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Missile control: It's not rocket science.

GLOBAL SECURITY POLICY BRIEF

Katarzyna Kubiak
June 2019

About the author

Dr Katarzyna Kubiak is a Policy Fellow on nuclear and arms control policy at the European Leadership Network. Previously, she was a Transatlantic Post-Doc Fellow for International Relations and Security (TAPIR) at the Norwegian Institute for Defence Studies and an associate at the German Institute for International and Security Affairs (SWP). Her research areas include nuclear arms control and disarmament, nuclear non-proliferation, and ballistic missile defence.

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Missile control: It's not rocket science.

Executive Summary

This report aims to inject urgency and incentivize a global missile discussion. Unbounded horizontal and vertical missile proliferation threatens the security of the international community as a whole and puts great powers under enormous stress. If concerned and responsible states do not start acting now, they will find themselves in a destabilizing missile-related arms race, magnified by ongoing WMD proliferation and new emerging technologies.

The alleged Russian violation of the Intermediate-Range Nuclear Forces Treaty and the US intent to withdraw from the accord highlight that bilateral or plurilateral arms control does not do justice to the geographical spread and technological advancements in missile systems. Simultaneously, existing regulations covering missiles are selective, porous, and insufficient to save the world from a costly, dangerous, potentially deadly arms competition.

To avoid the avoidable, the report recommends:

1. **Putting missiles high on the political agenda** through an EU-led missile control summit followed by detailed work in existing formats: First Committee of the UN General Assembly, UN Panel of Governmental Experts on missiles, NPT Review Conference.
2. **Strengthening existing non-proliferation measures.** The Missile Technology Control Regime co-chairs and/or a troika-led regime review should establish proper priorities for cruise missiles, address hypersonic vehicles, short and medium range missiles, cope with new technologies (3d printing) and improve implementation.
3. **Strengthening existing transparency and confidence building measures.** Germany, Austria and Sweden should hold further informal talks on reinforcing and/or complementing the Hague Code of Conduct against Ballistic Missile Proliferation; extend coverage to include cruise missiles, ballistic missile boosters for boost-glide vehicles and missile defence interceptors; work towards universalisation and strict implementation, promote voluntary adherence to individual provisions (pre-flight notifications) by non-signatories, and include the private sector to promote a culture of transparency.
4. **Reduce nuclear-tipped missile-related risks and improve operational safety.** Nuclear weapons possessor states could establish a missile incident reporting system; publicly agree that cyberattacks on nuclear command and control are impermissible and denounce using them for this purpose; globalise exchanges on missile force postures and missile crisis communication mechanisms; and de-alert nuclear-tipped missiles.
5. **Address new missile capabilities.** Forego arming cruise missiles with nuclear warheads. Negotiate a test ban on hypersonic vehicles and if this is not feasible, a deployment ban. Prohibit placing nuclear warheads on hypersonic vehicles.

Missile control: it's not rocket science.

The author is grateful for generous commentary on earlier drafts of this report by Marc Finaud, Dr Jonathan Herbach, Łukasz Kulesa, Henrik Salander, Sahil Shah, Shatabhisha Shetty, Dr Waheguru Pal Singh (WPS) Sidhu, Sir Adam Thomson KCMG, and Carlo Trezza.

Proliferation of missile technology is a continuously growing international security challenge. Russian development of the Avangard hypersonic glide vehicle, the Tsirkon hypersonic cruise missile¹ and a nuclear-powered missile,² and the United States (US) developing a Long Range Stand-Off (LRSO) cruise missile, showcase a broader trend among technologically advanced powers for the development of next generation missile systems. Iran's failed satellite launch in February 2019³ was a reminder that further states aim to acquire capabilities that could lead to the development of intercontinental ballistic missiles (ICBM). India's anti-satellite missile test launch in March 2019,⁴ coinciding with a meeting of the UN Group of Governmental Experts – which seeks to build consensus around recommendations for curbing an arms race in outer space – highlights that this is imminent. In May 2019, a short-range ballistic missile test by North Korea, after yet another failed denuclearization summit, reminded us that states will continue developing missiles despite interdiction, international condemnation, sanctions and efforts to limit them asymmetrically.⁵

Delivery of the sarin nerve agent by a rocket/missile in Syria,⁶ as well as surface-to-air missiles and man-portable air defence systems (MANPADS) used by non-state armed groups against civilian⁷ and military⁸ aviation, demonstrate how short-range missile capabilities could also become a serious international problem. Finally, when SpaceX's Chief Operating Officer Gwynne Shotwell stated that the company's reusable launch vehicle and spacecraft system Big

Falcon Rocket could be used for military purposes (specifically to launch military weapons into space),⁹ it became clear that governments and governmentally funded agencies are losing their monopoly on the development and possession of missile technology.

Unbounded horizontal and vertical missile proliferation affects the security of the international community as a whole and puts great powers under additional stress. More and more sophisticated missiles in the hands of an increasing number of actors will likely aggravate interstate competition, increasing the costs of maintaining global and regional stability as well as the costs and risks of military engagement. This may constrain the projection capabilities of great powers, leading to reduced confidence in and reliance upon these states as security partners. Moreover, missiles remain the weapon of choice to deliver a payload of weapons of mass destruction (WMD) quickly and accurately.

