpable threat. As such, arms control is entering a period of profound instability.

3. Focused and engaged policies toward Russia and China will be essential to the maintenance and evolution of arms control. NATO Allies remain committed to a dual-track approach of deterrence and dialogue with Russia and continue to debate their approach to China. The Alliance is actively seeking ways and means to balance potential opportunities of cooperation, while remaining clear eyed about the challenges China's rise poses to the liberal international order. NATO's 2030 Initiative and the expected launch of the Strategic Concept review are two approaching windows of opportunity to indicate Allies' commitment to strengthening existing arms control agreements, and to signal their collective political will to negotiate frameworks to handle new challenges.

4. This preliminary report identifies three key historical lessons that underpin the current arms control frameworks; the need for open communications for crisis management; proliferation risk mitigation; and arms race limiting. Well-functioning arms control, therefore, allows states to reap the peace and stability benefits from the cycles of negotiation, dialogue, and cooperation. Understanding these lessons can help leaders focus on ways to overcome the challenges facing arms control today.

5. While individual states sign and adhere to any new arms control treaties, NATO as an institution and member state parliaments will have essential roles to help strengthen implementation and adherence, share information for policy clarity, and create strong supporting legal frameworks. As such, the report concludes with interim recommendations for committee members to consider for debate and action.

Focus of the Report

1. While arms control is a complex subject covering a wide range of issue areas from strategic forces to small arms, this report focuses principally on the evolving challenge of achieving increased stability among great powers' nuclear forces and the extended benefits this stability provides to arms control more broadly. Stability in modern arms control flows from nuclear forces to the conventional, not vice versa.

2. As such, this report highlights the benefits of 'nuclear learning' between the United States and the Soviet Union during the Cold War, which translated into broader post-Cold War conventional arms control measures. Unfortunately, today, as any arms control expert will attest, this framework is unstable and is therefore in need of focused attention.

II. THE LOGIC OF ARMS CONTROL

6. States pursue arms control to reduce the likelihood of war. In theory, arms control agreements bolster security and stability by enhancing the transparency of the participants' armed forces and military deployments. Adversaries familiar with one another's armed forces – including their composition, size, and physical location – are less likely to misperceive one another's intentions and escalate with offensive military actions. Transparency between adversaries also undercuts the motivation to arms race, thereby achieving important cost-saving benefits. On the one hand, these cost-saving measures can result in a so-called "peace dividend." By mutual reducing the size of armed forces, arms control agreements can liberate funds to be spent on non-military programs. On the other hand, cost-saving measures in one area of a defence budget could facilitate greater expenditures in another area deemed more beneficial to a state's overarching security needs.

7. The principal obstacle to successful and durable arms control is, of course, mutual distrust. Adversaries are fearful of one another and seek military advantages to preserve their security. National governments, then, are deeply sceptical of attempts to limit their military capabilities, fearing that their adversaries will cheat, circumvent, or violate mutually agreed-to arms control restrictions in order to gain relative advantages. To overcome mistrust, then, states craft robust verification regimes ranging from the mutual exchange of notifications to rigorous on-site inspections of weapons sites. Verification procedures are intrusive by definition, but certify treaty compliance, foster transparency and predictability, and, in turn, build confidence and trust.

A. THE BIRTH OF ARMS CONTROL: 1962 – 1989

8. The foundation of modern arms control was laid in the aftermath of the Cuban Missile Crisis, when transparency between the superpowers was low and mutual distrust high.[1] Having gone to the brink during the Crisis, both superpowers recognised their mutual interests in preventing another crisis – or at least lessening its intensity. The crisis jumpstarted a process that is now referred to as "nuclear learning" (Nye, 1987). Over the next three decades, the US and the Soviet Union would continuously return to the negotiating table to resolve issues they considered to be of mutual strategic concern. With each successful round of negotiations, the foundation of the broader arms control architecture was strengthened, transparency and familiarity increased, and trust and confidence bolstered.

9. The first lesson learned after 1962 was the need for **open lines of communication and effective crisis management**. During the Crisis, strategic communications between Washington and Moscow had been dangerously deficient. Messages were relayed slowly, allowing time for new, contradictory messages to arrive that sowed confusion on both sides. Each also lacked an understanding of the other's strategic perspective, opening the possibility of accidental but no less disastrous escalation. After the crisis had subsided, then, leaders in Washington and Moscow

[1] The first international efforts to establish forms of arms control began with the early Hague Conventions at the turn of the 20th Century, which resulted in early attempts to ban certain types of munitions, the use of asphyxiating gases, and projectile delivery systems (such as via hot air balloons). None of these restrictions was respected in WWI. After WWI, another series of treaties and agreements sought to limit and, in some cases eliminate, some forms of armaments. For example, the Washington Naval Conference (1921-22) produced three major treaties limiting great power naval arms racing and the 1925 Geneva Protocol prohibited the use of asphyxiating and poisonous gases and bacteriological weapons in international conflicts. Despite its limitations, the Geneva Protocol remains the legal foundation for a series of subsequent related arms control treaties.

established a direct communications line which could relay messages instantly and with consistency. In June 1963, the superpowers signed the "Memorandum of Understanding," often referred to as the "hotline agreement." This original agreement has since between continuously updated to take advantage of improvements in technology (Arms Control Association, 2020a).

10. The next lesson learned regarded the need for **limits on the "horizontal" proliferation of nuclear weapons.** The 1962 Crisis impressed on both sides the need to limit the number of nuclear decision-makers in order to reduce the risk of nuclear crises that were out of their direct control. In, 1968, the superpowers corralled the international community to sign the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), a cornerstone agreement committing signatories to halt the spread of nuclear weapons, to assist non-nuclear states with the peaceful use of nuclear energy, and, eventually, to work toward verifiable disarmament.[2] In 1975, the US and the Soviet Union also worked closely together to found the Nuclear Suppliers Group (NSG), a critical non-proliferation regime that controls the global transfer of nuclear materials and technology (Georghe, 2019).

11. The final lesson was the clear need for **"arms race stability."** Even while they deepened strategic communications and worked together on regimes like the NPT, both superpowers raced to develop larger and more varied nuclear arsenals relative to their rival. Both superpowers challenged the concept of mutually assured destruction (MAD) and sought advantages over the other; each also feared that technological innovations could one day render their arsenals vulnerable to the other (Nye, 1987). In the resulting arms race, huge sums of money were spent, but for little to no relative gain. Neither side could escape the logic of MAD or their rivals' ability to keep pace. Beginning in the 1970s, with both superpowers encountering significant economic difficulties, both sides agreed to first limit and eventually reduce their nuclear arsenals. In 1972, they signed the Strategic Arms Limitation Talks (SALT I) agreement, which successfully constrained the number of ICBM launchers on each side. A core component of SALT I was the Anti-Ballistic Missile (ABM) Treaty, which limited the superpowers' deployment of Ballistic Missile Defence (BMD) systems (Thompson, 2016). Throughout the second half of the 1970s, the two sides also negotiated the SALT II agreements, although those limitations never came into force. Finally, in 1987, the US and the Soviet Union capped off a decades-long process to eliminate the deployment of ground-launched intermediate and medium range nuclear missiles in Europe with the Intermediate-Range Nuclear Forces (INF) Treaty.[3]

12. These three core nuclear lessons still inform the basis of arms control and nuclear deterrence today. Open communication, non-proliferation, and strategic arms limitations together formed the foundation on which subsequent arms control agreements could be constructed. This included further reductions in strategic nuclear forces, but also limitations on non-nuclear related forces.

