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THE POTENTIALLY REVOLUTIONARY IMPACT OF EMERGING AND DISRUPTIVE TECHNOLOGIES AND STRATEGIC CONVENTIONAL WEAPONS ON THE NUCLEAR DETERRENCE DEBATE

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I. INTRODUCTION

Article 6 of the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) obliges the nuclear weapon states—China, France, Russia, the United Kingdom and the United States, who are the five states officially recognized as possessing nuclear weapons by the NPT—to disarm their nuclear weapons over time. While no deadline has been set, it is abundantly clear that most non-nuclear weapon states expect action from the nuclear weapon states. The longer it takes, the more polarized the two groups of states become, with potentially negative repercussions for the NPT.[1] Advocates of nuclear deterrence argue that it yields security advantages, meaning that even if a world without nuclear weapons is desirable in principle and legally required under the NPT, politically it is not feasible in the current circumstances.

There are, however, three new elements in the debate that may help convince the sceptics of a nuclear weapon-free world. First, new non-nuclear technology and weapons are in the making that are likely to further destabilize the current nuclear order. Second, there is a newcomer to the scene—the Treaty on the Prohibition of Nuclear Weapons (TPNW)—which is the result of the non-nuclear weapon states' frustration at the lack of nuclear disarmament. The TPNW should be regarded

[1] Pretorius, J. and Sauer, T., 'When is it legitimate to withdraw from the NPT? Withdrawal as a political tool to move nuclear disarmament forward', *Contemporary Security Policy*, vol. 43, no. 1 (2022).

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SUMMARY

This paper posits that the combination of emerging and disruptive technologies and strategic conventional weapons may have a revolutionary impact on the future of the debate about nuclear weapons. While emerging and disruptive technologies may yield additional arguments to keep relying on nuclear weapons to defend against them, they are often regarded as destabilizing for the global nuclear order, which makes it more likely that nuclear deterrence will fail and nuclear weapons will be used. At the same time, strategic conventional weapon systems (including hypersonic missiles) have deterrence characteristics comparable to nuclear weapons. Because they could be used in a way that at least seeks to comply with jus in bello principles, by minimizing civilian harm (in comparison with nuclear weapons), they are also more credible as a deterrent. This may in turn increase political willingness to seriously consider delegitimizing nuclear weapons, and eventually replacing them with the alternative option: modern conventional weapons.

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as a signal of this frustration.[2] Its goal is to ban nuclear weapons, and stigmatize them and their possessors, including by invoking international humanitarian law. Nuclear weapons are weapons of mass destruction whose use in all likelihood will be contrary to international humanitarian law (jus in bello). Third, the war in Ukraine has made the debate about nuclear weapons much more concrete.[3] It shows that even established nuclear weapon states and founding fathers of the NPT, such as Russia, are willing to attack (relatively large) non-nuclear weapon states and threaten to use nuclear weapons. While advocates and opponents of nuclear deterrence will tease out different lessons from this war, it is hard to escape the conclusion that it has brought the world closer to nuclear war, and that it is still not over.

This paper focuses on new non-nuclear technology and weapons. It posits that emerging and disruptive technologies (EDTs), such as hypersonic weapons, cyber capabilities and artificial intelligence (AI), as well as strategic conventional weapons (advanced conventional weapon systems designed and deployed to accomplish strategic functions), may have a revolutionary impact on the future of nuclear weapons—in two main ways.[4] First, while EDTs may yield additional arguments to keep relying on nuclear weapons as a deterrent against these new systems, they are also regarded as destabilizing and disruptive for the global nuclear order, which makes it more likely that nuclear deterrence will fail and nuclear weapons may be used. Second, strategic conventional weapons (sometimes in combination with EDTs) arguably have similar or more credible deterrence characteristics than nuclear weapons and may gradually replace them as weapons of deterrence. These non-nuclear weapons could form the bedrock of deterrence policies in a world without nuclear weapons. Although it is not the intention of this paper to sketch out the road towards nuclear elimination, the new insights it provides may help the current proponents of nuclear deterrence to become less sceptical of the idea of eliminating nuclear weapons. As a result, these insights may strengthen the level of acceptability of the idea of a world without nuclear weapons, which in turn may stimulate new research on how to disarm nuclear weapons in a multilateral way.

The paper is structured as follows. First, it outlines the historical and ongoing debate about nuclear weapons, which is centred on the effectiveness of nuclear deterrence, with references to the role of nuclear weapons in the Ukraine war (section II). This is followed by a short description of EDTs, in particular hypersonic weapons, cyber capabilities and AI (section III). It then argues for the growing vulnerability of nuclear weapons due to EDTs (section IV). The paper continues by considering why potential mitigating strategies to combat the destabilizing effect of these new technologies and weapon systems are unsatisfying (section V). It also argues that strategic conventional weapons in combination with some of the emerging technologies and weapon systems could be a viable alternative for nuclear deterrence (section VI). Lastly, the paper highlights the implications of this analysis for the European Union (EU; section VII) and provides an overarching conclusion (section VIII).

II. THE NUCLEAR WEAPONS DEBATE

Nuclear weapons have always been controversial, ever since (and even before) their first use. Already in 1946, US military strategist Bernard Brodie wrote that as a result of the creation of nuclear weapons, the purpose of the US military establishment could no longer be to fight and win wars, rather it was to prevent them from being fought.[5] That idea gained ground when the Soviet Union obtained nuclear weapons four years later, and even more once it acquired intercontinental ballistic missiles at the end of the 1950s. Both superpowers—the USA and the Soviet Union—found themselves in a situation of mutual assured destruction (MAD). If either power started a nuclear or large-scale conventional war with the other, it could escalate to a global nuclear war. Advocates of nuclear deterrence therefore believe that it has prevented the start of large-scale wars against nuclear-armed states.[6] The fact that nuclear weapons have not been used on the battlefield since 1945 is regarded as evidence that nuclear deterrence 'works'.[7]

[2] Meyer, P. and Sauer, T., 'The Nuclear Ban Treaty: A sign of global impatience', *Survival*, vol. 60, no. 2 (2018).

[3] Sauer, T., 'How useful are nuclear weapons in practice? Case-study: The war in Ukraine', *Journal for Peace and Nuclear Disarmament*, vol. 7, no. 1 (2024).

[4] Hoffmann, F., 'Strategic non-nuclear weapons and strategic stability—Promoting trust through technical understanding', FRS paper, Nov. 2021, p. 2.

[5] Brodie, B., *The Absolute Weapon* (Harcourt Brace: New York, 1946).

[6] Waltz, K., 'The spread of nuclear weapons: More may be better', *Adelphi Papers*, vol. 21, no. 171 (1981); Freedman, L., *The Evolution of Nuclear Strategy* (IISS: London, 1981); and Jervis, R., *The Meaning of the Nuclear Revolution* (Cornell University Press: Ithaca, 1989).

[7] Gaddis, J. L., *The Long Peace* (Oxford University Press: Oxford, 1989).

According to the nuclear revolution theory, nuclear weapons yield strategic stability, security and peace; and if nuclear deterrence works, there is no reason to eliminate nuclear weapons.[8]

Critics of nuclear deterrence question the underlying theoretical assumptions of this reasoning.[9] What about leaders who behave irrationally? Further, nuclear deterrence theory makes a distinction between vital and more trivial national interests. Only the former is supposed to be protected by the nuclear deterrent. The problem is that it is not always clear—certainly not to outsiders—what the vital interests of a country in practice are, and that as a result risks are taken by the enemy that may trigger nuclear escalation.[10] Lastly, how credible is nuclear deterrence? Even if the vital interests are clear and even with rational leaders, the credibility of nuclear deterrence essentially remains in the eye of the beholder. Many observers in the nine nuclear-armed states—in chronological order, the USA, Russia, the UK, France, China, Israel, India, Pakistan and North Korea—believe that nuclear deterrence is a credible instrument to guarantee security and peace, because nuclear weapons are so destructive and therefore so difficult to use, and because of possible retaliation.[11] Others, however, are convinced that nuclear weapons are too destructive to be used, and therefore in all likelihood will not be used, and as a result are not a credible deterrent.[12]

Apart from this more theoretical debate about the conditions that are needed for a credible nuclear deterrent, the question of nuclear deterrence in practice remains. Critics do not deny that since 1945 no major war has broken out between nuclear-armed states, but they point to crises such as the Cuban missile crisis, when the world simply 'lucked out', as former US Secretary of Defense Robert McNamara used to say.[13] In addition, there have been attacks by nuclear-armed states on non-nuclear-armed states, for instance Russia against Ukraine, and the USA against Iraq, Afghanistan and Libya. Do these examples show that non-nuclear weapon states need nuclear weapons too (as some nuclear weapon advocates would argue)? Do they show that nuclear-armed states feel protected and emboldened by their nuclear deterrent to attack non-nuclear-armed states? If so, nuclear weapons seem to make the world more unstable, in contrast to what the nuclear revolution theory implies.[14]

Nuclear-armed states have also clashed with each other: there were border skirmishes between China and the Soviet Union in 1969, there have been several between India and Pakistan, and also between India and China. It is difficult to square these examples with the so-called stabilizing characteristics of nuclear weapons. In 1999, one year after India and Pakistan tested nuclear weapons, Pakistani military forces occupied parts of Indian Kashmir.[15] The war that erupted caused 1000 deadly casualties. Advocates of nuclear deterrence have responded that the odds are that nuclear weapons have prevented an even bigger (nuclear) war.[16] That said, in February 2019 Pakistan attacked India again, resulting in a dogfight with tactical aircraft that set a precedent between two nuclear-armed states.[17] These are examples of Snyder's stability/instability paradox: stability in the sense that nuclear weapons prevent large-scale wars or minor wars escalating to large-scale wars; instability in the sense that nuclear weapons may not prevent minor wars.[18] However, it is sufficient that the nuclear threshold is crossed just once in order for nuclear escalation to result in global Armageddon. That risk is simply too overwhelming, according to the opponents of nuclear deterrence.