While not yet employed in conflict, a few states have managed to shoot down their own satellites,¹⁰ demonstrating an increasing missile threat to human activity in outer space as well as to the command, control and warning architecture. Similarly, risks posed by new emerging technologies (cyber, weapon systems with autonomous functions, or mathematic methods) might undermine the safety, security and control of missile systems. Furthermore, the growing popularity of dual-capable missiles that can deliver either a conventional or non-conventional warhead could have destabilising and devastating consequences.

The 2002 US withdrawal from the Anti-Ballistic Missile (ABM) Treaty and the deployment of ballistic missile defences revived the emphasis on missile defence penetration capabilities. At the same time, developing and maintaining offensive capabilities remains cheaper than with defensive

capabilities, limiting the role of deterrence by denial in addressing missile threats and proliferation. As developing and maintaining offensive capabilities remains cheaper than with defensive capabilities, existing missile defence systems can only defend against limited attacks and put a growing strain on capabilities needed elsewhere.¹¹ As such, deterrence by denial has only a limited role to play in addressing missile threats and proliferation.

The foreseeable collapse of the Intermediate-Range Nuclear Forces (INF) Treaty, a landmark 1987 accord which removed a major threat to European security by eliminating an entire class of ground-launched ballistic and cruise missiles, would make it only the most recent arms control victim. Existing regulations covering missiles are selective, porous and insufficient to save the world from costly, dangerous and potentially deadly arms competition.

“Existing regulations covering missiles are selective, porous and insufficient.”

Yet there is no excuse for inaction. The German Federal Minister for Foreign Affairs, Heiko Maas, seeks ‘proposals for a comprehensive regime that creates transparency for missiles and cruise missiles’¹² and launched a Missile Dialogue Initiative. Addressing post-INF Treaty security challenges, NATO allies committed themselves to ‘uphold, support, and further strengthen arms control, disarmament, and non-proliferation, as a key element of Euro-Atlantic security, taking into account the prevailing security environment’.¹³ To prove that these are not merely empty words, they now need to fill these pledges with substance.

This report discusses challenges and opportunities in thinking about ways towards a more comprehensive missile

control framework. It reflects on current trends in the proliferation of missile systems and technology, assesses the success of present instruments and how they can be strengthened, and explores possibilities of developing new ones to address the challenges of missile and missile technology proliferation, and possession-related risks.

The missile renaissance: trends in missile proliferation

Around 31 states have **ballistic missiles**,¹⁴ including all nine nuclear-weapon armed states. While the trend to acquire ballistic missiles is growing, some are contending with the technology’s physical limits in the face of ballistic missile defence systems. Thus, **cruise missiles** have begun to catch on. Their development is easier, harder to detect and intercept, 10 times cheaper than ballistic missiles,¹⁵ and the missile itself performs with better accuracy and reliability.¹⁶ Around 75 states have cruise missiles,¹⁷ the vast majority of which are intended for conventional operations. However, eight of these states are nuclear weapons possessors and five are believed to mount nuclear warheads on their cruise missiles.

All nuclear weapon possessor states are currently modernising their nuclear weapons arsenals. This includes **upgrading old or developing completely new missile systems**.¹⁸