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2 The superpowers also signed the 1963 Partial Test Ban Treaty, which limited the testing of nuclear weapons to underground tests, and the 1967 Outer Space Treaty, which prohibits the deployment of nuclear weapons in space.

3 The INF Treaty banned all missile systems with ranges between 500 and 5500 kilometers. INF was a landmark agreement that significantly reduced tensions on the European mainland. Beginning in 1976, the Warsaw Pact had deployed the SS-20 IRBM system in Europe. The SS-20 deployment raised concerns amongst the Allies that the Soviet Union would look to "decouple" NATO Europe from its North American Allies. In 1983, NATO deployed Pershing II MRBMs and BGM-109G GLCMs in response.

B. THE EXPANSION OF ARMS CONTROL, 1989 – 2001

13. In 1989, as the Soviet Union and Warsaw Pact unravelled, an environment permissive to further arms control emerged. As such, negotiators strove to expand the scope of arms control beyond the nuclear realm. The promise of the Helsinki Final Act (1975), which established confidence and security-building measures (CSBMs) to help reduce the chances for armed conflict by miscalculation, appeared ripe to be fulfilled (OSCE, 1975). The negotiation of the 1990 Vienna Document established a framework of transparency and verification mechanisms covering armed forces and larger weapons platforms. NATO and Warsaw Pact members subsequently signed the Conventional Forces in Europe (CFE) Treaty, drastically reducing the number of conventional forces deployed on the European mainland. Finally, the Open Skies Treaty, first negotiated in 1992, came into effect in 2002 and mandated its participants grant mutual aerial observation over other participating states' entire territory.

14. The Vienna Document, CFE Treaty, and the Open Skies Treaty serve as three mutually reinforcing pillars of arms control. As a result of the predictability, transparency, and military stability created by adherence to all three, there was a significant level of disarmament and force reduction in Europe. Since the CFE Treaty entered into force in 1992, its signatories have destroyed approximately 100,000 pieces of treaty-limited equipment such as tanks, helicopters, and artillery systems (NATO, 2021). The resulting cost savings related to reduced force commitments accrued absolute gains for all, and significant relative gains for the superpowers (CBO, 1991).

15. While these three pillars were negotiated in the shadow of SALT I and the INF Treaty, the permissive environment of the 1990s also opened the possibility for further reductions in the superpowers' nuclear arsenals. In 1991, the Strategic Arms Reduction Treaty (START) committed both superpowers to reductions in their nuclear stockpiles and delivery systems – especially ICBMs. In 1993, the US and the newly sovereign Russian Federation then concluded START II, which aimed to further reduce strategic nuclear forces. While START II never entered into force, 2002 saw Russia and the US sign the Strategic Offensive Reductions Treaty (SORT) [4], which brought strategic arsenal down to levels below those that had originally been agreed to for START II (Thompson, 2016; Freedman, 2018). In 1995, the signatories of the NPT also agreed to extend the treaty indefinitely.

16. In parallel, significant advances in arms control related to other forms of Weapons of Mass Destruction (WMD) also accrued as a result of the auspicious moment of the 1990s. For example, the Chemical Weapons Convention (CWC), signed in 1993 and entered into force in 1997, banned the production, stockpiling, and use of chemical weapons and mandates their verifiable destruction.[5]

C. THE EROSION OF ARMS CONTROL, 2001 – 2021

17. Awakened to new dangers emanating from rogue state and non-state actors, decision-makers in NATO – and the United States in particular – began directing their energies toward the threat of terror attacks – especially those potential attacks that could be delivered via missile launches in regions like the Middle East, Central Asia, and the Korean Peninsula. In response to this changing strategic environment, the United States announced its withdrawal from the ABM

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4 Also referred to as the Moscow Treaty.

5 The success of the CWC added to the 1972 Biological and Toxin Weapons Convention, which requires signatories from developing biological or toxin weapons and to destroy any stockpiles of supply which have no justification for prophylactic, protective, and other peaceful purposes.

Treaty with Russia in December 2001 and declared its intention to develop limited BMD capabilities that could neutralise the threat of missile attacks sourced from (amongst other regions) NATO's south-eastern flank in the Middle East.

18. An unfortunate side consequence of this shifted focus and the actions that followed was the unintentional misalignment of the great powers' perceptions of the strategic environment. Whereas Washington and the Allies' shifted their focus squarely on the emerging threat of non-state actors and rogue states, Moscow continued to be unsettled by its post-Cold War role in Euro-Atlantic security and disregarded the myriad attempts by NATO Allies to partner with Russia to take on these new shared international security challenges. Allies' bona fides toward a genuine new phase of cooperation with Russia can be seen in the NATO-Russia joint statement and the subsequent creation of the NATO-Russia Council[6]. Still, Russia regrettably misinterpreted the Allies' actions as directed against at its core strategic interests – namely, its strategic missile-based nuclear deterrent. The 2002 withdrawal from the ABM Treaty was judged by Russian President Vladimir Putin to be "a mistake," one that necessitated a response in terms of Russia's nuclear strategy and posture (Neilan, 2001).

19. In December 2007, Russia announced it would cease implementation of its CFE Treaty obligations, citing, among other things, that the restrictions it contained did not apply to China. As the divergence on missile defence continued, Russia turned its focus to the development of new missile systems capable of circumventing missile defences. Some of the restarted programmes were legacy systems begun in the 1980s that had been subsequently stopped due to arms control commitments (Cooper, 2018). A key component of this renewed programme was the development, of a medium range ground launched cruise missile system known as the 9M729 (or SSC-8 in NATO's nomenclature), a system in violation of the INF Treaty which Russia began testing as early as 2008 (Woolf, 2020a).

20. Events in 2010 brought hope for a critical breakthrough on the issue, as the NATO-Russia Council pledged to develop a comprehensive joint analysis for NATO-Russia missile defence cooperation (NATO, 2010). Unfortunately, serious attempts at negotiation only lasted from November 2010 to the three months following the NATO 2012 Summit (Zadra, 2014). Russia ceased cooperation on BMD cooperation in 2013. Neither side was able to surmount fundamentally opposing views on the construction of a cooperative missile defence system (Zadra, 2014).