Nuclear-armed states have even been attacked by non-nuclear-armed states. The 1973 Arab–Israeli War is arguably an example of this, as well as the Falklands

[8] For the nuclear revolution theory, see Arceneaux, D., 'Whether to worry: Nuclear weapons in the Russia–Ukraine war', *Contemporary Security Policy*, vol. 44, no. 4 (2023). For the idea to keep nuclear weapons, see Kroenig, M., *The Logic of American Nuclear Strategy* (Oxford University Press: Oxford, 2018).

[9] Schell, J., *The Fate of the Earth* (Knopf: New York, 1982); and Wilson, W., 'The myth of nuclear deterrence', *Nonproliferation Review*, vol. 15, no. 3 (2008).

[10] Weldes, J., *Constructing National Interests* (University of Minnesota Press: Minneapolis, 1999).

[11] It is generally acknowledged that a credible nuclear deterrent requires a second-strike capability. Invulnerable delivery vehicles would be ideal for a second-strike capability. Mobile delivery vehicles (e.g. stealthy submarines with sea-launched ballistic missiles, or mobile land-based missiles) may help in this regard.

[12] Wilson (note 9).

[13] Pélopidas, B., 'The unbearable lightness of luck: Three sources of overconfidence in the manageability of nuclear crises', *European Journal of International Security*, vol. 2, no. 2 (July 2017).

[14] Bell, M., *Nuclear Reactions* (Cambridge University Press: Cambridge, 2021).

[15] Qadir, S., 'An analysis of the Kargil conflict 1999', *RUSI Journal*, vol. 147, no. 2 (2002).

[16] Hagerty, D., *Nuclear Weapons and Deterrence Stability in South Asia* (Palgrave: London, 2020).

[17] Hersman, R., 'Wormhole escalation in the new nuclear age', *Texas National Security Review*, vol. 3, no. 3 (Autumn 2020).

[18] Snyder, G., 'The balance of power and the balance of terror', ed. P. Seabury, *The Balance of Power* (Chandler: Scranton, 1965).

war. The Falkland Islands apparently belonged to British vital interests as the UK fought back (with conventional means) after the invasion by Argentina, something the junta in Argentina had not expected and therefore had miscalculated. Recent examples include the Ukrainian (counter)attack in the Russian Kursk region and air attacks by Iran against Israel, which were unexpected. Proponents of nuclear deterrence seem to believe that such wars in such circumstances will, in all likelihood, not escalate to the nuclear level. Yet opponents point out that the latter is indeed a belief, and that a rational defence policy should not be based on optimism and luck.[19]

The main conclusion that can be drawn from this ongoing debate is that nobody knows whether and to what extent nuclear deterrence has worked. If a war does not happen, it is nearly impossible to pinpoint the causality. The reason why archrivals France and Germany did not fight another large-scale war after 1945 probably has much more to do with European integration than with the existence of French nuclear weapons. The reason why there has not been a World War III (yet) arguably has more to do with memories of the previous world wars, increased global welfare and the creation of a network of international organizations and international regimes than with nuclear weapons.[20] Nuclear deterrence may have made a difference, but that difference may be less than the advocates believe and it may be more than the opponents believe. As observers of international politics, we simply do not know, and we should admit that for the sake of intellectual honesty. It is much too simplistic to state that 'nuclear deterrence works' or 'nuclear deterrence does not work'; that 'nuclear weapons have (not) kept the peace'; or, as British academic and historian Lawrence Freedman claims, that 'the nuclear emperor has no clothes, but is still the emperor'.[21] Regardless, in contrast to the ambiguous advantages, there is always the risk of authorized or unauthorized use, use after a false alarm, and accidental or incidental use of nuclear weapons.

To conclude, while the advantages of nuclear weapons are unclear, the costs are very well known, and are more easily imaginable due to the ongoing war in Ukraine. Ideally, the number of nuclear weapons would gradually be reduced and finally reach zero, which is also a legally binding obligation under the NPT (and the TPNW). That said, the possessors of nuclear weapons do not seem convinced of the urgency or the feasibility of fulfilling this obligation. What is regularly raised in this debate, however, is the need to have an alternative to nuclear weapons. This paper argues that the arrival of strategic conventional weapons, including hypersonic missiles (see EDTs below), may provide that alternative.

III. EMERGING AND DISRUPTIVE TECHNOLOGIES (EDTS)

The development, production and use of EDTs—some of which have already been used in wars, including in Ukraine—is a trend that may have more impact on the future of nuclear weapons than previous debates. Because of their relevance to the topic discussed, this paper limits the list of EDTs to hypersonic weapons, cyber capabilities and AI, and this section provides an overview of each area.[22]

Hypersonic weapons

Hypersonic weapons are weapons that fly more than 6000 kilometres per hour or at a minimum of Mach 5, which is five times the speed of sound; in contrast to most ballistic missiles, their warheads can be manoeuvred in flight and guided towards their target.[23] Hypersonic weapons, as opposed to long-range ballistic missiles, do not stay long in the atmosphere. They come in two formats: glide vehicles on top of boosters (usually ballistic missiles); or cruise missiles. The main characteristic of hypersonic weapons is the combination of speed, accuracy (thanks to precision guidance and remote sensing) and manoeuvrability, which makes them (at least in theory) harder to neutralize by missile defence.[24] 'As with great power rivalry, the

[19] Pélopidas (note 13).

[20] Mueller, J., 'The essential irrelevance of nuclear weapons', *International Security*, vol. 13, no. 2 (Autumn 1988).

[21] Freedman (note 6).

[22] Other EDTs that may fall under the same heading are drones, autonomous weapon systems, space systems, and missile defence.

[23] In contrast to what sometimes is believed, hypersonic missiles do not fly faster than intercontinental ballistic missiles. Hypersonic cruise missiles are much faster than existing cruise missiles, but fly higher and are therefore more easily detectable by radars.

[24] Lowther, A. and McGiffin, C., 'America needs a "dead hand"', War on the Rocks, 16 Aug. 2019; and Zutt, M. and Onderco, M., 'How emerging technologies impact the future of nuclear risk and arms control', ELN Commentary, 1 Sep. 2020. For a more critical view on hypersonic missiles, see Oelrich, I., 'Cool your jets: Some perspectives on the hyping of hypersonic weapons', *Bulletin of the Atomic Scientists*, vol. 76, no. 1 (2020); Futter, A., 'Explaining the nuclear challenges posted by emerging and disruptive technology: A primer for

primary advantage of hypersonic weapons in non-great power conflicts appears to be their ability to execute quick, precise strikes with little to no warning', according to one expert.[25] Depending on the missile system, they can be armed with conventional or nuclear warheads. Conventionally armed hypersonic missiles belong to the category of strategic conventional weapons, according to the definition in this paper (see below).

Australia, China, France, Germany, India, Japan, North Korea, South Korea, Russia, the UK and the USA are developing, and some of them also deploying, hypersonic weapons.[26] Russia, for instance, has deployed the Avangard hypersonic system, which in the future is supposed to be launched by the Sarmat intercontinental ballistic missile (ICBM). In addition, it has deployed and already used the Kinzhal air-launched (dual-capable) hypersonic ballistic missile in the war in Ukraine.[27] Russia has also built the Zircon (dual-capable) hypersonic sea-launched cruise missile. China, as another example, has deployed the DF-17 and the DF-41, which are ballistic missiles able to launch hypersonic weapons, including the DF-ZF hypersonic glide vehicle. Moreover, the USA is developing short- and intermediate-range hypersonic systems.[28]

Cyber capabilities

Hand in hand with the introduction of the world wide web, experts warned already in the 1990s against the potential destabilizing role of cyberattacks, by both state and non-state actors.

At first sight, a major difference between conventional (or nuclear) kinetic attacks and cyber attacks is the difficulty of finding out who carried out a cyber-attack. Given sufficient budgetary and technological means (such as in China, Russia and the USA), however, attribution is possible.[29] That said, even if the source of a cyberattack is identified, attributing it to a specific entity (i.e. a state or non-state actor) and then determining whether they acted on their own or on another's behalf is not easy.

Russia's cyberattack against Estonia in 2007 was one of the first major cyberattacks.[30] Other noteworthy examples include those against Nokia in 2014, NotPetya in 2017, SolarWinds in 2020 and Colonial Pipeline in 2021. The best known example in the nuclear domain is the Stuxnet attack, whereby Israel and the USA sabotaged the Iranian enrichment programme during the period 2009–10, causing temporary delays to Iran's nuclear programme.[31]

Up to now, there have not been any direct deaths caused by cyberattacks.[32] Some observers therefore conclude that the impact of cyberwarfare should not be blown out of proportion.[33] They argue that it is 'often too slow, too weak, and too volatile to achieve strategic goals'.[34] Others are more concerned.[35] A cyberattack that could bring down an electricity network for a couple of days, for example, may have far-reaching consequences in modern societies. As a result, cyberspace is regarded as a new domain of warfare (besides land, air, sea and space) and, depending on their capabilities, states are not limiting themselves to

European policymakers and professionals', EU Non-Proliferation and Disarmament Consortium, Non-Proliferation and Disarmament Paper no. 73, Mar. 2021; and Lissner, R., 'The future of strategic arms control', Council on Foreign Relations Discussion Paper Series on Managing Global Disorder no. 4, Apr. 2021.

[25] Lee, C. A., 'Technology acquisition and arms control: Thinking through the hypersonic weapons debate', *Texas National Security Review*, vol. 5, no. 4 (Fall 2022), p. 34.

[26] Sayler, K. M., *Hypersonic Weapons: Background and Issues for Congress*, Congressional Research Service (CRS) Report for Congress R45811 (US Congress, CRS: Washington, DC, 14 Aug. 2024); Grevatt, J. and Udoshi, R., 'South Korea develops hycore hypersonic cruise missile', *Janes*, 25 Jan. 2022; and Sharp, A., 'North Korea tests hypersonic missile, threatening US', *Foreign Policy*, 20 Mar. 2024.