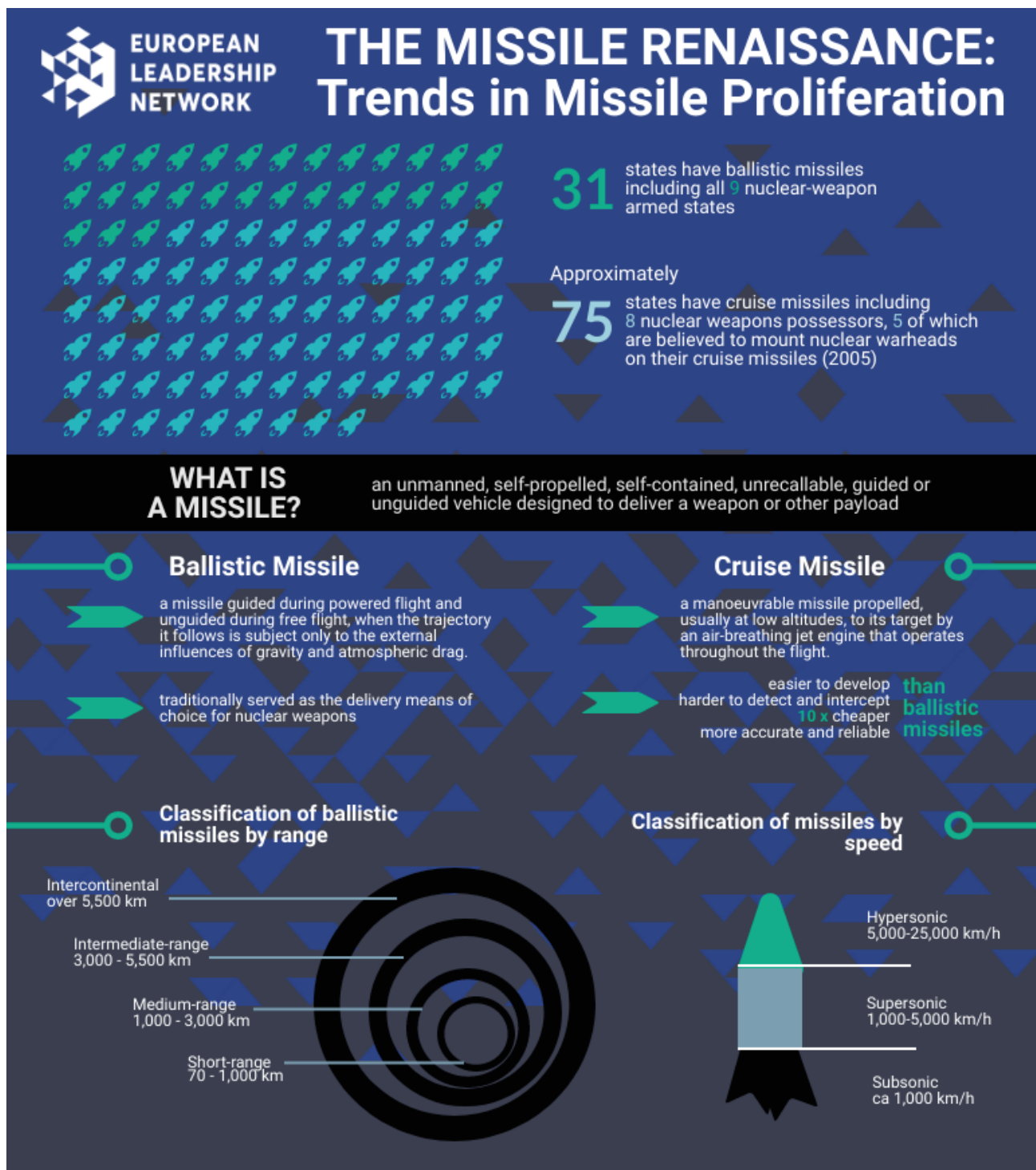
While being a technology-driven capability,¹⁹ **hypersonic missiles** are believed to promise new military advantages²⁰ and applications.²¹ Combining high speeds, extraordinary manoeuvrability and unusual flight altitudes, this future capability is expected to defeat most existing and envisioned missile and terminal air defence systems.²² As of today, the US, Russia and China are flight testing boost-glide vehicles, which are flown on top of and detached from ballistic missiles that then glide to their targets. Russia, US and Australia are also testing hypersonic cruise missiles.²³

Given the technological challenges affecting the development of hypersonic vehicles, experts predict initial capabilities within 10 to 20 years.²⁴

It is important to note the development of so-called **anti-satellite (ASAT) technologies**, including missiles, designed to disable or destroy space objects like satellites. Moreover, despite their offensive potential and destabilising nature, **missile defence interceptors**, used to hit incoming missiles, are usually considered as defensive and less

threatening. As the focus of this study is on missiles designed to hit terrestrial targets, ASAT weaponry and interceptors will not be addressed by the missile control steps described.

There is a versatile set of utility-driven motivations pushing states to acquire missiles. They can fly extremely quickly over long distances, enabling surprise attacks. They can overcome air defence systems and hinder freedom of manoeuvre for traditional aircraft. They do not require sending military



personnel to the enemy's territory, avoiding the risk of same-side casualties.

Due to their high speed, payload capacity and survivability, ballistic missiles traditionally served as the delivery means of choice for nuclear weapons. Slower flying vehicles like cruise missiles are regarded as more suitable for the delivery of chemical and/or biological payloads, which require a slow release above the target.²⁵

Next to traits inherent to the missiles themselves, there are more structural drivers for missile proliferation. First, states want to balance out the capabilities of their opponents. Second, the parochial interests of state bureaucracy and/or political, economic, military or private actors advocate for the acquisition or development of missiles. Third, missile technology has been used as a barter commodity, e.g. to acquire secret information or to bolster a state's finances. Finally, missiles serve symbolic purposes, boosting the perception of national and international prestige or modernity.²⁶

Past and existing regulatory mechanisms

In a few historical cases, states were **obliged to abandon** certain missile systems and related activities. In 1954, Germany committed not to manufacture long-range and/or guided missiles.²⁷ After the Gulf War, United Nations Security Council Resolution (UNSCR) 687 (1991) required Iraq, under international supervision, to eliminate all ballistic missiles with a range greater than 150 km and related infrastructure. In 2015, UNSCR 2231, which endorsed the Joint Comprehensive Plan of Action (JCPOA), called upon Iran to refrain from activity related to ballistic missiles capable of delivering nuclear weapons. A range of UN Security Council resolutions call on North Korea to refrain from and sanction its missile-related efforts. Moreover, UNSCR 1540 (2004) prohibits all UN member states from providing any form of support to non-

state actors who attempt to develop, acquire, manufacture, possess, transport, transfer or use WMD and their means of delivery, especially for terrorist purposes.