21. In 2014, Russia dramatically escalated its divergent views with Allies on the role Moscow should have in Euro-Atlantic security. Russia's illegal and illegitimate annexation of Crimea set off a chain of provocative Russian brinkmanship articulated well in the Alliance's 2018 summit declarations:

"The Euro-Atlantic security environment has become less stable and predictable as a result of Russia's illegal and illegitimate annexation of Crimea and ongoing destabilisation of eastern Ukraine; its military posture and provocative military activities, including near NATO borders, such as the deployment of modern dual-capable missiles in Kaliningrad, repeated violation of NATO Allied airspace, and the continued military build-up in Crimea; its significant investments in the modernisation of its strategic forces; its irresponsible and aggressive nuclear rhetoric; its large-

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[6] In 2002, Allies sought to reboot their breadth and depth of their cooperation with Russia via the launching of the NATO-Russia Council. The NRC's original agreement pledged to work on eight key areas, including terrorism, non-proliferation, arms control and confidence-building measures, and theatre missile defence. https://www.nato.int/cps/en/natohq/official_texts_19572.htm

scale, no-notice snap exercises; and the growing number of its exercises with a nuclear dimension. This is compounded by Russia's continued violation, non-implementation, and circumvention of numerous obligations and commitments in the realm of arms control and confidence- and security-building measures (NATO, 2018)."

22. The statement continues by condemning Russia's use of destabilising hybrid tactics, from disinformation campaigns to election interference, and its egregious violation of the Chemical Weapons Convention via its use of a military-grade nerve agent in the United Kingdom.

23. Russia's violations and circumvention of its arms control obligations – especially in the post-2014 era - have fractured almost every element of the existing arms control framework. Unable to gain Russia's return to compliance with the treaty, the United States withdrew from the INF treaty in 2019 with the full support of NATO Allies. In November 2020, the United States withdrew from the 2002 Open Skies Treaty for similar reasons – Russia's persistent noncompliance with its obligations.

24. In light of this slow breakdown – which includes the weakening of the Vienna Document, the suspension of the CFE, the precarious continuation of the Open Skies Treaty without the United States, and the collapse of the INF Treaty – there was understandable pessimism about the likelihood both the United States and Russia could come to an agreement on the extension of the New START agreement, due by 5 February.

25. Despite lingering disagreements about the expansion of the scope of the treaty (to cover tactical nuclear weapons) and the failure to expand the number of signatories (China's refusal to participate), New START was extended in quick order by the United States and Russia in the weeks following the inauguration of President Biden. The New START Treaty limits the US and Russia to 1,550 deployed nuclear warheads, 700 deployed strategic nuclear delivery systems, and 800 total deployed and non-deployed strategic delivery systems. To ensure adherence, New START includes an unprecedented verification regime requiring the application of "unique identification numbers" to all treaty-accountable weapons. These ID numbers allow both sides to track relevant warheads and delivery systems; whenever a weapon is produced, deployed, or withdrawn, a notification is sent to the opposing party describing when and where a weapon is being moved (IISS, 2020).[7]

III. ARMS CONTROL IN A NEW NUCLEAR AGE – CHALLENGES AHEAD

26. With the collapse of the INF Treaty, the arms control architecture between the US and Russia now rests uneasily on New START, the final nuclear arms control agreement in force and one that acts as a keystone holding up the broader complex of arms control agreements that emerged in the 1990s.

[7] Under New START, strategic nuclear delivery systems include ICBM launchers, SLBM launchers, and heavy bombers equipped with nuclear weapons. The number of warheads on each ICBM and SLBM is counted as the number of re-entry vehicles, while all heavy bombers are counted as a single warhead regardless of total warheads onboard (Center for Arms Control and Non-Proliferation, 2017). Moreover, New START defines a heavy bomber as any nuclear weapons-capable bomber with a range of over 8,000 kilometres or capable of carrying long-range missiles armed with a nuclear warhead (Vaddi, 2019). New START places no limits on stockpiled (non-deployed) nuclear warheads. The parties were granted seven years from ratification to comply with these limits, which they achieved in 2018 (US State Department, 2021).

27. The five years that remain within the New START framework, then, are an undeniable historic juncture for arms control. In essence, the extension of New START granted the international community a five-year deferral to rescue the arms control architecture. In the broad scope of arms control history, a five-year grace period is an extraordinarily short period of time. Indeed, what was built over half a century beginning after the Cuban Missile Crisis could easily fall apart in the next half decade unless concerted and deliberate action is taken. Unfortunately, there are significant obstacles to such action.

28. Today, we are visibly entering a "new nuclear age;" one that arguably holds greater challenges compared to the Cold War nuclear era (Lieber and Press, 2017; Miller and Narang, 2019; Levgold and Chyba, 2020). A defining characteristic of this new nuclear era is the emergence of "nuclear multipolarity," a sharp departure from the relative stability of the bipolar Cold War nuclear order. Nuclear multipolarity is driven by the "vertical" proliferation of existing nuclear arsenals in states like China, North Korea, India, and Pakistan as well as the increasing potential of "horizontal" proliferation of nuclear weapons to non-nuclear states in regions like the Middle East and East Asia.

29. Vertical nuclear proliferation in particular is fuelled by an ongoing revolution in technology. As new capabilities are enabled by emerging and disruptive technologies like Artificial Intelligence (AI) and existing capabilities like missile accuracy become ever more widespread, NATO's nuclear adversaries are vertically proliferating their arsenals to take advantage of these new developments. In a repeat of the Cold War arms race, states like Russia and China are developing new nuclear weapons, both in an attempt to gain potential advantages over NATO member states and to hedge against unforeseen technological developments. As the lessons of history show, however, this nascent arms race is likely to be as expensive as it will be futile.

A. VERTICAL NUCLEAR PROLIFERATION

30. NATO Allies have been modernising their nuclear forces to ensure the safety, security, and effectiveness of existing systems. Other nuclear powers have been actively expanding their arsenals vertically. This development is deeply concerning from the perspective of crisis stability and inter-state nuclear communications. A key element of nuclear learning during the Cold War was the growing familiarity that emerged between the United States and the Soviet Union. Arguably, the salience of the nuclear arms race diminished through the decades of the Cold War because leaders in both superpowers came to develop strong – indeed, intimate and personal – relationships with their counterparts. In a world of nuclear multipolarity, where states like Russia, China, North Korea, India, and Pakistan are all expanding their nuclear arsenals, the lessons of crisis stability and open communications as well as the interpersonal relationships through which those lessons were shared could be lost in a complex web of novel and contentious nuclear relationships.[8]

31. Since the mid-2000s, **Russia** has been replacing aging nuclear delivery systems, developing so-called "exotic" strategic delivery systems, and expanding its stockpile of tactical nuclear weapons. In 2021, Russia will deploy the RS-28 *Sarmat* ICBM (SS-X-29 or SS-X-30), which is expected to replace the Cold-War era R-36M ICBM (SS-18 *Satan*). Russia is also developing "hypersonic" weapons systems.[9] These include the *Avangard* hypersonic "boost-glide" vehicle (HGV), a guided warhead that carries a two-megaton payload, as well as the 3M22 *Tsirkon* hypersonic cruise missile, a tactical nuclear weapon that manoeuvres at low altitudes to evade

[8] See Annex A for details on North Korean, Indian, and Pakistani modernisation efforts.