[27] Kirby, P.,'Russia claims first use of hypersonic Kinzhal missile in Ukraine', BBC News, 19 Mar. 2022. Others state that the Kinzhal is a ballistic missile that is highly manoeuvrable, which should not be categorized as a hypersonic missile. See Missile Threat, Center for Strategic and International Studies (CSIS) Missile Defense Project, 'Kh-47M2 Kinzhal', accessed 15 Oct. 2024.

[28] Oelrich (note 24), p. 37.

[29] Rid, T. and Buchanan, B., 'Attributing cyber attacks', *Journal of Strategic Studies*, vol. 38, no. 1–2 (2015); and Blagden, D., 'Deterring cyber coercion: The exaggerated problem of attribution', *Survival*, vol. 62, no. 1 (2020).

[30] For a good overview of major cyberattacks, see Jaikaran, C., *Cybersecurity: Selected Cyberattacks, 2012–2022*, Congressional Research Service (CRS) Report for Congress R46974 (US Congress, CRS: Washington, DC, 9 Aug. 2023).

[31] Futter, A., *Cyber Threats and Nuclear Weapons: New Questions for Command and Control, Security and Strategy*, RUSI Occasional Paper (RUSI: London, 2016), pp. 25–26. Whether Stuxnet was legitimate is beyond the scope of this paper.

[32] Futter (note 31), p. 32.

[33] Rid, T., 'Cyber war will not take place', *Journal of Strategic Studies*, vol. 35, no. 1 (2011).

[34] Maschmeyer, L., 'Why cyber war is subversive, and how that limits its strategic value', War on the Rocks, 17 Nov. 2021.

[35] Futter (note 31); and Cattler, D. and Black, D., 'The myth of the missing cyberattacks: Russia's hacking succeeded in Ukraine—and poses a threat elsewhere, too', *Foreign Affairs*, 6 Apr. 2022.

defensive operations. The use of AI can make offensive cyberattacks even more effective.[36]

Artificial Intelligence (AI)

AI is not a weapon per se but technology that uses big data and algorithms, which in turn can be used to make weapon systems more efficient.[37] These deep learning models improve themselves on a daily basis, and AI will in all likelihood become available to an increasing number of state and non-state actors in the future. In the war in Ukraine, for instance, AI is being used to identify the deceased, analyse radio signals and satellite imagery, create deepfake news, and target artillery more efficiently.[38] Another example of AI is swarm robotics, which could be used to map mobile military vehicles with much less risk to human safety.[39] AI can also be used for early warning (e.g. Project Maven that is used for US counterinsurgency and counterterrorism operations); air defence; and the guidance and manoeuvrability of hypersonic and other kinds of missiles and weapons, so they reach their targets more easily.[40]

IV. THE GROWING VULNERABILITY OF NUCLEAR WEAPONS AS A RESULT OF EDTS

Central to this paper is the question of how the above-mentioned EDTs will impact nuclear deterrence and, at least according to the proponents of nuclear deterrence, stability. Crisis stability (including first-strike stability) means that nuclear forces and doctrines are geared in such a way that the chances of nuclear weapons being used in a crisis are minimized and they are not likely to be used out of fear that the other side will strike first, destroying one's own second-strike capability.

In principle, the impact of each new weapon system on crisis stability could be assessed separately. However, it is arguably more useful to evaluate the combined impact of these weapon technologies, as the most effective way to use them is together (e.g. AI that facilitates cyber and kinetic attacks). It should also be noted that not all of these EDTs necessarily have a negative impact on nuclear deterrence and, therefore, nuclear stability. Big data and AI can play a positive role with respect to stability in the sense that political decision makers may have better early-warning data and more time for decision making during a crisis.[41]

That said, there are numerous ways in which EDTs can have a negative effect on crisis stability, by neutralizing or at least minimizing the so-called stabilizing effect of nuclear weapons.[42] Back in 2017, observers warned that 'changes in technology . . . are eroding the foundation of nuclear deterrence'.[43] Today, the main danger is that EDTs make nuclear weapons more vulnerable, as they can make it easier and more credible to attack an enemy's nuclear forces and key nuclear infrastructure (e.g. command-and-control and early-warning systems).[44] Indeed, experts note that:

> States investing in strategic non-nuclear weaponry today could potentially give themselves the option to consider preemptive strikes that knock out an adversary's nuclear capabilities, thereby completely altering the military dynamics of a conflict in the future.[45]

[36] Favaro, M., *Weapons of Mass Distortion*, 2021 edition (King's College London: London, May 2021), p. 15.

[37] Johnson, J., 'Artificial intelligence in nuclear warfare: A perfect storm of instability?', *Washington Quarterly*, vol. 43, no. 2 (2020), p. 198.

[38] Kahn, L., 'Mending the "broken arrow": Confidence building measures at the AI–nuclear nexus', War on the Rocks, 4 Nov. 2022.

[39] Favaro (note 36), p. 16; and Johnson, J., 'Deterrence in the age of artificial intelligence and autonomy', *Defense and Security Analysis*, vol. 36, no. 4 (2020), p. 432.

[40] Johnson, J., '"Catalytic nuclear war" in the age of artificial intelligence and autonomy', *Journal of Strategic Studies*, 13 Jan. 2021.

[41] Legvold, R. and Chyba, C., 'Introduction: The search for strategic stability in a new nuclear era', *Daedalus*, vol. 149, no. 2 (Spring 2020), p. 8; Favaro (note 36), p. 21; Cox, J. and Williams, H., 'The unavoidable technology: How artificial intelligence can strengthen nuclear stability', *Washington Quarterly*, vol. 44, no. 1 (2021), pp. 73–77; and Durkalec, J., Peczeli, A. and Radzinsky, B., 'Nuclear decision-making, complexity, and emerging and disruptive technologies', ELN Report, Feb. 2022.

[42] Acton, J., 'Escalation through entanglement: How the vulnerability of command-and-control systems raises the risk of an inadvertent nuclear war', *International Security*, vol. 43, no. 1 (2018); Karaganov, S. and Suslov, D., 'The new understanding and ways to strengthen multilateral strategic stability', Moscow Higher School of Economics Report, 2019, p. 12; Altmann, J., 'Technology, arms control and world order', Toda Peace Institute Policy Brief no. 89, Sep. 2020; Chyba, C., 'New technologies and strategic stability', *Daedalus*, vol. 149, no. 2 (Spring 2020); Johnson (note 37); Johnson, J., 'Inadvertent escalation in the age of intelligence machines', *European Journal of International Security*, vol. 7, no. 3 (2022); Johnson (note 39); Johnson (note 40); Favaro (note 36); Erastö, T., *New Technology and Nuclear Disarmament* (SIPRI: Stockholm, May 2021), p. 11; Futter (note 24); Futter, A. and Zala, B., 'Strategic non-nuclear weapons and the onset of a third nuclear age', *European Journal of International Security*, vol. 6, no. 3 (2021); Lissner (note 24); and Hoffman, F. and Alberque, W., 'Non-nuclear weapons with strategic effect: New tools of warfare?', IISS Roundtable Report, Mar. 2022.

[43] Lieber, K. and Press, D., 'The new era of counterforce: Technological change and the future of nuclear deterrence', *International Security*, vol. 41, no. 4 (Spring 2017), p. 9.

[44] Alternatively, early-warning systems can also be regarded as being part of command-and-control systems.

[45] Futter and Zala (note 42), p. 268.

The result—crucially—is that the enemy will be aware of this vulnerability and may be under pressure to use their (sometimes small number of) nuclear weapons in a preemptive, destabilizing 'use them or lose them' way.[46]

EDTs are particularly useful for attacking three types of strategic targets related to nuclear weapons: (*a*) early-warning systems; (*b*) the nuclear forces themselves; and (*c*) command-and-control systems. First, early-warning systems in the form of radars and (sometimes) satellites are crucial for nuclear-armed states. That applies to large nuclear-armed states like the USA and Russia, and also to a certain extent France and the UK, and more and more China, which rely on a deterrence by denial (maximum deterrence) posture. Such a posture aims to deny the enemy a possible victory (also in nuclear war) and goes beyond being able to 'punish' the enemy (with nuclear weapons). A deterrence by denial posture therefore ideally requires an extensive nuclear force structure (including tactical nuclear weapons), a declaratory policy that keeps all options open (including first use) and a sophisticated operational policy (including nuclear weapons on alert, ready to be fired at short notice). As one observer notes: 'There is currently no defense against hypersonic missiles, which makes deterrence by denial much more difficult'.[47] However, it also applies to small nuclear-armed states (like North Korea) that may be concerned about possibly losing all their nuclear forces in a preemptive first strike.[48] Depending on the state, early-warning systems could potentially be neutralized by EDTs, either in a non-kinetic way through jamming (generating noise to interfere with satellite signals) and spoofing (broadcasting a false signal) via electromagnetic interference (by radio waves), cyberattacks (targeting data) or accurate modern conventional missiles against radars.[49]

Second, both cyber and hypersonic weapons can be used to attack and neutralize the nuclear forces of the enemy. The latter action—to neutralize—is the main declared goal of deterrence by denial postures. ICBMs, in particular, are cyber-sensitive, but even submarines (regarded as almost invulnerable nowadays) may be vulnerable to hacking.[50] Moreover, as a result of big data and AI, the exact location of mobile ICBMs or submarines may become available in the future, which would be nothing less than revolutionary.[51] Submarines are regarded as having substantially contributed to strategic stability and are generally seen as the most secure component of a second-strike capability. 'Invulnerable' submarines, however, may become vulnerable due to sensors on underwater drones or swarm robotics that operate in an autonomous way.[52] This could be destabilizing, as it may put more pressure on nuclear-armed states to use their vulnerable nuclear weapons sooner rather than later.

Third, cyberattacks and/or kinetic attacks can be used to disrupt the nuclear command-and-control systems of the enemy.[53] In the literature, a distinction is made between disabling and enabling cyberattacks. Disabling attacks include both sabotage of command-and-control systems, weapons or early-warning systems and stealing information, while enabling attacks go further and include exploding the command-and-control systems, launching the forces of the enemy, sending launch orders to the enemy's forces, and spoofing early-warning systems into believing

[46] For a critical view on pre-emptive wars, see Reiter, D., 'Exploding the powder keg myth: Preemptive wars almost never happen', *International Security*, vol. 20, no. 2 (Fall 1995).