In other cases, states **banned** missiles and related systems on a voluntary basis. The 1972 US-Soviet ABM Treaty prohibited antiballistic missile systems, permitting both parties only a limited number of fixed launchers and interceptor missiles. The 1972 Biological Weapons Convention and 1993 Chemical Weapons Convention prohibit means of delivery designed for biological and toxin agents and chemical weapons respectively. The 1987 INF Treaty required the US and USSR to entirely eliminate ground-based ballistic and cruise missiles in the range of 500-5500 km, together with corresponding launchers and infrastructure. The unilateral US and Russian Presidential Nuclear Initiatives (PNI), which reduced mainly tactical nuclear weapons arsenals, included missiles,²⁸ but both countries question each other's full implementation of these commitments. After renunciation of its WMD-related activities in December 2003, Libya converted most of its Scud-B arsenal into defensive short-range weapons, pledged to eliminate any missiles capable of travelling 300km with a 500kg payload, and removed its missile infrastructure.²⁹

Strategic arms control agreements between the US and USSR/Russia cover missiles marginally or indirectly, through limitations on launching infrastructure. The 1972 Strategic Arms Limitation Talks (SALT) agreement froze the overall number of land-based ICBM and ballistic missile launchers on submarines, but did not cover missiles per se. The 1979 SALT II agreement placed a ceiling on ICBM and SLBM launchers as well as on air-to-surface ballistic missiles capable of ranges of over 600 km. The 1991 Strategic Arms Reduction Treaty (START) cut the amount of deployed heavy ICBMs and their warheads by half, banned production, flight-testing and deployment of heavy ICBMs and SLBMs and corresponding launchers, and

limited technical specifications of existing missiles. The 2010 New Strategic Arms Reduction Treaty (New START) capped the overall number of ICBMs, SLBMs and heavy bombers assigned to nuclear missions at 700; and allowed the US and Russia to retain 800 deployed and non-deployed corresponding launchers and bombers.

Additionally, states agreed to some missile-related **transparency and confidence building measures**. In 1971, the US and USSR committed to notify each other in advance of certain missile launches.³⁰ In 1987, Moscow and Washington agreed to set up Nuclear Risk Reduction Centres,³¹ which were upgraded in 2012³² and are still operating now, for the transmission of notifications and communications at government-to-government level; these have been used to notify each other of ICBM and SLBM launches. In 1998, the US and Russia agreed to widen coverage of strategic ballistic missile launches notifications, previously scattered in a range of agreements.³³ In 2000, Washington and Moscow established a Joint Centre for the Exchange of Data from Early Warning Systems and Notifications of Missile Launches (JDEC MOA)³⁴ and signed another Memorandum of Understanding on Notifications of Missile Launches.³⁵ In 2005, India and Pakistan agreed on pre-notifications of ballistic missile flight-testing.³⁶

In 1994, Washington and Moscow committed to **de-target** strategic nuclear missiles aimed at each other.³⁷ This meant that respective strategic forces would either not contain targeting information (Trident II) or would target oceans (Minuteman III).³⁸ The missiles can, however, be retargeted at fairly short notice (seconds to minutes).³⁹ Similar declarations followed between the UK and Russia,⁴⁰ Russia and China (1994), and China and the US (1998).⁴¹

Due to the political nature of these declarations and the absence of agreed upon verification measures, concerns arose over whether all sides were complying

with these commitments.⁴² Additionally, in Article XII of the INF Treaty, the US and Russia agreed 'not to interfere with national technical means of verification of the other Party', widely interpreted as a form of mutual immunity granted to satellites from attacks by missiles.

Some 35 member states use the 1987 **Missile Technology Control Regime (MTCR)**, an export control system, to deny other states access to entire missile systems and technology necessary for their development. While the MTCR is considered successful in thwarting horizontal proliferation of ICBMs, considerably delaying missile development in Libya and Syria, it did not prevent aspirants like Egypt, Iran, Israel, North Korea and Pakistan from acquiring intermediate-range ballistic missiles.⁴³ Also, the lower-priority status prescribed to cruise missiles ultimately allowed for their proliferation.⁴⁴ Additionally, the 2012 US-South Korean deal, extending Seoul's missile range from the 500 km allowed by the MTCR to 800 km (to reach any target in North Korea without posing a threat to China or Japan),⁴⁵ exemplifies how the regime suffers from inconsistent implementation.⁴⁶ It also has a bad reputation among many of the 120 developing states comprising the Non-Aligned Movement, which deem it a supplier's cartel designed to hamper technological progress to small and medium powers.⁴⁷

The 2002 **Hague Code of Conduct against Ballistic Missile Proliferation (HCoC)** is the only multilateral transparency and confidence-building instrument for the proliferation of ballistic missiles capable of carrying WMD. By requesting pre-launch notifications and annual declarations from its 140 signatory states, the HCoC aims to foster transparency about ballistic missile and civilian space programmes; and provides warning of missile launches. However, key missile possessors (including China, Egypt, Israel, Iran, North Korea, Pakistan and Saudi Arabia) have not signed it. The HCoC also fails to address cruise missiles and hypersonic

vehicles and suffers from lax adherence.

The 1996 **Wassenaar Arrangement (WA)** is another voluntary export control instrument promoting transparency and greater responsibility in transfers of conventional arms and dual-use goods and technologies among its 42 member states. Its Munition List includes several references to missiles and related equipment.