[9] Hypersonic weapons are those that fly at speeds over Mach 5. They can often manoeuvre mid-flight and are difficult for radar systems to detect due to their variable flight paths and high speed.

radar coverage.[10] Russia has also announced two exotic nuclear delivery systems: the outlandish *Poseidon*, an autonomous nuclear torpedo designed to trigger a nuclear-induced tsunami off an adversary's coast, as well as the *Burevestnik*, a radar-evading, nuclear-powered cruise missile with an ostensibly unlimited range due to its nuclear propulsion system (Woolf 2020b; Barrie and Boyd, 2021). Finally, Moscow is expanding its suite of tactical nuclear weapons, to include the 9M729 (SSC-8) GLCM and the potentially hypersonic *Kinzhal* (Dagger) ALBM. (Episkopos, 2020).

32. This new collection of nuclear systems is worrisome when placed in the context of Moscow's aggressive and increasingly opaque nuclear doctrine. In 2009, Moscow declared that it reserved the right to launch "pre-emptive nuclear strikes" in conflicts as small as "local wars" (Reuters, 2009). Since then, defence analysts have hotly debated whether or not Moscow has further transitioned to a so-called *escalate to de-escalate* strategy- e.g. during a crisis or a conventional war, Russian forces might initiate a limited nuclear strike with a low-yield tactical weapon to signal resolve and compel the enemy to back down (Oliker and Baklitskiy, 2018).[11] Taken together, Russia's growing arsenal and its potential willingness to brandish nuclear weapons significantly undermine crisis stability with NATO nuclear states. Although open lines of communication dating back to the Cold War remain relatively strong, the current trajectory of Moscow's arsenal and doctrine undercut these historical gains.

33. As **China's** power and stature has risen, so too has its appetite for a larger and more diverse nuclear arsenal. China has historically maintained a nuclear stockpile of roughly 200 to 320 high-yield warheads, deliverable mostly via land-based systems. (Kristensen and Korda, 2020a). Today, however, US military officials estimate Beijing will double its nuclear warheads stockpile by 2030, while Chinese state media commentators suggest Beijing could grow its arsenal to as many as 1000 nuclear warheads (Gould, 2020; Tian, 2020).

34. Beijing is also steadily improving its nuclear triad. First, the People's Liberation Army (PLA) is replacing its older, liquid-fuelled missiles systems with a new generation of solid-fuelled, road-mobile missile systems. These include the DF-26 IRBM, a system equipped to carry both conventional and nuclear missiles (Kristensen and Korda, 2020a). These dual-use systems are especially concerning, as in the event of a crisis, an adversary may unwillingly target nuclear systems believing them to be conventionally armed, leading to inadvertent escalation (Talmadge, 2017). China has also recently deployed the H-6N strategic bomber variant, capable of delivering nuclear-tipped ALBMs (Panda, 2018). Beijing's final hurdle is the deployment of a credible sea-based deterrent. Under development since the mid-2000s, China's *Jin*-class SSBN is now entering service and is the most advanced subsurface vessel deployed by the PLAN. The *Jin*-class's vulnerability to advanced ASW capabilities is yet to be evaluated, with some analysts claiming the *Jin*-class radiates sonar signatures during radio silence, a critical vulnerability (Zhao, 2018; CSIS, 2015).

35. With the expansion and modernisation of China's nuclear arsenal, there is the thorny issue of China's nuclear doctrine. For decades, Western strategists have puzzled over China's "minimum deterrence" nuclear strategy: China has maintained a no first use policy and – until now – a relatively small nuclear stockpile; likewise, the opacity of Chinese strategic culture has produced uncertainty about Chinese nuclear concepts (Fravel and Medeiros, 2006). With Beijing expanding its arsenal and delivery systems, Beijing's doctrine must now be clarified. Indeed, a lack of

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[10] Russia plans to mount *Avangard* weapons atop *Sarmat* ICBMs when the latter enter into service. Meanwhile, the *Tsirkon* is in the testing phase. Reports indicate that trials will conclude in 2021 (Suciu, 2021).

[11] During the "Zapad" military exercises in 2009 and 2011, Russia simulated tactical nuclear strikes on Polish and Swedish forces, including a strike on Warsaw (Stoltenberg 2015).

familiarity with China's doctrine and strategic culture could seriously undermine existing crisis management practices and increase the changes of misperception – especially if dual-capable systems like the DF-26 become the mainstay of Beijing's arsenal.

B. HORIZONTAL NUCLEAR PROLIFERATION

36. With intensifying strategic competition throughout the international system – driven in part by emerging nuclear multipolarity – non-nuclear weapons states may increasingly feel the need to acquire a nuclear deterrent to guarantee their national security. Of course, the more states that possess nuclear weapons, the more challenging arms control will become – if only due to the added number of players that must be negotiated with. Such an outcome would also undermine the rules-based international order (of which the NPT is a key pillar) and thereby lessen the authority of negotiated treaties that are the basis of effective and verifiable arms control.

37. Horizontal proliferation can significantly increase the likelihood of misperception and escalation between states. Logically, the greater number of actors with nuclear weapons, the greater the risk of accidental escalation. In other words, if nuclear multipolarity is a defining destabilising characteristic of the new nuclear age, horizontal proliferation will only magnify the instability of the new nuclear age.

38. Still, proliferation brings more immediate, tangible threats in the form of deliberate, non-nuclear escalation between nations. As nuclear weapons pose an existential threat to a state's survival, leaders perceive their rivals' attempts to acquire them as a justification for drastic action. Some states have opted for preventive strikes against their rivals' nuclear facilities in an attempt to the prevent them from acquiring such a capability in the first place. Perhaps the most well-known example is Israel preventive strikes on Iraq's Osirak nuclear reactor in 1981 (Mizokami, 2019). Of course, just because a state lacks a nuclear capability with which to retaliate does not mean that it is not capable of a robust conventional response. Indeed, while the Osirak attack in 1981 did not prompt an immediate response on the part of Saddam Hussein's regime, which was occupied by the ongoing war with Iran, the strategic context in regions like the Middle East and East Asia today (where proliferation is most likely) are far more likely to produce a prompt and robust response.

39. To that end, proliferation's regional "cascading" character is another concern. When states acquire nuclear weapons, their rivals are pressured to match their capability in search of defence, which, in turn, generates an exponential cascade of other rivals seeking nuclear arms as well (Allison, 2004). East Asia is a focus of such fears today. Three regional non-nuclear players (Japan, South Korea, and Taiwan) stand out as nuclear "hedgers" or "turnkey" states, meaning each possesses the technological and economic capacity to build a nuclear weapon on short notice. In the shadow of a rising China and a nuclear North Korea, these turnkey states might one day be inclined to match their rivals' capability. Cascade risks are also palpable in the Middle East. As Iran continues to pursue nuclear capabilities, its regional rivals have expressed their willingness to pursue a nuclear capability in response. Saudi Crown Prince Mohammed Bin Salman has openly stated he would match an Iranian bomb (Reuters, 2018).