[47] Lee (note 25), p. 37.

[48] Many scholars of nuclear deterrence have recommended that the Soviet Union/Russia and the USA develop a nuclear force structure declaratory and operational policy under the heading of maximum deterrence/deterrence by denial posture. For an elaboration of the concepts of deterrence by punishment and deterrence by denial, see Snyder, G., *Deterrence and Defense* (Princeton University Press: Princeton, 1961). For an elaboration of the parallel concepts minimum and maximum deterrence, see Sauer, T., *Nuclear Inertia: US Nuclear Weapons Policy after the Cold War* (I.B.Tauris: London, 2005), especially chap. 1; and Sauer, T., 'A second nuclear revolution: From nuclear primacy to post-existential deterrence', *Journal of Strategic Studies*, vol. 32, no. 5 (2009). For a different view on Russia, see Sokov, N., 'Russia clarifies its nuclear deterrence policy', Vienna Center for Disarmament and Non-Proliferation, 2 June 2020.

[49] Acton (note 42), pp. 82–92; and Favaro (note 36), p. 13.

[50] Johnson (note 40), p. 7. Others—like Jürgen Altmann—are less convinced about the possibility of denial of service attacks; Altman, J., Communication with author, 29 June 2023.

[51] Holmes, J., 'Sea changes: The future of nuclear deterrence', *Bulletin of the Atomic Scientists*, vol. 72, no. 4 (July 2016), pp. 228–33; and Baker, L., 'Interview: Rose Gottemoeller on the precarious future of arms control', *Bulletin of the Atomic Scientists*, 29 July 2024. For a more sceptical view, see Snyder, R. and Pélopidas, B., 'Correspondence: New era or new error? Technology and the future of deterrence', *International Security*, vol. 43, no. 3 (Winter 2018/2019); Coté, O., 'Invisible nuclear armed submarines or transparent oceans?', *Bulletin of the Atomic Scientists*, vol. 75, no.1 (2019); and Fetter, S., Communication with author, 10 Dec. 2023. The author also wishes to thank one of the reviewers, who made the point that even if the location is known, one still needs the means to successfully take the submarines out.

[52] Lieber and Press (note 43), pp. 32–46; and O'Doherty, J., 'Is America buying nuclear weapons to win a war or to prevent one?', *Bulletin of the Atomic Scientists*, 20 Aug. 2024.

[53] Acton (note 42); and Wan, W., Kastelic, A. and Krabill, E., *The Cyber–Nuclear Nexus: Interactions and Risks*, Friction Points Series no. 2 (UNIDIR: Geneva, 9 Nov. 2021).

that an attack is underway, thus provoking a false alarm or even nuclear attack.[54] In fact, there is the risk that: 'While nuclear systems—and especially C2—will of course be among the best protected against cyber threats and almost certainly air-gapped from the wider internet, they are by no means invulnerable'.[55]

Thus, some observers conclude that 'proliferation and modernization of nuclear weapons may raise the risk [of nuclear crisis via cyber] slightly', arguing that 'Cyberwar is not war per se, but in rare circumstances it may make escalation to thermonuclear war more likely'.[56] Nuclear-armed states are, of course, aware of the vulnerabilities caused by these EDTs. The main danger is that they will be under immense pressure to safeguard their own nuclear forces and systems in crisis, and as a result use them, possibly even in a preemptive way.[57] In the ongoing war in Ukraine, for example, this would apply to a possible cyberthreat by the USA against Russia, which 'could in practice make [nuclear] use [by Russia] more likely'.[58]

There are numerous clear and direct ways in which EDTs can have a negative impact on crisis stability. As the old nuclear world order disappears, it seems that the new one may be (even) more unstable. In fact, due to the ongoing deployment of EDTs, the use of nuclear weapons may be more likely in future crises.

V. HOW TO MITIGATE THE DESTABILIZING EFFECT OF EDTS ON NUCLEAR DETERRENCE?

The nuclear-armed states, even Russia and the USA, are struggling to adapt their nuclear policies to technological changes. As a result, they have not been able to fully take into account the impact of the existence of EDTs on their nuclear postures.[59]

Four different mitigating strategies could, at least theoretically, be imagined: (*a*) banning EDTs (multilaterally) while maintaining the existing nuclear deterrence by denial posture (i.e. maximum deterrence); (*b*) limiting these weapon systems while keeping a deterrence by denial posture; (*c*) living with (limited or unlimited) EDTs, but switching to a nuclear deterrence by punishment posture (i.e. minimum deterrence); and (*d*) banning nuclear weapons (multilaterally) while maintaining EDTs and strategic conventional weapons.[60] This paper argues that the first three strategies do not substantially mitigate the problem of the destabilizing effect of EDTs on strategic stability.

First, in principle one could ban EDTs (or some of them). In practice, however, that is extremely unlikely to happen. Due to the overall civilian benefits of AI, for example, a ban on it is more or less unthinkable. China, Russia and the USA are also all carrying out cyberattacks, and no progress has been made to ban such attacks.[61] While not impossible, it is highly unlikely that these EDTs will be banned in the short or medium term.

Second, a less radical solution consists of trying to limit the destabilizing effect of EDTs, while maintaining the existing nuclear deterrence by denial postures.[62] That is partly what is happening today. Track-1 (e.g. United Nations Groups of Governmental Experts and UN Open-Ended Working Groups) and track-2 multilateral diplomacy try to create norms with respect to the use of cyber and AI. One problem is that the lack of trust and confidence between states will complicate the implementation of anything that is agreed, especially in times of geopolitical tensions. Another problem is that technology is always evolving. Furthermore, 'countries do not need significant numbers of hypersonic missiles in order to use them effectively and still undermine strategic stability, making numerical limits on missiles and warheads less useful than other measures', as one expert observes.[63] In short, the destabilizing effect of EDTs on nuclear deterrence will likely prevail. Another problem is that the conventional–nuclear entanglement risk will not be resolved. This refers to the risk that a missile attack with a conventional warhead, for instance against the nuclear command-and-control system or

[54] Futter (note 31), p. 14.

[55] Futter (note 31), p. 13.

[56] Gartzke, E. and Lindsay, J., 'Thermonuclear cyberwar', *Journal of Cybersecurity*, vol. 3, no. 1 (Mar. 2017).

[57] Johnson (note 39), p. 429.

[58] Lonergan, E. and Yarhi-Milo, K., 'Cyber signaling and nuclear deterrence: Implications for the Ukraine crisis', War on the Rocks, 21 Apr. 2022.

[59] Favaro (note 36), p. 3. This was confirmed by a high-level Ministry of Foreign Affairs official in one of the nuclear armed states to the author in Nov. 2021.

[60] In theory, there is one more option: banning nuclear weapons *and* banning conventional prompt global strike and emerging and disruptive technologies and weapon systems.

[61] Cattler and Black (note 35).

[62] Klare, M., 'A strategy for reducing the escalatory dangers of emerging technology', *Arms Control Today*, Dec. 2020; and Williams, H., 'Asymmetric arms control and strategic stability: Scenarios for limiting hypersonic glide vehicles', *Journal of Strategic Studies*, vol. 42, no. 6 (2019).

[63] Lee (note 25), p. 42.

early-warning systems of an enemy, is perceived as a prelude to a nuclear attack, or that a conventional attack is misinterpreted as a nuclear attack, leading to inadvertent escalation.[64] Lastly, the overarching risks related to nuclear weapons will remain.

A third solution consists of living with EDTs and moving from a nuclear deterrence by denial to a nuclear deterrence by punishment posture. EDTs are currently destabilizing for countries with a deterrence by denial posture (e.g. France, Russia, the UK and the USA, and increasingly China), because they may be able to neutralize (part of) the nuclear forces and nuclear infrastructure that are needed for a posture geared towards launching nuclear weapons at short notice, as deterrence by denial postures prescribe. The easiest way to become less dependent on nuclear forces on high alert and the potential destabilizing effect of EDTs would be to move to lower alert levels, and towards a deterrence by punishment posture.[65] In this regard, it should be noted that regardless of the impact of EDTs, many observers have always preferred a deterrence by punishment instead of a deterrence by denial posture.[66] At the end of the cold war, US President Ronald Reagan and Soviet General Secretary Mikhail Gorbachev agreed that 'a nuclear war cannot be won and must never be fought'.[67] A similar statement was repeated for the first time by all five permanent members of the UN Security Council (China, France, Russia, the UK and the USA; the P5) at the beginning of 2022.[68] Such statements arguably take away the motive of possessing a deterrence by denial posture.[69] That said, the USA and Russia have not moved to a deterrence by punishment posture (yet), and there are indications that China is moving away from such a posture.[70]

In addition, even if one believes that deterrence by punishment is less risky and less dangerous than deterrence by denial and could be perceived as being as (or even more) credible than deterrence by denial, it still does not resolve the potential vulnerability problem of mobile systems (e.g. mobile ICBMs and submarines) as a result of EDTs. On the contrary, one could argue that these mobile systems become even more important as a second-strike option in a deterrence by punishment posture because there are fewer assets under such a posture and because these mobile systems are the least vulnerable. As EDTs may potentially be able to neutralize invulnerable submarines, the resistance to move to a deterrence by punishment posture will in all likelihood only grow. Finally, as long as there are dual-capable missiles (meant for both nuclear and conventional warheads), the conventional–nuclear entanglement problem remains. While some of the nuclear risks will be mitigated by a minimum deterrence posture, the danger of a relatively large-scale nuclear war remains.

In short, these three potential solutions do not substantially mitigate the problem of the destabilizing effect of EDTs on strategic stability. The fourth and last option is considered below.