While the above list sets out a range of previous and existing missile-relevant instruments, it is not fully complete.⁴⁸

The scope of the missile problem

Notwithstanding past and existing efforts to address specific aspects of missiles, no universal norm, treaty or agreement governing the development, testing, production, acquisition, possession, transfer, deployment or use of missiles exists.⁴⁹ Despite broad consensus for the need to stop the further spread of WMD-capable missiles, there is no agreement on how to do so.⁵⁰ The difficulty stems from the multitude of actors and motivations behind missile proliferation. Missiles are considered legitimate for interception and space launches, a means of delivery for conventional weapons; and in the case of nuclear-weapon state parties to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), for nuclear weapons too.

“As history has shown, non-proliferation measures do not prevent regional powers from developing missiles.”

As history has shown, non-proliferation measures do not prevent regional powers from developing missiles, delaying the process at best. Technological military solutions such as ballistic missile defences do not effectively discourage would-be proliferators from continuing their missile

efforts, but instead encourage development of more sophisticated missiles to overcome them, and decoys to fool them. Existing instruments apply double standards, lack wide adherence and strict implementation. Further horizontal and vertical missile proliferation is therefore a given.

Missile-related security implications will increase. First, the threat will spread from mainly regional and limited individual intercontinental scenarios to directly affecting major powers. Principal missile developers will see the playing field levelled against them by medium-sized states.⁵¹ Second, while mainly affecting states with effective ballistic missile defence systems, hypersonic vehicles will encourage hair-trigger tactics (e.g. a launch-on-warning postures, pre-emption policies) which will increase crisis instability,⁵² and contribute to a costly arms race dynamic.⁵³ Third, new emerging technologies, the propensity for machine and human error and simple negligence⁵⁴ will make it harder, if not entirely impossible, to ensure a high level of missile system resilience, safety and security. Fourth, the trend towards dual-capable missiles has important implications for decision-makers. Today, in cases of potential ICBM strikes, the attacked side knows whether what it sees flying on the radars will deliver a nuclear payload or not and can react accordingly. There is no such assurance with other missile types. Especially in a crisis, the dual-use character of some missiles might have destabilising and potentially devastating implications. Fifth, missiles remain the preferred means of terrorising populations and delivering WMD, with WMD horizontal proliferation persisting as a serious concern.⁵⁵ Moreover, this may amplify in light of new sources of tensions.⁵⁶ Finally, short-range missile capabilities,⁵⁷ widely neglected by existing instruments, have already led to serious international problems. Scud-B missiles with a range of 300 km served as a main proliferation blueprint in such regard.⁵⁸

Recommendations

The most sustainable way to eliminate missile-related risks involves their legally binding prohibition and verified elimination. Yet in the assumption that states will not give up existing missile capabilities easily or at all, a step-by-step approach could be established that establishes rules which limit arms competition and create conditions conducive for more comprehensive arms control and non-proliferation efforts. Where possible, interested states should strive to improve existing instruments. Where necessary, they should work toward new arms control measures in order to reduce the prospect of war, diminish the incentives to engage in a prolonged arms race, reduce the risk involved in maintaining and operating existing missiles, lower the potential for accidents and incidents, minimize the probability of miscalculation, misperception and escalation, and ensure respect for international humanitarian law in armed conflict.

While this report addresses missile-related challenges from the perspective of particular missile technologies and individual instruments, in many cases, missile regulation requires regional, tailor-made approaches that take into account the particular balance of power and security arrangements, as well as the historical, technological, political and cultural context of individual regions.⁵⁹ Such missile control regimes are currently discussed for the Middle East⁶⁰ and North Korea. And while region-specific arrangements are not a focus in this report, they could also draw from ideas presented here.

Put missiles high on the political agenda

Although the **First Committee of the United Nations General Assembly** maintains missiles on its agenda (recent exceptions

include 2015 and 2017), it has not published any resolution on that issue within the last decade.⁶¹ Yet to achieve a better, more effective framework to respond to missile challenges, states should place missiles high on the political agenda.

Aspiring to a stronger role in foreign and security policy, and stepping into the arms control leadership void left by the US, the **European Union (EU)** could convene a **missile control summit**. Given that the Council of the European Union has been undertaking activities to further enhance multilateral efforts against missile proliferation,⁶² and that a new EU foreign policy chief replacing Federica Mogherini later this year will seek new areas of engagement, the missile issue could become one of their flagship projects. With its track record in building normative frameworks, Brussels could draw attention around the globe, at the highest possible level, to the comprehensive threat posed by and need to better regulate missiles and related technology. Of course, the EU would need to include such a proposal on the EU-NATO agenda first to ensure that it does not undercut NATO defence efforts. However, such an initiative would also serve NATO's commitment to arms control, disarmament and non-proliferation, which do not necessarily reside on the top of its daily priority list.

In principle, priority should be given to WMD-capable missiles: there is already a broad political understanding among states to limit proliferation of missiles and missile technology for the delivery of all types of WMD. Brussels could facilitate a consensus-building process in defining missile-related risks, building persuasive narratives on the necessity of global/regional missile force posture dialogues, and scouting common denominators to address these challenges through non-proliferation and arms control instruments. The conference could conclude with an action plan: with individual or like-minded states taking ownership to transmit individual action points to relevant forums

and ensure their further discussion and implementation.