40. Finally, proliferation also raises the risks of nuclear terrorism and of nuclear weapons falling into the hands of non-state actors. Terrorist groups like Deash have made explicit their desire to acquire a nuclear capability, while Al-Qaeda and other criminal organisations' past efforts to acquire nuclear weapons on the black market are well documented (Ward, 2018; CFR, 2006). Increased proliferation will facilitate these actors' quest: The more nuclear weapons that exist, the greater the chances one of those weapons could be stolen, sold, or simply lost. Indeed, while the US, the UK, and France place strict controls on their nuclear weapons, not every

state is as assiduous. During the chaos that followed the fall of the Soviet Union, the threat of "loose nukes" was all-too real. Several criminal syndicates were caught trying to smuggle Highly Enriched Uranium (HEU) out of the country, spurring the US to work directly with the Russian Federation to secure the erstwhile Soviet arsenal (CFR, 2006).

C. EMERGING AND DISRUPTIVE TECHNOLOGIES

41. Finally, technological changes arriving in the next decades raise more profound questions for arms control. Will emerging and disruptive technologies alter the fundamental calculus of nuclear deterrence? Will advances in missile technology and surveillance undermine MAD? These questions probe at the very foundations of NATO security and must be answered for future arms control to have durability.

42. The most difficult challenge arms control faces is the increasing uncertainty and opaqueness of the future, which is exacerbated by the emergence of powerful new technologies. If states cannot be assured that the *quality* of their nuclear systems will be adequate against their adversaries' technologies, they will almost certainly pursue an expansion in the *quantity* of their systems as compensation. A qualitative arms race is already underway as we speak – and placing limitations on it becomes more difficult as time passes. A quantitative arms race has yet to begin in earnest, but the more time lost, the more likely it becomes a pressing reality.

43. Experts have identified several emerging technology domains as particularly threatening to the two key qualitative pillars of nuclear survivability – hardening and concealment (Lieber and Press, 2017).[12] If those two qualitative pillars are undermined by new technologies, we are likely to see a reliance on the third, quantitative pillar of deterrence – namely, redundancy.[13] An increasing reliance on redundancy would have disastrous implications for arms race stability.

44. First**,** improvements in **missile accuracy** have rendered hardening measures obsolete. Many states have equipped their missile systems with advanced onboard GPS and inertial guidance systems that allow even long-range ICBMs to strike hardened targets with remarkable precision. Missile accuracy portends sea-changes to nuclear deterrence. First, accurate missiles render so-called "counterforce warfighting," where states engage in controlled nuclear exchanges against one another's delivery systems, far more realistic. The more accurate the missile, moreover, the smaller the payload required for a successful strike. (Lieber and Press, 2017). Smaller payloads significantly lower the environmental damage involved in nuclear strikes, paving the way for "low-casualty" nuclear use (Kristensen and Korda, 2020b). Improved missile accuracy may soon allow for the use of conventional warheads against nuclear targets.

45. Advances in **Intelligence, Surveillance, and Reconnaissance (ISR)** capabilities equally undermine concealment measures. Since the late Cold War, the United States has been developing ISR tools capable of tracking SSBNs and mobile ICBMs (Long and Green, 2015; Bin, 2007). Improvements in military-grade remote sensing like radar satellites and remotely piloted aircrafts that have taken place in the intervening decades have deepened these capabilities (Lieber

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12 Hardening entails the construction of missile silos and platform shelters capable of withstanding or "soaking up" nuclear strikes. Concealment entails the use of deception and mobility to evade targeting altogether. Concealment efforts range from the use of simple measures like camouflage and decoys to the employment of highly sophisticated mobile delivery systems like SSBNs and road-mobile ICBMs.

13 Redundancy involves the numerical build-up of nuclear warheads, their delivery systems, and the Nuclear Command, Control, and Communication (NC3) networks needed to operate them. The logic of redundancy is to deploy such a vast quantity of systems that only a very small percentage of systems are needed to ensure a retaliatory strike.

and Press, 2017). When coupled with advances in missile accuracy and the ongoing advances in Anti-Submarine Warfare (ASW) capabilities, advanced militaries with high-grade ISR may soon find themselves in the position to "see" the entirety of a state's nuclear arsenal. In a conflict, they would therefore have an incentive to launch a disarming first strike. This is especially true against a weaker nuclear power like North Korea, which lacks a sophisticated undersea deterrent.[14]

46. Moreover, **Artificial Intelligence (AI) and other advanced computing systems** could soon revolutionise several aspects of nuclear deterrence. First, AI could allow states to process ISR data at rates previously thought impossible. Currently, our ability to collect data on mobile nuclear assets outstrips our ability to process that data into actionable insights (Pomerleau, 2017; DARPA, 2019). The introduction of powerful new AI software bridges the gap (SIPRI, 2019). AI portends such immense advances in computing power that states will no longer look for the needle in the haystack but instead examine every single strand of hay in the stack to determine if one of these strands is a needle. This ISR revolution is especially impactful for detecting sea-based nuclear systems like SSBNs (Geist and Lohn, 2018).

47. Beyond tracking nuclear weapons, there could soon be **AI-enabled autonomous systems** that target delivery systems more effectively. AI application in conventional air defence systems already undermines the most vulnerable pillar of the nuclear triad, the long-range bomber, as defending radar stations and batteries can rapidly and effectively identify and shoot down incoming targets via AI-powered "kill webs" (The Economist, 2021). Soon however, more futuristic capabilities like AI-coordinated undersea drone swarms or Highly Autonomous Unmanned Ships could be used to undermine the sea-based leg of the nuclear triad and AI-backed BMD could undermine missile-based deterrent forces (Bidwell et al., 2018; DARPA, 2019; SIPRI, 2020).

48. Challenges may also emerge with **AI-powered Nuclear Command, Control, and Communications (NC3).** In the late 1980s, the Soviet Union developed and deployed the Perimeter system, often referred to as the "Dead Hand" nuclear response system (Lowther and McGriffin, 2019). The system was designed to trigger a nuclear response automatically in case a state's leadership is incapacitated by the enemy (Peck, 2018). Today, experts fear states could equip their strategic forces with much more advanced AI systems, which might then mistakenly trigger a nuclear launch due to a glitch or an error in early warning systems.

49. In fact, AI directly threatens NC3 itself by facilitating **offensive cyber capabilities**. Rapid advances in the capabilities of AI-powered algorithms improve the scale and intensity of cyber-attacks. These AI-powered cyber-attacks could be used as force multipliers that magnify or complement an incoming first strike (SIPRI, 2020). A potential attacker could use cyber to overload or disable the NC3 systems that govern the use of the defender's nuclear weapons. In this context, the most destabilising aspect of AI is its machine-like speed. Already, the use of missiles in nuclear deterrence dramatically compresses the timeframes leaders have in crisis situations. The use of AI will further compress these decision-making windows, deepening the stress that leaders experience, thus increasing the possibility of miscalculation (Johnson and Krabill, 2020).