VI. A MORE CREDIBLE CONVENTIONAL DETERRENT THAN NUCLEAR BRINKMANSHIP

The fourth strategy to mitigate the destabilizing effect of EDTs on nuclear deterrence is to eliminate nuclear weapons, as required by the NPT, while allowing some or all of the emerging and disruptive

[64] Posen, B., *Inadvertent Escalation* (Cornell University Press: Ithaca, 1991); Acton (note 42); Acton, J., 'Cyber warfare and inadvertent escalation', *Daedalus*, vol. 149, no. 2 (2020); Karaganov and Suslov (note 42); Johnson (note 42); and Mishra, S., Kubiak, K. and Stacey, G., 'New technologies, complexity, nuclear decision making and arms control', ELN Workshop Summary Report, 22–23 Mar. 2021. Others do not regard entanglement as a major problem; see Peters, R., Anderson, J. and Menke, H., 'Deterrence in the 21st century: Integrating nuclear and conventional force', *Strategic Studies Quarterly,* Winter 2018, pp. 15–43; Kroenig, M. and Massa, M., 'Are dual-capable weapon systems destabilizing?', Atlantic Council Issue Brief, June 2021; and Harvey, J. and Soofer, R., 'Nuclear priorities for the Biden administration', Atlantic Council Issue Brief, 15 Dec. 2021, p. 7. For nuclear entanglement in the USA–China case, see Talmadge, C., 'Would China go nuclear? Assessing the risk of Chinese nuclear escalation in a conventional war with the United States?', *International Security*, vol. 41, no. 4 (2017); Acton (note 42), pp. 59, 71; Chyba (note 42), p. 159; and Stålhane Hiim, H., Fravel, T. and Langset Troan, M., 'The dynamics of an entangled security dilemma', *International Security*, vol. 47, no. 4 (Spring 2023).

[65] Johnson (note 39), p. 439; and Gallagher, N., 'Re-thinking the unthinkable: Arms control in the twenty-first century', *Nonproliferation Review*, vol. 22, no. 3–4 (2015).

[66] Jervis, R., *The Illogic of American Nuclear Strategy* (Cornell University Press: Ithaca, 1985); Sauer, 'A second nuclear revolution' (note 48); Erastö, T., 'Revisiting "minimal nuclear deterrence": Laying the ground for multilateral nuclear disarmament', SIPRI Insights on Peace and Security no. 2022/6, June 2022; and Glaser, C., Acton, J. and Fetter, S., 'The US nuclear arsenal can deter both China and Russia', *Foreign Affairs*, 5 Oct. 2023.

[67] Ronald Reagan Presidential Library and Museum, 'Joint Soviet–United States Statement on the Summit Meeting in Geneva', 21 Nov. 1985.

[68] White House, 'Joint Statement of the Leaders of the Five Nuclear-Weapon States on Preventing Nuclear War and Avoiding Arms Races', 3 Jan. 2022.

[69] Erastö (note 42), Summary.

[70] Suh, E. and Reichender, L., 'China's nuclear arms race', DGAP Policy Brief no. 5, Mar. 2022.

technology. Based on the analysis above, it is the option supported by this paper. As argued by US physicist Stephen Lukasik, there are 'a number of technologies that can be combined to protect a nation's security that were not on the horizon when the decision to develop nuclear weapons was made'.[71] Indeed, some EDTs could be responsible for both sounding the death knell for nuclear weapons and easing the passage to a world without nuclear weapons—a world in which one could rely on strategic conventional weapons as the only deterrent, in the form of ballistic, cruise and/or hypersonic missiles, as well as drones and aircraft.[72]

From V-2s to prompt global strike systems

Ballistic missiles were used for the first time in World War II, with V-2s in particular used by Germany. The first versions of cruise missiles (V-1s), which are slower than ballistic missiles, also date back to the 1940s. The first ICBMs, which were produced by the Soviet Union, date from 1957. Less well known is that the first hypersonic missiles were designed by Germany in the 1930s. Only ballistic missiles were produced in large quantities during the first two decades of the cold war.

Due to improvements in technology in the 1970s, especially with respect to accuracy (linked to satellites and GPS), a new generation of much more accurate missiles were developed and deployed in the 1980s, including cruise missiles. The USA used these weapon systems, particularly GPS-steered (Tomahawk) cruise missiles and precision-guided munitions, in the 1990–91 Gulf War. Afterwards, the US Defense Department estimated that only 50 out of 850 targets (i.e. 6 per cent) were misidentified.[73] These weapons were part of a whole new category of weapons and technology that resulted from the so-called Revolution in Military Affairs (RMA).

Not only did the accuracy increase, so too did the destructive capacity of conventional weapons. A US Air Force analyst at the time explained the development as follows: 'Today we've got conventional weapons that approach the effectiveness of the old nuclear stuff. We can dig out those Iraqi bunkers more effectively with guided 2000 pound bombs than with tactical nuclear weapons—and without the moral downside'.[74] The evolution in the destructive capacity of conventional weapons is also clearly demonstrated by the comparison that 4500 B-17s in World War II or 95 F-105s in the Viet Nam War would each have to drop two bombs to obtain the same destructive capacity as one F-117 dropping one bomb of a similar weight (900 kg) in the 1980s and 1990s.[75] In short, the combination of more accurate missiles and bombs and the increased destructive capacity of conventional weapons changed warfighting substantially.

The arrival of accurate conventional missiles, and in particular so-called prompt global strike (PGS) weapons, should also be situated in the context of the debate about the remaining relevance of nuclear weapons after the cold war. In contrast to what could have been expected, the 1994 Nuclear Posture Review under the administration of US President Bill Clinton did not lead to major changes in US nuclear weapons policy.[76] That said, the idea of 'mini-nukes'—very low-yield nuclear weapons—resurfaced in order to combat proliferation. Low-yield nuclear weapons would cause less damage and be ideal to preventatively take out a nascent nuclear weapon programme in 'rogue states'.[77] The latter was regarded as one of the 'new' threats at that time.[78] Sceptics argued that lowering the nuclear threshold would be dangerous, and that accurate conventional missiles with penetrator warheads would be better and more legitimate instruments to take out hard targets (see below).[79] In this context, the George W. Bush administration then came up with the notion of PGS weapons.[80] The idea was to acquire accurate (hypersonic) ballistic missiles—either ICBMs or submarine-launched ballistic missiles (SLBMs)—with conventional warheads that would be able to take out

[71] Lukasik, S., 'To what extent can precision conventional technologies substitute for nuclear weapons?', ed. H. Sokolski, *The Next Arms Race* (US Army War College, Strategic Studies Institute: Carlisle, PA, 2012), p. 394.

[72] Erastö (note 42).

[73] Lukasik (note 71), p. 399.

[74] Quoted by Price, R. and Tannenwald, N., 'Norms and deterrence', ed. P. Katzenstein, *The Culture of National Security* (Columbia University Press: New York, 1996), p. 140.

[75] White, P., Pendley, R. and Garrity, P., 'Thinking about no nuclear forces', ed. R. Cowen Karp, *Security Without Nuclear Weapons* (Oxford University Press: Oxford, 1992), p. 113. That said, using these weapons against Iraq is easier than against Russia or China.

[76] Nolan, J., *An Elusive Consensus* (Brookings Institute Press: Washington, DC, 1999); and Sauer, T., *Nuclear Inertia* (note 48).

[77] Dowler, T. W. and Howard II, J. S., 'Stability in a proliferated world', *Strategic Review*, vol. 23, no. 2 (Spring 1995).

[78] For a critical view, see Klare, M., *Rogue states and nuclear outlaws* (Hill and Wang: New York, 1995).

[79] Nitze, P., 'A conventional approach', *Proceedings*, vol. 120, no. 5 (May 1994); and Erastö (note 42), p. 11.

[80] Gormley, D., 'US advanced conventional systems and conventional prompt global strike ambitions', *Nonproliferation Review*, vol. 22, no. 2 (2015).

any target in the world within one hour. However, because of the risk of entanglement of conventional and nuclear weapons (see section V), and under pressure from Congress, the idea was put on hold. Later on, President Barack Obama, who wanted to diminish the role of nuclear weapons, would reintroduce the idea of conventional PGS. His administration proposed the development of new and separate missiles for conventional tasks in order to minimize the entanglement risk.

Unsurprisingly, these new weapon systems and their impact on the change of thinking in the USA also affected military thinking in Russia and China.[81] As a result of the end of the cold war and encouraged by US military operations in the 1990–91 Gulf War, Russia and China tried to find complements for nuclear weapons too. This was also linked to the fact that a series of arms control treaties had led to significant decreases in nuclear weapon numbers: the 1987 Treaty on the Elimination of Intermediaterange and Shorter-range Missiles (INF); the 1991 Treaty on the Reduction and Limitation of Strategic Offensive Arms (START I); and the 1993 Treaty on Further Reduction and Limitation of Strategic Offensive Arms (START II). Russia was particularly concerned about the combination of US missile defence (since US President Ronald Reagan's Strategic Defense Initiative in the 1980s) and modern conventional missiles, both PGS systems and cruise missiles.[82] Given the poor state of nuclear readiness in Russia in the 1990s, the USA could have launched a first strike (or that was at least the fear).[83] That situation also helps to explain Russia's anger when the Bush administration announced the USA's unilateral withdrawal from the Treaty on the Limitation of Anti-Ballistic Missile Systems (ABM Treaty) in 2001. The withdrawal triggered a major reinvestment programme in (conventional and nuclear) hypersonic missiles (e.g. Avangard) in Russia that could be used either for warfighting or strategic stability (read deterrence) purposes. The latter started in the 1980s, but was accelerated in the 2000s, as it became more affordable due to the increasing gas and oil revenues.[84] More recently, China became concerned about the increasing number of US medium- and intermediate-range offensive and defensive missiles in the region (e.g. in South Korea), which led to the acceleration of its hypersonic development programme.