Issues of general interest that the EU summit could not cover in depth, which go beyond established mechanisms, could be looked at by the **UN Panel of Governmental Experts on missiles**. It concluded the last of its three meetings in 2008.⁶³ With a diverse representation of delegates from 25 states at its last session, including all five NPT nuclear-weapon states as well as Egypt, India, Iran, Israel, Libya, Pakistan and South Korea, the panel has the attention of most key players. Egypt, Indonesia and Iran, with the backing of Denmark, Germany, France, Poland, Hungary and the UK – all of which participated at the last gathering – could draft a resolution to reinvigorate this format. This time, however, the panel should be given a clear mandate to address specific missile-related issues. This would provide the necessary focus, push for actionable recommendations and generate expectations for their subsequent implementation. In particular, the panel could establish working groups aimed to reduce missile-related risks and address new capabilities.

“Brussels could facilitate a consensus-building process in defining missile-related risks.”

Another framework to address missile proliferation is the **NPT Review Conference**. In its preamble, the Treaty refers to the elimination of nuclear weapons and the means of their delivery. Nuclear weapons arsenal modernisation (or, if we call a spade a spade, vertical proliferation) is – if not directly against the letter – clearly against the spirit of the accord. Long-term or even indefinite modernisation/extension programmes are difficult to reconcile with commitments to ‘pursue negotiations in good faith on effective measures relating to cessation of the nuclear arms race at an early date and to nuclear

disarmament’,⁶⁴ and ‘further diminish the role and significance of nuclear weapons in all military and security concepts, doctrines and policies’.⁶⁵ Yet for years, states failed to use the conference to address nuclear modernisation more broadly.

The NPT Review Conference may offer some common ground at least for discussion between nuclear and non-nuclear weapon states. The 16 states whose foreign ministers stated at a meeting on 11 June 2019 in Stockholm that in the context of new capabilities and technologies, ‘a potential nuclear arms race – which would serve no one’s interest – must be avoided’,⁶⁶ could reach out on the nuclear-tipped missile problem to the wider NPT community. A ministerial-level meeting, planned for early 2020 in Berlin to discuss a pre-Review Conference declaration of intent, could serve as a good opportunity to do so.

Strengthen existing non-proliferation measures

Keeping in mind all its drawbacks and weaknesses, **MTCR** co-chairs and/or troika should commit to a comprehensive **review of the regime**. First, they should give proper priority to cruise missiles. Second, because the MTCR relates to weapon systems which can deliver an explosive warhead of at least 500 kg over 300 km, hypersonic missiles able to strike precisely with a lighter warhead or their kinetic power alone might not necessarily fall under the payload level. This should be clarified, with discussions about addressing hypersonic vehicles initiated.

Third, consideration should also be given to preventing proliferation of short and medium range missiles, technology and materials. Fourth, the MTCR also needs to cope with new technologies, like additive manufacturing (3D printing).⁶⁷ Finally, if states do not want to face more and more complex WMD-capable missile challenges, they should strictly observe the regime’s provisions and refrain

from inconsistent implementation.⁶⁸ Member states could also consistently introduce legislation allowing sanctions against any nations which export items restricted by the MTCR agreement, such as the US.⁶⁹

Strengthen existing transparency and confidence-building measures

As the HCoC is the only multinational transparency and confidence-building measure, signatory states need to **strengthen and widen its provisions**. Germany (Missile Dialogue Initiative initiator), Austria (HCoC Point of Contact) and Sweden (2019-2020 HCoC Chair) should further explore reinforcing and/or complementing the HCoC.⁷⁰

Key players like China, Israel and North Korea are yet to sign it. However, since 2004, eight UN General Assembly resolutions supporting the HCoC⁷¹ were adopted by a number of states not on the HCoC signatories list, with others abstaining rather than voting against.⁷² It seems that the restrictive nature of the HCoC is one of the main reasons why a substantial number of states with ballistic missile programmes still hesitate to subscribe to the Code.⁷³

In order to increase the instrument's appeal and eliminate its main structural flaw, the HCoC needs to widen its focus to also include cruise missiles⁷⁴ and ballistic missile boosters for boost-glide vehicles as relevant carriers of weapons of mass destruction,⁷⁵ and potentially missile defence interceptors too. For each new missile category, it should include pre-launch and test flight notifications. Annual declarations of policies should also include information on stockpiles, deployments and developments. This would constitute a comprehensive missile transparency regime. On the other hand, if HCoC direct membership is not attainable in the short term, incentivising voluntary adherence to its specific provisions, including pre-flight notifications and/or reporting missile-related activities, should be

considered.

Yet even the best amendments will be of little value unless signatory states fix their loose adherence to HCoC's commitments: especially when it comes to national missile systems and space programmes that contribute to delivery systems for WMD. For example, the US committed to exercise maximum possible restraint in the development, testing and deployment of ballistic missiles capable of delivering WMD only as far as it meets its 'national security requirements consistent with US national security strategy'⁷⁶. Other states regularly fail to submit their annual declarations.⁷⁷ Whether a state shoulders its HCoC-related notification and declaratory responsibilities could be publicly announced and thereby fall under public scrutiny. HCoC's credibility, legitimacy and effectiveness arguably depends on it.