50. Finally, new developments in **anti-satellite (ASAT) space weapons** could add yet another challenge to strategic stability. As of late 2020, the United States, Russia, China, and India have successfully tested land-based missile systems capable of kinetically striking satellites in orbit

[14] Such a possibility is hotly debated amongst academics and military officers. That said, there is no debate that these technological advances are rendering the possibility of "counterforce warfighting" more salient than at any time since the 1970s (Lieber and Press, 2017).

(Harrison, 2020). Alongside so-called "non-kinetic" space weapons which utilise cyberattacks and robotic arms, ASATs could undermine the very foundation on which modern militaries function. The organisational and technical systems that allow militaries to operate – often referred to as Command, Control, Communication, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) – are reliant on interconnected, electronic systems embedded in orbiting satellites. In a nuclear crisis – or any other crisis between ASAT-armed militaries – the first use of ASAT systems to "blind" adversary C4ISR could severely undermine strategic stability and result in nuclear escalation (Blair, 2019).

IV. ARMS CONTROL TOMORROW – ALLIED WAYS AND MEANS

51. The challenges of the new nuclear era are daunting. Still, the Allies should take heart in the fact that they possess both the institutional *memory* and the institutional *means* to tackle these challenges head on. The lessons of the Cold War – the need for open communications and crisis management, strong and robust non-proliferation regimes, and arms race stability – are all readily accessible to arms control experts and there exists a wealth of experience in arms control negotiation and formulation within the Alliance that can be tapped on relatively short notice.

A. LESSONS FROM THE COLD WAR – A BLUEPRINT FOR THE FUTURE?

52. The new nuclear era's three core challenges of vertical proliferation, horizontal proliferation, and emerging technologies each reflect lessons from the initial period of nuclear learning that took place between the United States and the Soviet Union after the Cuban Missile Crisis.

53. First, the vertical expansion of existing nuclear arsenals in Russia and China should impress on all parties the need for open communications and better mechanisms for crisis stability. As Russia and China expand their nuclear arsenals and develop new delivery systems, their nuclear use doctrines have become increasingly muddied in the eyes of the Allies. While the Allies possess dedicated hotlines with both Moscow and Beijing, there is every reason to believe that communications on a substantive level must be deepened (Arms Control Association, 2020a). As such, Allied arms control efforts should home in on the need to break existing barriers of communication between the nuclear powers and to generally develop a great capacity for consultations between all the nuclear powers – but especially NATO, Russia, and China.

54. Second, the increasingly long shadow of potential horizontal proliferation should impress on the system's great powers – namely, the United States, Russia, and China – the need for closer cooperation on non-proliferation efforts. Indeed, it was the tight knit cooperation between Washington and Moscow that gave the NPT and NSG the wherewithal needed to be an effective non-proliferation regime for the past fifty years. With the development of larger nuclear powers like China, future arms control efforts will be required to maintain strict controls on the distribution of nuclear materials globally (Georghe, 2019).

55. Finally, the changing technological environment, characterised by emerging and disruptive technologies, could naturally spark a fully-fledged arms race between the US, Russia, and China. To a certain extent, such an arms race is already underway as we speak. All parties are currently seeking the most advanced technologies and looking to apply them creatively to their nuclear postures. This is concerning – especially from the perspective of cost-savings. The development of new technologies like AI and robotics will be hugely expensive and will consume enormous amounts of energy from the system's great powers. While these technologies will be pursued regardless of their application to nuclear systems, the Allies should work to decouple the relationship between these technologies and nuclear weapons as much as possible through new arms control efforts.

B. NATO'S ENDURING ROLE IN ARMS CONTROL AND NON-PROLIFERATION

56. As political leaders work to revise arms control frameworks to reflect the current security environment and, therefore, address principal security concerns on all sides in an effort to strengthen strategic stability, NATO will have an important role. As reflected in this report, the Alliance, both historically as well as today, plays an important role as a consultative forum for Allied understanding of and policy toward a broad range of arms control agreements and issues. While NATO member states agree to and respect treaties individually, the NATO Alliance serves as an invaluable clearing house for information sharing and provides 30-nation platform to amplify consensus positions on critical issues related to arms control.

57. Alongside US, French, and UK modernisation efforts[15], the Alliance as a whole continues to play its part in ensuring that current arms control and non-proliferation efforts are robust and rigorous. Important committees meet frequently at NATO Headquarters to discuss key aspects of the Alliance's work in these areas. These include the High-Level Task Force on Arms Control, the Verification and Coordination Committee, the Arms Control, Disarmament and Non-Proliferation Committee, and the Committee on Proliferation. Through these committees, NATO member states also work diligently to coordinate arms control, non-proliferation, and disarmament policy.

58. Broader Allied participation in NATO's nuclear posture is equally indispensable to continued Allied security and deterrence. As NATO public documentation notes: "NATO's nuclear deterrence also relies on US nuclear weapons deployed[14] in Europe and supporting capabilities and infrastructure provided by Allies. A number of European NATO members have dual-capable aircraft dedicated to the delivery of these US nuclear weapons. (NATO, 2020a)" Nuclear sharing is critical as it shares the benefits, responsibilities, and risks of nuclear deterrence amongst the Allies. Via Allied provision of supporting capabilities, the maintenance of dual-capable aircraft and coordinating organisations like the Nuclear Planning Group (NPG),[16] nuclear sharing is an essential trust-building inter-Allied measure that strengthens NATO's deterrent credibility. Finally, it is also an essential element to non-proliferation, as it removes the incentives for nations to develop their own nuclear capability (Stoltenberg, 2020).

59. It should be noted, however, that the Alliance is opposed to the Treaty on the Prohibition of Nuclear Weapons (TPNW). NATO member states believe that the current security environment is not conducive to nuclear disarmament. As the North Atlantic Council noted in a public statement on the TPNW, "a world where states that challenge the international rules-based order have nuclear weapons, but NATO does not, is not a safer world" (NATO 2020b). In a time when NATO adversaries are expanding their nuclear arsenals, now is not the time to engage in unilateral and unverifiable disarmament. Indeed, NATO member states are also in agreement that the TPNW remains at odds with the existing non-proliferation and arms control architecture. NATO has clearly affirmed that the NPT – especially Article VI – is the only credible path to nuclear disarmament. By contrast to the NPT, TPNW lacks rigorous mechanisms for verification (NATO, 2020b).

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15 See Annex B on Allied Nuclear Modernisation Efforts.

16 The Nuclear Planning Group (NPG) is the principal discussion forum for Allies within NATO on nuclear issues. The NPG reviews NATO's nuclear policy, to include the safety, security and survivability of nuclear weapons, and communication and information systems. All Allies are members of the NPG, except for France, which decided not to participate (NATO, 2020a). The NPG High Level Group (HLG) serves as the senior advisory body to the NPG. The HLG's remit is NATO's nuclear policy, planning and force posture, in addition to matters related to the safety, security, and effectiveness of NATO's nuclear deterrent (NATO, 2020a).