Not only for warfighting, but also for deterrence

Due to the fact that conventional weapons could be used without endangering the entire globe, it can be argued that conventional deterrence is more credible than nuclear deterrence. Already in the early 1980s, US political scientist Samuel Huntington wrote: 'Effective retaliation means credible retaliation, and in today's world, credible retaliation means *conventional* retaliation'.[85] Just a few years later and for the same reasons, in 1988 a team led by Fred Iklé and Albert Wohlstetter advised the US government to rely more on conventional weapons for deterrence purposes.[86] In case of an (unlikely) deterrence failure, strategic conventional weapons—meaning advanced conventional weapon systems designed and deployed to accomplish strategic functions—could be used in a proportionate manner, which is not the case for nuclear weapons.[87]

Linked to issues of credibility and the end of the cold war, in the 1990s many experts recommended a conventional instead of a nuclear deterrent, or at least complimenting nuclear with conventional deterrence.[88] In 1991 William J. Perry, who would later serve as US secretary of defense, wrote: 'This new conventional military capability adds a powerful dimension to the ability of the United States to deter war'.[89] Former US ambassador and nuclear 'hawk' Paul Nitze also concluded: 'Smart conventional weapons are safer,

[81] McDermott, R. and Bukkvoll, T., 'Tools of future wars—Russia is entering the precision-strike regime', *Journal of Slavic Military Studies*, vol. 31, no. 2 (2018); and Ven Bruusgaard, K., 'Russian nuclear strategy and conventional inferiority', *Journal of Strategic Studies*, vol. 44, no. 1 (2021), p. 12.

[82] Arbatov, A., 'A new era of arms control', Carnegie Moscow Center, 24 Oct. 2019; and Ven Bruusgaard (note 81), pp. 17–18.

[83] Lieber, K. and Press, D., 'The end of MAD? The nuclear dimension of nuclear primacy', *International Security*, vol. 30, no. 4 (Spring 2006).

[84] Ven Bruusgaard (note 81), p. 18.

[85] Huntington, S., 'Conventional deterrence and conventional retaliation in Europe', *International Security*, vol. 8, no. 3 (1983/1984), p. 56, Author's emphasis.

[86] Iklé, F. and Wohlstetter, A., *Discriminate Deterrence: Report of the Commission on Integrated Long-Term Strategy*, Jan. 1988.

[87] Hoffmann (note 4), p. 2.

[88] Perry, W., 'Desert storm and deterrence', *Foreign Affairs*, vol. 70, no. 4 (Fall 1991); Cropsey, S., 'The only credible deterrent', *Foreign Affairs*, Mar./Apr. 1994; Warnke, P. C., 'Strategic nuclear policy and non-proliferation', *Arms Control Today*, vol. 24, no. 4 (May 1994); MccGwire, M., 'The anatomy of the argument', ed. J. Rotblat, *Nuclear Weapons: The Road to Zero* (Westview Press: Boulder, 1997); and Dembinski, M., Kelle, A. and Müller, H., 'NATO and non-proliferation: A critical appraisal', PRIF Report no. 33, Apr. 1994.

[89] Perry (note 88), p. 66.

cause less collateral damage, and cause less threat of causing escalation—therefore offering greater flexibility for use in situations where nuclear weapons use would be politically or militarily impractical'.[90] Similarly but less radically, in 1997 the bipartisan US National Defense Panel's report—looking ahead to the year 2010—concluded that conventionally armed ICBMs could provide 'a supplement *or alternative* to nuclear arsenals of the Cold War'.[91] Moreover, in 2005 Barry Watts, former director of program analysis and evaluation at the US Department of Defense, noted the 'growing ability of accurate, non-nuclear . . . munitions to achieve military effects comparable to nuclear weapons, without the collateral damage of nuclear employment'.[92]

Today, conventional missiles have strong strategic (including deterrence) potential, especially because they have improved in terms of speed, pinpoint accuracy (due to improved guidance), and to a lesser extent manoeuvrability. In addition, warhead technology and therefore hard-target-kill capability have been improved. In all likelihood, AI will further boost these capabilities.[93] Nikolai Sokov from the Vienna Center for Disarmament and Non-Proliferation argues:

> Like nuclear weapons and unlike traditional conventional weapons, [the] use [of long-range precision-guided conventional weapons] can have strategic outcomes severely degrading the fighting capacity of the adversary—not just its military capability, but also its industrial capacity, transportation networks and its command, control and communication systems.[94]

A 2022 International Institute for Strategic Studies (IISS) report entitled 'Non-Nuclear Weapons with Strategic Effect: New Tools of Warfare' similarly argues that 'the significant capabilities of conventional long-range strike capabilities, including for strategic purposes, are well-known and understood, *thus contributing to their deterrent value'*. The report concludes that 'non-nuclear strategic weapons are not only much more usable politically, they also do not necessarily invite nuclear retaliation'.[95] The latter is by definition impossible in a world without nuclear weapons; so too is the problem of conventional–nuclear entanglement. Another advantage of hypersonic missiles is that a country does not need many because they are hard to defend against.[96]

An increasing number of experts can envision a scenario where strategic non-nuclear weaponry would replace nuclear deterrence and see it as a real option. SIPRI analyst Tytti Erästö is optimistic: 'Precision-strike weapons have the potential to *substitute* nuclear weapons as a more credible and less risky source of deterrence against conventional aggression'.[97] A 2020 Chatham House report states that 'many of the new capabilities are non-nuclear and could augment *or even replace* nuclear weapons for certain deterrence functions'.[98] Similarly, a 2023 Wilton Park conference report concludes that:

> . . . many of these [nuclear] measures could be politically difficult. Non-nuclear measures could include improving or developing: cyber capabilities and resilience, multilateral cooperation in space resilience, and coordinated deterrence campaign planning, missile defence capabilities, deep precision strike capabilities.[99]

Today, for instance, South Korean conventional precision-strike weapons are used as the main deterrent against North Korea (apart from US extended nuclear deterrence), particularly in the form of a potential decapacitation strike.[100] Thus, some observers conclude: 'That a nonnuclear power is attempting to deter a nuclear-armed rival and incorporate both counterforce and countervalue targeting vividly illustrates how advanced remote sensing and precision

[90] Nitze (note 79), p. 46.

[91] US National Defense Panel, *Transforming Defense: National Security in the 21st Century*, Dec. 1997, Author's emphasis.

[92] Quoted in Gormley (note 80), p. 125.

[93] Hoffmann (note 4).

[94] 'How to deal with long-range precision-guided conventional weapons, an interview with Nikolai Sokov', EU Non-Proliferation and Disarmament Consortium Newsletter no. 38, May 2022, p. 1.

[95] Hoffman and Alberque (note 42), p. 6, Author's emphasis.

[96] Lee (note 25), p. 45. That applies to nuclear weapons as well; in practice, however, the USA and the Soviet Union built tens of thousands of nuclear weapons.

[97] Erastö (note 42), p. 13, Author's emphasis. See also Lukasik (note 71).

[98] Quoted by Futter, A., 'The risks posed by emerging technologies to nuclear deterrence', eds B. Unal, Y. Afina and P. Lewis, *Perspectives on Nuclear Deterrence in the 21st Century*, Research Paper (Chatham House: London, Apr. 2020), Author's emphasis.

[99] Majnemer, J. and Repussard, E.-N., 'NATO's new 'deterrence baseline' and the future of extended nuclear deterrence', Wilton Park Report, Sep. 2023.

[100] Bowers, I. and Stålhane Hiim, H., 'Conventional counterforce dilemmas: South Korea's deterrence strategy and stability on the Korean Peninsula', *International Security*, vol. 45, no. 3 (Winter 2020/21); Pollack, J., Varriale, C. and Plant, T., 'The changing role of allied conventional precision-strike capabilities in nuclear decision-making', *Nonproliferation Review*, vol. 27, no. 1–3 (2020); and Sauer, T., 'US extended nuclear deterrence in Europe and East Asia: A comparative analysis', *Asian Affairs*, vol. 53, no. 3 (2022).

guidance have sparked a revolution in military affairs'.[101]

Other experts are willing to consider conventional deterrence as a new option, although they do not (yet) regard it as the most likely scenario.[102] Although Lieber and Press are not ready to abandon nuclear deterrence, they too conclude: 'Nuclear deterrence can be robust, but nothing about it is automatic and everlasting'.[103] Cimbala and Korb recommend denuclearizing the US ICBMs and turning them into a strategic conventional PGS system. They conclude:

> By mid-century, nuclear weapons could remain deployed in the arsenals of major powers but without their status as mainstays of deterrence, passing that baton to advanced non-nuclear weapons offering deterrence by denial preferentially to deterrence by threat of regional or global annihilation.[104]

Furthermore, in the US government there have also been sporadic but clear moves in the direction of delegitimizing nuclear weapons and replacing them with conventional weapons, although to a limited extent and without much fanfare. Financing the research and development of conventional PGS missiles started in 2003 under the Bush administration. Limited doctrinal changes were then introduced by the Obama administration in the 2010 Nuclear Posture Review, the 2010 Quadrennial Defense Review and the 2013 Nuclear Employment Guidance.[105] In contrast to the existing policy at the time, the Nuclear Posture Review stated that 'our conventional weapons capability is an effective deterrent in all but the most extreme circumstances'.[106] The Nuclear Employment Guidance later directed the US Department of Defense 'to strengthen non-nuclear capabilities and reduce the role of nuclear weapons in deterring non-nuclear attacks' and 'to conduct deliberate planning for non-nuclear strike options to assess what objectives and effects could be achieved through non-nuclear strike options, and to propose possible means to make these objectives achievable'.[107] The 2013 guidance claimed: 'Planning for non-nuclear strike options is a central part of reducing the role of nuclear weapons.'[108] And contrary to expectations, the nuclear posture reviews under both Donald J. Trump and Joe Biden continued the line of integrating conventional and nuclear deterrence.