Finally, as states have lost their monopoly on developing and operating missiles, HCoC members should contemplate including the private sector (e.g. Space X) in the conversation, with the aim of fostering a culture of transparency within the industry.

Reduce missile-related risks and improve operational safety

Missiles are prone to machine and human errors, and are increasingly vulnerable to cyber-attacks and sabotage. Past examples of accidents and incidents include but are not limited to the accidental placement of a training tape showing a missile attack into the live US warning system in 1979,⁷⁸ the 1995 Russian misinterpretation of a joint Norwegian-American research rocket study launch,⁷⁹ or the 2018 Hawaiian⁸⁰ and Japanese⁸¹ false missile alerts. Cyber-based threats increase the risk of launch as a result of miscalculation and unauthorized use, reduce confidence in early warning as well as command and control systems, and could disrupt communication between officials,

operators and nuclear systems, and/or international counterparts in a potential crisis.⁸²

While instruments like the HCoC contribute to the prevention of miscalculation and misperception related to ballistic missile-launches, and each missile-possessing country should do its best to prevent machine and human error, more needs to be done.

Missile-possessing states could set up an **incident reporting system**. While announcing all mishaps in great detail is unfeasible due to the prevailing culture of secrecy and great hesitancy to reveal technical specification and individual service weaknesses to potential enemies, sharing at least some incident information together with lessons learned could increase the overall safety and security of missiles worldwide. Establishing a safety and security culture elsewhere provided not only better, more efficient intra-service cooperation and communication; but a significant reduction of mishaps altogether.⁸³ If a global system is politically unattainable, it should at least be contemplated among nuclear-weapon possessor states, among friends and partners and/or as regional reporting systems.

“No rules for preventing and dealing with cyber-induced missile-related risks exist.”

At the same time, no rules for preventing and dealing with cyber-induced missile-related risks exist. Therefore, all states operating missiles, but those placing WMD on top of missiles in particular, must immediately work towards reducing such risks. Possible action points include **(1) Publicly agreeing that cyberattacks on nuclear command and control are impermissible; (2) Political declarations to refrain from cyber-attacks on missile early warning and command and control systems.**⁸⁴ The UK, which currently coordinates the P5 process, could press the delivery of such a declaration at the 2020

NPT Review Conference. At the same time, it should work to get other nuclear-weapon possessor states not party to the NPT (India, Israel, North Korea and Pakistan) on board.

Another important but widely non-existent risk reduction mechanism involves **exchanges on missile force postures and missile crisis communication**. Exceptions include arrangements within the US-Russia and India-Pakistan dyads, which need to be widened to include all missile-possessing states with nuclear weapons.

Simultaneously, verifiably **de-alerting nuclear-tipped missile forces**,⁸⁵ so extending the time necessary to launch them, would provide decision-makers with more time and prevent unnecessarily hasty escalation. States place missiles on high alert to avoid being caught by surprise. Yet with the development of new emerging technologies operating nuclear missiles on high alert becomes increasingly dangerous; in a crisis or due to misperception and misunderstanding, nuclear-tipped missiles can have devastating consequences. There are several ways to de-alert missiles, including by placing physical barriers atop missile silos (verifiable from space), removing and storing warheads away from missiles, removing or altering firing switches,⁸⁶ batteries, gyroscopes and/or guidance mechanisms from re-entry vehicles, to mention but a few. Such mechanisms could be designed or built in, utilising current modernisation efforts.

The US, Russia and France are believed to deploy nuclear warheads on high alert at all times. British SLBMs are kept on a reduced operational alert status and would require several days' notice to be able to fire.⁸⁷ In peacetime, China, India, Israel and Pakistan are thought to store their nuclear warheads separately from launchers.⁸⁸ However, China and Pakistan are said to have recently considered a readiness level increase.⁸⁹ De-alerting could be part of negotiations related to cyber activities and/or constitute a vital element of a New START follow-up agreement

between the US and Russia. Moreover, members of the past Non-Proliferation and Disarmament Initiative⁹⁰ and the De-alerting Group⁹¹ should place de-alerting onto the 2020 NPT Review Conference agenda.

Address new missile capabilities

a. Cruise missiles

As long as states prefer denying their opponents military objectives by advancing ballistic missile defence systems, there are few incentives to limit their cruise missile capabilities. Prospects of making the INF Treaty multilateral, an idea unsuccessfully pitched by Russia and the US to the UN in 2007,⁹² are dim, given the likely demise of the accord and prevailing belief that Washington and Moscow must first reduce their stockpiles to the level of states with smaller nuclear arsenals, if the latter are to enter any arms control talks. Presuming that cruise missiles remain in state arsenals, the international community could try to **forego arming cruise missiles with nuclear warheads**. Carrying some very specific risk implications, they are widely considered as destabilising.⁹³

Five states would need to verifiably dismount nuclear payloads from their cruise missiles: China, France, India, Pakistan and Russia; and four would only need to pledge not to mount nuclear ordnance on their existing or prospective cruise missiles: Israel, North Korea, the UK and US. Verification could be provided by an 'evidence of absence' proposal tabled by the UN Office for Disarmament Affairs (UNODA).⁹⁴ Using key elements of the New START Treaty, it includes provisions to confirm physical absence of weapons on missiles, adapted procedures for managed access to confirm absence of weapons in storage facilities, and radiation detection techniques to determine the non-nuclear status of inspected objects.