C. THE ROLE OF PARLIAMENTS IN ARMS CONTROL

60. The impact arms control has on national security is important for a parliamentary audience. Parliamentarians' choices about force modernisation and deployments are (at least in part) shaped by national governments' international arms control commitments. Further, arms control is an issue that is often featured prominently in the court of public opinion, which requires an informed parliament to act as a democratic conduit for the views of their constituents and the positions eventually taken by the government in the name of their citizens.

61. Additionally, parliaments also have a critical role in the development of national arms control policy, treaty negotiations and ratification, as well as implementation. As a result of international arms control commitments, parliaments must also play a role in enacting and maintaining a national legal framework reflecting these commitments – specifically overseeing such critical actions as export controls and sanctions regimes.

62. Finally, parliaments serve as vital democratic fora for accountability and scrutiny of government policies. Parliaments have a duty to hold governments accountable for arms control commitments, and, at times, to allow for criticism of government policies and decisions. Parliamentary scrutiny of national commitments to international arms control, therefore, further fosters one of its essential elements – transparency – increased transparency acts as a reinforcement mechanism for confidence among arms control signatories, thereby lengthening the shadow of future stability offered by the understanding that both governments and parliaments are working assiduously to uphold and maintain national commitments to international arms control.

V. PRELIMINARY CONCLUSION AND RECOMMENDATIONS FOR NATO PARLIAMENTARIANS

63. Today, then, the drivers of the new nuclear age are significant obstacles to arms control. The expansion of existing nuclear arsenals, potential proliferation cascades, and the uncertain ramifications of emerging and disruptive technologies each offer challenges to Allied efforts to preserve stability and security in the international system. Still, this new nuclear age could very well be remembered as an era where arms control was redoubled rather than an era of unrestrained global nuclear expansion. NATO Allies – and the parliamentarians that participate in member state governments – can have a defining impact on how this nuclear era is remembered. As such, this report recommends the following steps and initiatives. Allies must:

a. Encourage the fostering of a new generation of arms control experts. While the lessons of the past are as salient as ever, there is currently not supply of trained professionals to meet the demand. Further, the human capital that exists within the Alliance must be rejuvenated and directly put into contact with the older generation of arms control experts. To do so, NATO parliamentarians could encourage the development of new training programs, expand in-house arms control expertise via new hiring, and of a dedicated working group of professionals from a range of worlds – policy, academic, science, and engineering – to feed an interoperative community constantly seeking to refresh dynamic thinking on the myriad challenges facing Allies in arms control. Particular emphasis should be placed on scientific and technical expertise to develop new methods of verification and regimes for treaty implementation. All of these would serve to boost the profile of NATO as the key forum for consultation on nuclear and arms control issues.

b. Maintain and sustain the ongoing pressure campaigns via sanctions and other diplomatic channels to bring Russia back to the bargaining table for future arms control frameworks.

Allies must find the ways to convince Moscow that Russia's future peace and security will benefit from its cooperation on arms control.

c. Work in concert to develop a coherent NATO policy to induce Chinese participation in arms control frameworks early in the process as a means of engaging it with other global powers responsible for the maintenance of global peace and security. Such efforts can help persuade China that its future security can benefit significantly from multilateral cooperation on a range of arms control issues. A key means of bringing China to the bargaining table for future arms control treaties will be via the pressing need to regulate norms for the use of many of the key EDTs outlined in this report, which have the potential to undermine deterrence and lead to an increasingly unstable global strategic environment.

d. Continue to be strong advocates of effective current and future arms control treaties that reflect the strategic environment in which the Alliance exists. Many of the challenges posed by nuclear force modernisation and expansion by NATO's competitors would benefit from the transparency provided by the exchange of information, dialogue, and limitations provided by well-functioning arms control. Allies can play their part to be strong advocates of arms control by upholding their commitments and being vigilant about their expectations that all signatories follow suit. The upcoming NPT review conference is an ideal venue to reposition Allied focus and determination to engage with the challenges facing arms control today and over the horizon. To this end, Allies must continue to voice their strong commitment to the NPT and its provisions. Allies should also maintain a unified consensus that the TPNW is not in the interest of global stability, as it does not promote effective and verifiable disarmament and ignores the realities of today's global strategic environment. Still, it should be acknowledged that, while the Alliance's technical arguments against the TPNW remain sound, the broader movement driving the treaty does indeed pose a moral-ethical challenge to the Alliance's reliance on nuclear weapons, which does indeed have an emotional resonance with democratic audiences. Parliamentarians can serve as essential links to help maintain a better-informed public about the treaty's dangers and the Alliance's efforts to uphold its NPT commitments more broadly.

e. Protect and, if possible, deepen their science and technology edge – especially as it relates to technologies critical to a strong, durable nuclear deterrent. Particular focus should be paid to developing new defensive countermeasures that can negate gains in offensive nuclear capabilities. Already, the Allies have taken welcome strides to expand investment in these areas; however, even greater efforts should be made to encourage inter-Allied partnerships and sustained, deep cooperation with private industry in the development of new and emerging technologies. Such partnerships not only expand NATO's scientific and technological capability, but also help the Allies determine which technologies are most ripe for investment, application and deployment.

f. Encourage an exploratory debate regarding the future development, implementation, and use of AI in all weapon systems – especially as it relates to nuclear command-and-control. Although AI arguably remains an "emergent" technology, one whose ramifications may not be fully felt for another decade, it is clear that AI will revolutionise warfare through its potential as a force multiplier. AI will likely make decision-making by both human and autonomous sources far more comprehensive, intelligent, and rapid than is currently the case. This multiplication effect could act as stabilising force, one that improves early warning systems, retaliatory capabilities, and other systems used for robust defence and deterrence, or it could act as a destabilising force, one that strengthens offensive systems, thereby encouraging pre-emptive offensive attacks and the erosion of crisis stability. Parliamentarians should consider AI's current gestation period as a window of

opportunity during which they can formulate “rules-of-the-road” for stabilising AI implementation.

g. Push for multilateral agreements capable of reducing the risks of increased weaponisation of space. An evolving new class of potential space-based weapons poses a critical threat to all global communications systems. Disrupted or destroyed satellite networks can have not only seriously adverse economic and social impacts, but, in the worst-case scenario, could also lead to precipitous and dangerous escalation to unintentional nuclear use if a state believes such an attack on a satellite network would limit command and control of their nuclear systems.

h. Advocate for the establishment of standards, norms, and predictability in the use of offensive cyber systems against nation states – especially as it relates to nuclear deterrence. Cyberattacks on nuclear command and control systems are especially dangerous as they carry similar escalatory risks as space weapons but are far more difficult to attribute. In the event of a cyberattack on nuclear command and control systems, there is a real risk that a state might attribute the attack to the wrong actor, thereby adding a new and dangerous wrinkle to the problem of misperception and unintentional nuclear use.