Biden's 2022 Nuclear Posture Review 'underscores the linkage between the conventional and nuclear elements of collective deterrence and defense', which is now called 'integrated deterrence'. It further states: 'Non-nuclear capabilities may be able to complement nuclear forces in strategic deterrence plans and operations in ways that are suited to their attributes and consistent with policy on how they are employed'.[109] The October 2023 Final Report of the (bipartisan) Congressional Commission on the Strategic Posture of the USA was a mixed bag; it did not recommend a diminished role for nuclear weapons, but at the same time it pushed to 'prioritize funding and accelerate long-range *non-nuclear* precision-strike programs . . . in greater quantities than currently planned'. It also argued that 'the objectives of US strategy must include effective *deterrence* and defeat of simultaneous Russian and Chinese aggression in Europe and Asia *using conventional forces*'.[110] When the report was presented, Rose Gottemoeller—one of the meeting participants—emphasized the need to build up conventional capabilities so that the USA would not have to rely on nuclear weapons.[111] As well as non-nuclear precision-strike programmes (hypersonics), the report recommended increased funding for cyber defences, emerging technologies such as AI, quantum computing, big data analytics, and directed energy.[112] In the same month, a State Department report went even further:

> Over the long term, one way to reduce the demand for nuclear weapons would be to broaden the defense and deterrence portfolio, including by developing more advanced conventional means, such as advances in precision, in order to provide the

[101] Bowers and Hiim (note 100), p. 36.

[102] Futter and Zala (note 42), pp. 273–274.

[103] Lieber and Press (note 43), p. 49. In a more recent article, in contrast to previous publications, Lieber and Press criticize a pure counterforce strategy and opt for a so-called hybrid approach, in between deterrence by denial and deterrence by punishment. Lieber, K. and Press, D., 'US strategy and force posture for an era of nuclear tripolarity', Atlantic Council Issue Brief, Apr. 2023; and Harvey and Soofer (note 64), pp. 2, 11–12. See also Gerson, M., 'Conventional deterrence in the second nuclear age', *Parameters*, vol. 39, no. 3 (Autumn 2009).

[104] Cimbala, S. and Korb, L., 'Rethinking the US strategic triad', *Bulletin of the Atomic Scientists*, 20 Dec. 2023.

[105] Kristensen, H., 'Forget LRSO; JASSM-ER can do the job', Federation of American Scientists, 16 Dec. 2015.

[106] Quoted by Erastö (note 42), p. 11.

[107] Quoted by Kristensen (note 105).

[108] Quoted by Kristensen (note 105).

[109] Quoted by Kristensen, H. and Korda, M., 'The 2022 Nuclear Posture Review: Arms control subdued by military rivalry', Federation of American Scientists, 27 Oct. 2023.

[110] *America's Strategic Posture: The Final Report of the Congressional Commission on the Strategic Posture of the US*, Executive Summary, Oct. 2003, Author's emphasis.

[111] Mauroni, A., 'The strategic posture commission's amazing trip back to the future', War on the Rocks, 13 Dec. 2023.

[112] Mauroni (note 111).

President with more decision-making space and effective strategic options in the event of an existential threat or nuclear coercion against the United States or one of our allies.[113]

Interestingly, in October 2022 President Biden made it implicitly clear that the USA would respond with conventional weapons if Russia used a tactical nuclear weapon in Ukraine.[114]

The Chinese expert Tong Zhao also recommends that 'by managing the risk of nuclear escalation, Washington and its allies could more effectively collaborate on strengthening their conventional deterrence, a factor that holds greater sway than nuclear weaponry in shaping the outcome of future conflicts'.[115] China has deployed the medium-range DF-17 hypersonic missile (with a glide vehicle) that according to China has a purely conventional deterrent mission.[116]

There are also Russian voices that emphasize conventional instead of nuclear deterrence, although they date back to before the start of the war in Ukraine.[117] Russian experts such as Valeriy Akimenko have recommended replacing tactical nuclear weapons with conventional weapons, and using conventional weapons instead of nuclear weapons for de-escalation in a crisis.[118] Akimenko believes even the Russian government understands the stakes, arguing: 'An analysis of Russian military theory and practice suggests that Russia's views have undergone an evolution, moving from reliance on nuclear deterrence towards a greater emphasis on non-nuclear deterrence'.[119] He refers to the 2014 Russian military doctrine, and also quotes Sergei Shoigu, then Russian minister of defence, who stated in 2017: 'In the future, a gradual transfer of the deterrent factor from the nuclear to the non-nuclear plane is possible'.[120] This language was later confirmed in the June 2020 Russian statement on nuclear deterrence.[121] It remains to be seen what lessons Russia will draw from the war in Ukraine.

Criticisms

Of course, there remain many sceptics to the idea of strategic conventional weapons as the only deterrent, partly because the idea of nuclear weapons being around forever is so dominant.[122] One group of critics is concerned that because conventional weapons are less destructive and therefore more usable, the world will witness more conventional wars.[123] Conventional deterrence may also fail, just like nuclear deterrence, which would result in instability. In fact, former British defence strategist Michael Quinlan once said: 'Better a world with nuclear weapons but no major war than one with major war but no nuclear weapons'.[124] This paper, however, sees that argument as a false dichotomy. In a world with nuclear weapons, major wars can happen as well. The ongoing wars in Ukraine and the Middle East are just such examples. That said, the major advantage of non-nuclear deterrence is that the destruction will remain limited, at least in comparison with nuclear weapons, and that the risk of the destruction of the whole civilization is negligible compared to the current situation. As Henry D. Sokolski, executive director of the Nonproliferation Policy Education Center, argues: 'If there is some way to accomplish military missions without resorting to nuclear arms, most military planners favor it. A key reason why is the inability to know, after the nuclear shooting begins, when and where it might stop'.[125] In addition, traditional arms control could and should help to limit the number of conventional weapons, just as with nuclear weapons during the cold war.

[113] US Department of State, International Security Advisory Board (ISAB), *Report on Deterrence in a World of Nuclear Multipolarity* (US Department of State: Washington, DC, Oct. 2023), p. 15.

[114] Sanger, D., 'Biden says Russian use of nuclear weapon would be a "serious mistake"', *New York Times*, 25 Oct. 2022.

[115] Zhao, T., 'It's time to talk about no first use', *Foreign Policy*, 6 Nov. 2023.

[116] Stålhane Hiim, Fravel and Langset Troan (note 64), p. 183.

[117] Kokoshin, A., *On the System of Non-Nuclear Deterrence in Russia's Defense Policy* (Moscow University Press: Moscow, 2012); Podvig, P., 'Blurring the line between nuclear and nonnuclear weapons', *Bulletin of the Atomic Scientists*, vol. 72, no. 3 (2016), p. 148; and Akimenko, V., 'Russia and strategic non-nuclear deterrence', Chatham House Briefing Paper, July 2021.

[118] See Erastö (note 42), p. 13; and Akimenko (note 117).

[119] Akimenko (note 117), p. 2.

[120] Akimenko (note 117), p. 15.

[121] Russian Ministry of Foreign Affairs, 'Basic Principles of State Policy of the Russian Federation on Nuclear Deterrence', 2 June 2020. See also Gross Stein, J., 'Escalation management in Ukraine: "Learning by doing" in response to the "threat that leaves something to chance"', *Texas National Security Review*, vol. 6, no. 3 (Summer 2023).

[122] Pélopidas, B., 'The birth of nuclear eternity', eds S. Kemp and J. Anderson, *Futures* (Oxford University Press: Oxford, 2021).

[123] Leah, C., 'Deterrence and arms control in a second conventional age', *Comparative Strategy*, vol. 34, no. 5 (2015).

[124] Quinlan, M., 'The future of nuclear weapons in world affairs', *Atlantic Council of the US Bulletin*, 20 Nov. 1996, p. 2, quoted by Gen. E. Habiger, 'Strategic forces for deterrence', *Joint Forces Quarterly*, Winter 1996/97, p. 66.

[125] Sokolski, H., 'A peek into our nuclear future', American Interest, 5 Aug. 2020.

Other critics argue that the current geostrategic situation is not conducive for the changes proposed in this paper. They claim that they will not be feasible and may not even be desirable. Most Russian experts and politicians, just like their US colleagues, do not (yet) want to go as far as replacing nuclear with conventional deterrence.[126] In France, too, most experts are not (yet) convinced.[127] The same applies to the other nuclear-armed states. However, it is important to note that the argument of this paper is not that nuclear-armed states may—let alone will—switch to conventional deterrence in the very short term. The argument is that nuclear-armed states first have to be convinced of the desirability and therefore feasibility of that (r)evolution, and that the analysis of this paper may contribute to the kind of thinking that could reopen the debate. That said, one could make the argument that the current geostrategic environment points to the need to de-emphasize the role of nuclear weapons more than ever before. The war in Ukraine has shown that nuclear weapons are not theoretical objects, but weapons that can and possibly will be used.[128]

Other critics agree that a world without nuclear weapons may offer more benefits than costs, but wonder whether the interim period towards a nuclear weapon-free world would not be too destabilizing. To sketch out a concrete path towards nuclear elimination, including conventional arms control and confidence-building measures, goes beyond the scope of this paper. Rather, the main goal is to show that a world with nuclear weapons is a dangerous world and that EDTs enhance the risk of nuclear weapon use. At the same time, it argues that the existence of some EDTs, particularly conventional hypersonic weapons, may help convince sceptics that disarming nuclear weapons is possible because there exists a valid alternative, namely modern conventional weapons. Yet only when sufficient experts and political leaders are convinced by the idea, can they start working towards that goal. This should be done in a multilateral and gradual way, involving all nuclear-armed states as well as (representatives of the) non-nuclear weapon states. This paper believes that the necessary conditions for eliminating nuclear weapons are universality (i.e. all nuclear-armed states should be on board); an intrusive verification and sanctions regime; a change in the UN Security Council constellation (e.g. including India as a permanent member); and improving the existing collective security arrangements, at both global and regional level (including setting arms control limits for conventional weapons). The end of the war in Ukraine may be a catalyst in this regard.[129]

Nevertheless, the threat of violent conflicts among states will always remain, and conventional weapons will not disappear either. Consequently, as long as there is no global security community—which is a community of states that do not fear each other—states will feel the need to have a deterrent.[130] That deterrent, however, has to be credible. One could make the argument that the pre-World War I and II conventional weapons did not have the characteristics of a credible deterrent, which partly explains the existence of many wars at that time.[131] Nuclear weapons, in contrast, are simply too destructive to be used. Their use would by definition violate international humanitarian law (except in very specific circumstances like attacking an aircraft carrier) and large-scale nuclear use could mean the end of civilization; as a result, a nuclear deterrent is not very credible either.[132] Like in the story of Goldilocks and the three bears, something is needed that is just right—not too much and not too little. Thus, the best deterrent would be something in between conventional and nuclear: speedy but highly accurate conventional missiles that can reach any target very quickly, be it hypersonic or not.