To assess the viability of a legally binding agreement, states could start by issuing

moratoria not to deploy cruise missiles equipped with nuclear warheads or – if this is not feasible – to forego development of a next generation of such missiles, and allow for a natural, age-related phase-out.

The Swiss and Swedish governments, which in 2016 kickstarted a process to reduce risks associated with nuclear-armed cruise missiles, and the UK, which in 2013 rejected pursuing sea-launched nuclear cruise missiles,⁹⁵ could lead conversations about limiting such capabilities and minimising related risks. The combination of a P5 member state with a NATO and non-NATO ally would lend this initiative more weight as would not be tilted in favour to a particular agenda or grouping.

b. Hypersonic missiles

As hypersonic technologies' most advanced aspirants (China and Russia in cooperation with India, and the US) will most likely want to cash in on their advantage, further proliferation of hypersonic technology is a given, making military calculations for all involved more complex and costly. At the same time, risks inherent in the deployment of hypersonic vehicles relate to their short timelines for attack and response, which could have escalatory consequences.

To avoid catastrophic scenarios, states developing such capabilities should **negotiate a test ban**. Testing is necessary to gain confidence and ensure reliability. And while developing hypersonic missiles can be partly done in laboratories and wind tunnels, confirming performance and debugging problems requires open air testing.⁹⁶ Curbing testing not only makes development of such weapons more difficult, but also makes these missiles less likely to carry nuclear warheads.

Despite scepticism that a test ban is unlikely unless technological precursors overcome all technological hurdles to the development of effective prototypes,⁹⁷ attempting one should not necessarily be abandoned.⁹⁸ To win the

moral high ground, establish good faith and common purpose, and eventually encourage other aspirants to join what could develop into a legally binding agreement which limits such capabilities altogether, concerned states could start by introducing unilateral testing moratoria.

“To avoid catastrophic scenarios, states developing hypersonic technologies should negotiate a test ban.”

Hypersonic missile flight tests have specific characteristics (flight profile, speed, heat) that make them easily identifiable. Additionally, tests of hypersonic vehicles are already being conducted in regions that allow for mutual verification.⁹⁹ Verifying compliance with a boost-glide vehicles test ban could proceed through satellites, ground-based, over the horizon and sea-based radars of individual states, and the infrasound sensor component of the Comprehensive Nuclear Test Ban Treaty Organization (CTBTO) International Monitoring System,¹⁰⁰ all used today to discern a ballistic missile launch. To ensure compliance for long-range hypersonic cruise missiles, however, a new, much denser net of over-ground sensors may be required.

While the US intends to use hypersonic vehicles with conventional or non-explosive warheads, China and Russia have not explicitly ruled out mounting such capabilities with nuclear warheads.¹⁰¹ The US should thus, at least for its own security, strive to **ban nuclear payloads on hypersonic vehicles** and work to promote the adoption by all states with hypersonic capabilities, thereby eliminating the warhead ambiguity of hypersonic vehicles. Together with CTBT signatories and member states, the CBTO should make all possible efforts to ensure that the emergence of hypersonic weapons does not lead to the resumption of nuclear testing.¹⁰²

If technology-driven curiosity proves stronger than common sense and responsible behaviour, rendering a test ban ‘impossible’, the international community should work towards a **deployment ban** instead.

The way ahead

Missile proliferation is a vicious circle resulting from states placing individual above collective, cooperative security. The international community continues to oversee the slow, yet increasing proliferation of missiles and their acceptance as legitimate weapons.

At the same time, missile-related threats already witnessed in past accidents, are being magnified by the involvement of more actors, cyber and other disruptive technologies. Missiles will grow in numbers and sophistication, complicating states’ security calculus, especially in conflict-prone regions, but also among established great powers.

As of today, the relevant arms control agreements are bilateral (INF Treaty); with other mechanisms being unilateral (export controls), coordinated among exporting states (MTCR, Wassenaar Arrangement), or multilateral but not legally binding and far from universal (HCoC). Yet missile demand will not be hindered, nor will related risks be reduced by applying porous, lazily implemented and discriminatory non-proliferation instruments. As the current political climate is rife with mistrust, expecting ground-breaking solutions in the short term would be unrealistic. Yet despite this environment, states have an obligation to take effective collective measures for the prevention and removal of threats to peace.¹⁰³ And it is in their interest too.

Concerned and responsible states should work towards raising the profile of the increasing danger posed by missiles: strength-

ening existing missile instruments, universalising a transparency and confidence-building culture, putting risk reduction measures in place, and addressing new missile types. It is the responsibility of nuclear-tipped missile-possessing states to ensure that no accident or incident ever happens.

By the same token, states without the missile capabilities enabling them to push for reductions or those which do not currently face missile concerns can champion norm-building, which in turn, can lead to increased international attention to missile-related risks, as well as threat-reduction measures.

This report aims to create a sense of urgency and incentivize a global missile discussion; but cannot do justice to developing detailed policy proposals. Further thinking and elaboration on each issue highlighted by this report is warranted.

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