ANNEX A – NORTH KOREA, INDIA, AND PAKISTAN NUCLEAR FORCE EXPANSIONS AND MODERNISATION

North Korea has illegally developed a small but potent nuclear arsenal. Experts believe Pyongyang has a stockpile of 30 to 40 nuclear weapons and fissile material to expand their arsenal to 70 weapons (Arms Control Association, 2020b). Likewise, a recent report suggests North Korea has successfully miniaturized its nuclear devices – a critical step for mounting nuclear warheads atop ballistic missiles (Nichols, 2020). Pyongyang aggressively tested its Hwasong-class missile systems throughout 2017, with the largest Hwasong-15 achieving a purported range of 13,000km – enough to strike the United States' Eastern seaboard. In January 2021, North Korea also unveiled an SLBM missile at a military parade, though it remains unclear whether this system has been tested (BBC, 2021). At the same parade, North Korean leader Kim Jong-un unveiled an ambitious modernisation program for the next decade, including the development of tactical nuclear weapons and new ICBM systems (Herskovitz and Lee, 2021). With its small and still rudimentary arsenal, North Korea has maintained an opaque nuclear strategy. Kim Jong-un has consistently engaged in inflammatory nuclear rhetoric and hinted he would use nuclear weapons first; however, North Korea is yet to outline an official doctrine. Similar to China, a lack of doctrinal clarity raises the possibility of misperception and escalation. Indeed, some argue that Pyongyang employs a "dynamic" nuclear strategy that varies according to the actions of its adversaries (Lee, 2021). A misunderstanding of how North Korea "varies" its strategy, then, could easily precipitate an escalation – even if the initial ambition is to ease nuclear tensions.

India has developed a nuclear arsenal of roughly 150 warheads, deliverable by a nascent nuclear triad. India relies primarily on its road-mobile strategic missile systems like the *Agni* series missiles as well as several road-mobile tactical nuclear delivery systems like the *Prithvi* SRBMs, most of which are aimed at Pakistani and Chinese targets. India is also one of the few nuclear powers to still rely heavily on its arsenal of air-launched gravity bombs and ALBMs (Kristensen and Korda 2020c). Finally, India has deployed the *INS Arihant* SSBN since 2016, with Indian Prime Minister Nahrendra Modi declaring India's full triad in 2018 (Dutta, 2018). After an embarrassing accident during *Arihant* sea trials, though, experts doubt India can sustain continuous sea-based deterrent patrols (Keller, 2018). In light of rapidly escalating strategic competition with China – not to mention ongoing tensions with arch-rival Pakistan – India continues to undertake expensive modernisation of its nuclear weapons arsenal. This includes the development of intercontinental range *Agni-VI* missiles as well as two further *Arihant* class SSBNs (O'Donnell and Bollfrass, 2020). While India's relatively strong conventional military offsets concerns that India will develop a destabilising first use doctrine, mounting tensions with the conventionally superior PLA are cause for concern.

Pakistan's nuclear weapons programme mostly mirrors developments in India's military posture; however, the asymmetric conventional military balance between the two pressures Pakistan to threaten nuclear first use. Like India, Pakistan professes to maintain a nuclear doctrine of "credible minimum deterrence," but there is significant disagreement as to what Pakistan considers to be the "minimum" (Mills, 2020). The Pakistani military thus maintains a policy of nuclear first use against other nuclear armed powers – namely, India – and has recently expanded its nuclear stockpile to 160 warheads, with some arguing Pakistan's arsenal is "the fastest growing in the world" (Sen, 2020). Like India, Pakistan also mostly relies on its land and air-based deterrent components to deliver its nuclear weapons. This includes an extensive collection of tactical, ground-based systems like the *Shaheen*-class SRBM/IRBM and *Babur*-class GLCM. Unlike India, however, Pakistan is yet to deploy a sea-based nuclear capability or an ICBM class missile – although both are under development (Arms Control Association, 2018).

ANNEX B – ALLIED NUCLEAR FORCE MODERNISATION

The **United States** is undertaking an extensive nuclear modernisation program, with plans to spend USD 494 billion in the next decade and USD 1.2 trillion by 2046. The program's contours follow recommendations made in the 2018 US Nuclear Posture Review (NPR), which called for the renewal of the US nuclear triad, the upgrading of the US NC3 and early-warning systems, and the development of a new sea-launched cruise missile (SLCM) in response to Russia's deployment of the 9M729 (CBO, 2019). In the short term, the US is actively reducing the number of warhead types in its arsenal from ten to five and is refurbishing its aging triad forces of *Minuteman III* ICBMs, the *Trident II* SLBM, and B-2 and B-52 long-range strategic bombers. In the longer term, the US is developing new systems to replace its Cold War-era arsenal. The B-21 bomber should begin replacing the existing strategic bomber force of B-1, B2, and B-52 aircraft in the mid-2020s, while the Ground Based Strategic Deterrent is slated to replace the *Minuteman III* starting in 2028. Finally, the first *Columbia* class SSBNs will enter service and replace the current *Ohio* class SSBN forces beginning in 2031 (Arms Control Association, 2018).

France has also committed to overhauling its nuclear arsenal, with plans to replace all of its key systems by 2035. French modernisation involves the development of new delivery systems and platforms as well as a more expansive approach to nuclear training simulations. Over the past decade, France has installed new M51 SLBMs throughout its deployed SSBN forces; in February 2021, France also launched its program to complement and eventually replace the current *Le Triomphant* class SSBN (Mackenzie, 2021). Similar to its sea-based deterrent upgrades, moreover, Paris has fully substituted its air-based deterrent force of Mirage 2000N aircraft squadrons with new Rafale B fighter-bombers, and plans to equip these with the ASN4G, a potentially hypersonic air-launched cruise missile, beginning in 2021 (Tertrais, 2020). Finally, France is enhancing nuclear readiness by carrying out rare simulations of nuclear strike missions, including an 11-hour mission in 2019 that tested all phases of a Rafale-led strike (Reuters, 2019).

The **United Kingdom** is also modernising its nuclear forces alongside the United States. As the United Kingdom's nuclear deterrent consists of a sea-based deterrent only, London is focusing its efforts on replacing its older *Vanguard* class SSBNs with the new *Dreadnought* class, slated to enter service by the early 2030s at a cost of GBP 41 billion. Likewise, in February 2020 the United Kingdom also announced it would pursue the development of a new nuclear warhead to replace its current Holbrook design. This latter program, as well as the refurbishment of *Trident II* D5 missiles, is being pursued in close cooperation with the United States (Ministry of Defence, 2020). As part of its Integrated Review of Security, Defence, Development and Foreign Policy, the United Kingdom announced in March 2021 that it would increase its stockpile of nuclear warheads by nearly 40 percent, from 180 to 260 total warheads. The move marks the first time that the United Kingdom will expand its nuclear capabilities since the end of the Cold War, reflecting its recognition of the rapidly changing nuclear deterrence environment.

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