VII. IMPLICATIONS FOR THE EU

Based on this analysis, the major policy recommendation to the EU is for member states to start thinking how to delegitimize nuclear weapons, both regionally and globally. As most of the EU member states are also North Atlantic Treaty Organization

[126] Rhodes, E., 'Conventional deterrence', *Comparative Strategy*, vol. 19, no. 3 (2000); and Stone, J., 'Conventional deterrence and the challenge of deterrence', *Contemporary Security Policy*, vol. 33, no. 1 (2012).

[127] E.g. Brustlein, C., 'Conventionalizing deterrence? US prompt strike programs and their limits', IFRI Proliferation Paper no. 52, Jan. 2015.

[128] Sauer (note 3).

[129] Sauer, T., 'The origins of the Ukraine crisis and the need for collective security between Russia and the West', *Global Policy*, vol. 8, no. 1 (2017); and Sauer, T., 'A call for a security order in Europe based on collective security instead of balance of power', *Scienza e Pace*, vol. 13, no. 2 (2022).

[130] On the concept of security community, see Deutsch, K. et al., *Political Community and the North Atlantic Area* (Princeton University Press: Princeton, 1957).

[131] Mearsheimer, J., *Conventional Deterrence* (Cornell University Press: Ithaca, 1983); and Rhodes (note 126).

[132] Wilson (note 9).

(NATO) members, the best way to do this is to reinvigorate the debate about the role of nuclear weapons in NATO with the goal of de-emphasizing their role.

Possible initiatives in this regard include: (*a*) reconsidering a policy of no first use (or sole purpose); (*b*) after the war in Ukraine, setting up negotiations with Russia to eliminate tactical (or sub-strategic) nuclear weapons; (*c*) after the war in Ukraine, withdrawing all tactical nuclear weapons to the home territory of the nuclear-armed states, meaning the USA (out of Germany, the Netherlands, Belgium, Italy and Turkey) and Russia (out of Belarus); (*d*) urging the USA and Russia to start negotiating a follow-up treaty to New START; (*e*) bringing nuclear alert levels down; (*f*) stimulating member states to attend TPNW meetings as observers; and (*g*) actively discussing how TPNW and NATO membership can be reconciled.

Furthermore, EU member states could put pressure on France to eliminate its nuclear weapons, or at least take steps in that direction. France could, for example, go from a dyad to a monad like the UK, reduce its number of nuclear weapons, reduce its alert levels, adapt declaratory policy to no first use or sole purpose, and more.

At the level of the UN, EU member states could support nuclear disarmament resolutions and actively discuss how to stimulate the nuclear-armed states to start multilateral negotiations to eliminate their nuclear weapons. They could also set up and/or co-finance a nuclear disarmament organization, comparable to the Organization for the Prohibition of Chemical Weapons (OPCW).

Although the question of the desirability of a Eurobomb is sometimes raised—including in February 2024, linked to criticism of US presidential candidate Trump and burden-sharing inside NATO—there does not seem to be much support, and the discussion tends to die out relatively quickly.[133] The idea is far from popular among EU member states that regard themselves as neutral (Austria, Ireland and Malta) or those that are categorized as Atlanticist (Eastern European and Scandinavian states). A full-scale Europeanization of the French nuclear weapons is only imaginable in an EU that has reached the end-stage of political integration. A European Defence Union can only exist in parallel with a European Political Union. Even small steps in the direction of the Europeanization of the French nuclear arsenal—for instance co-financing the weapons—would be at odds with the analysis made in this paper. Nuclear weapons are supposed to be de-legitimized according to the NPT and the TPNW, not to be re-legitimized in any form.

If the larger states in Europe (including Germany and Poland that already have Taurus and JASSM-ER missiles, respectively) would like to invest in more strategic weapon systems, this paper points in the direction of investing in modern conventional weapons.[134] Therefore, the second recommendation to the EU is for member states to boost their conventional weapons arsenals—not to compliment but to replace nuclear weapons. The recent decision to install US conventional intermediate-range missiles on European soil from 2026 onwards, as a result of the war in Ukraine, can thus only be regarded as legitimate if complimentary steps are taken to de-emphasize the role of nuclear weapons. Unfortunately, such steps are not (yet) taking place. In order to build up a conventional weapon deterrent, and not be dependent on the USA, a sufficient defence industrial base is needed in Europe.

In short, the objective should be an EU nuclear weapon-free zone that can defend itself with strategic conventional weapons. This is only realistic if Russia and the other nuclear-armed states agree to give up their nuclear weapons. Ideally, the EU would actively work to build a regional (and global) collective security order in which the size of the conventional deterrent (and the industrial base that is needed) could be contained in size. This would, of course, also require the cooperation of other regional powers in the world.

VIII. CONCLUSION

It is unclear whether the world has survived thanks to or despite nuclear weapons. That said, the goal—even

[133] Sauer, T., *Nuclear Arms Control* (Macmillan: London, 1998), especially the Epilogue, pp. 96–102; and Sauer, T., 'Power and nuclear weapons: The case of the European Union', *Journal for Peace and Nuclear Disarmament*, vol. 3, no. 1 (2020). For a different view, see Egeland, K. and Pélopidas, B., 'European nuclear weapons? Zombie debates and nuclear realities', *European Security*, vol. 30, no. 2 (2021). See also Sanger, D., 'An outburst by Trump on NATO may push Europe to go it alone', *New York Times*, 11 Feb. 2024.

[134] For a similar view, see Meibauer, G. and Laroche, C. D., 'German atomwaffen and the superweapon trap', War on the Rocks, 8 May 2024. See also Kulesa, L., 'Operationalizing the "Polish fangs": Poland and long-range precision strike', *Nonproliferation Review*, vol. 27, no. 1–3 (2020); and Blagden, D., 'Strategic stability and the proliferation of conventional precision strike: A (bounded) case for optimism?', *Nonproliferation Review*, vol. 27, no. 1–3 (2020).

for the nuclear-armed states—is to gradually diminish the number of nuclear weapons and to ultimately eliminate them. The latter has been agreed by all states, including by the five formal nuclear weapon states, when they signed and ratified the NPT.

The movement towards nuclear elimination, however, has come to a standstill. Nuclear arms control, not to mention nuclear disarmament, has been stalled since New START in 2010 and arguably stalled already in the mid 1990s. All of the nuclear-armed states are modernizing their arsenals; some of them, like China, are even building them up. One of the main reasons for this nuclear inertia or nuclear revival—apart from parochial industrial and bureaucratic interests—is the belief that nuclear deterrence 'works' and the resulting idea that there is no need to give up nuclear weapons and certainly not in a context of increased tensions between major powers. Critics have not been able to convince the advocates of nuclear deterrence that these beliefs are wrong (and vice versa). The war in Ukraine will probably not change the minds of opponents or proponents either.

Technology (in combination with political will), however, may do so. This paper argues that EDTs—referring to hypersonic missiles, cyber capabilities and AI—and strategic conventional weapons could more easily attack the early-warning and command-and-control systems of nuclear forces, or the forces themselves, which would be highly destabilizing. In addition, they may substantially undermine the invulnerability of nuclear submarines. The combination of both threats may be the final nail in the coffin of nuclear weapons and could speed up the process of nuclear elimination.

Yet eliminating nuclear weapons requires coming up with a valid alternative. Not by chance, the other main argument of this paper is that some of the same EDTs could provide such an alternative. They could not only supplement, but in time replace nuclear weapons as a deterrent. Strategic conventional weapons that are fast and accurate, including hypersonic missiles, come into this picture. Because they could be used in a way that at least seeks to comply with jus in bello principles, by minimizing civilian harm (in comparison with nuclear weapons), they are also more credible as a deterrent. This may in turn increase political willingness to seriously consider delegitimizing nuclear weapons, and eventually replacing them with the alternative option: modern conventional weapons.

A world without nuclear weapons will not mean a world without violent conflicts. The costs and benefits of a world with and without nuclear weapons have to be further assessed very carefully. If, however, the conclusion is that a nuclear weapon-free world is indeed desirable, as prescribed by the NPT and the TPNW, and given the increased awareness of the nuclear escalation risks in the war in Ukraine, the arrival of EDTs such as hypersonic missiles may make this scenario more politically feasible.

ABBREVIATIONS

AI	Artificial intelligence
EDT	Emerging and disruptive technology
ICBM	Intercontinental ballistic missile
NATO	North Atlantic Treaty Organization
NPT	Treaty on the Non-Proliferation of Nuclear Weapon
PGS	Prompt global strike
TPNW	Treaty on the Prohibition of Nuclear Weapons

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A EUROPEAN NETWORK

In July 2010 the Council of the European Union decided to support the creation of a network bringing together foreign policy institutions and research centers from across the EU to encourage political and security-related dialogue and the long-term discussion of measures to combat the proliferation of weapons of mass destruction (WMD) and their delivery systems. The Council of the European Union entrusted the technical implementation of this Decision to the EU Non-Proliferation Consortium. In 2018, in line with the recommendations formulated by the European Parliament the names and the mandate of the network and the Consortium have been adjusted to include the word 'disarmament'.

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The main aim of the network of independent non-proliferation and disarmament think tanks is to encourage discussion of measures to combat the proliferation of weapons of mass destruction and their delivery systems within civil society, particularly among experts, researchers and academics in the EU and third countries. The scope of activities shall also cover issues related to conventional weapons, including small arms and light weapons (SALW).

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