THE GROWING APPEAL OF MISSILES:

CURRENT DRIVERS BEHIND BALLISTIC MISSILE ACQUISITION AND DEVELOPMENT

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In many regions, a number of countries are currently developing or acquiring ballistic missiles. The efforts to procure these systems are especially visible in the Middle East, in Asia and in Europe. Some of these programmes have been active for years. Some have been triggered by ongoing conflicts and tensions. Indeed, ballistic missiles are being used extensively in current conflicts, in particular by Russia on Ukraine, Iran over Israel, but also by the Houthis in Yemen, over land targets as well as ships.

In addition to geopolitical factors, technological developments are modifying the role of ballistic missiles in military strategy: on the one hand, they are increasingly precise and some have the ability to aim very specific targets, on the other hand, the generalisation of missile defence means that relatively simple short-range systems can lose their relevance.

In this context, we can notice changes in the drivers that are pushing states to procure or design ballistic missiles. This paper starts with case studies, looking more closely at the drivers behind ballistic missile programmes in the Republic of Korea, Türkiye, Iran, Yemen (Houthis) and Ukraine. It then proposes explanations as to what purposes serve as main motivations for the development of ballistic missiles as of now, before considering what it means for ballistic missile control and non-proliferation.

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CONTENT

INTRODUCTION

For decades, ballistic missiles have been seen as potentially destabilising weapons, in particular due to their ability to carry weapons of mass destruction (WMDs) and their ability to overcome any potential defence. Driven by the United States, Western countries have endeavoured to adapt regulation to prevent the proliferation of these weapons (Missile Technology Control Regime, or MTCR). In addition, the international community has sought to limit the risks posed by their deployment through confidence-building measures (Hague Code of Conduct against Ballistic Missile Proliferation, HCoC). Nonetheless, these concerns and initiatives have not succeeded in curbing the appetite for ballistic missiles. Thus, an expert noted in November 2024 that 'Russia's use of ground-launched ballistic and cruise missiles against Ukraine has prompted a renaissance among some European countries to reacquire analogous capabilities.'[1] In other regions, the interest in ballistic missiles has been visible for a longer time. In the Middle East, Bahrain, Egypt, Iran, Israel, Qatar, Türkiye, and the United Arab Emirates, but also non-state actors such as the Houthis, militias in Iraq, and Hezbollah have acquired ballistic or quasi-ballistic systems. In the Indo-Pacific, many countries have launched ballistic missile programmes over recent decades, and newcomers are currently trying to procure this capability, such as Myanmar or Indonesia. In addition, hypersonic technologies have recently generated new dynamics, leading countries that traditionally had no visible interest in ballistic systems, such as Australia or Japan, to launch programmes requiring the development of launchers similar to ballistic missiles.

Contrary to the situation from the 1970s to the early 1990s, these recent efforts to procure deep strike capabilities are not systematically linked to a desire to use them for the delivery of WMDs. Technological developments and new concepts of uses have led to a new drive to import or domestically produce ballistic missiles as conventional weapons. Indeed, increased accuracy enabled by improved guidance systems allows for the use of ballistic missiles to destroy specific targets with conventional payloads. In addition, upgraded command, control, and intelligence systems make it possible to identify precisely the location of key targets and strike them, even if these targets are mobile, hidden, or buried. Ballistic missiles are now developed or acquired for deep strike operations, as a complement to traditional airpower. Nonetheless, ballistic missiles and WMDs remain closely associated, and some countries deeply involved in the development of ballistic capabilities are suspected of nuclear proliferation or do not completely rule out the development of nuclear weapons in the future.

In the context of these various efforts to develop missile arsenals, the international community has witnessed extensive uses of missiles on the ground. In Ukraine, Russia has launched more than 250 ballistic missiles on military and civilian infrastructure since the beginning of its aggression. Most of them have found their target and contributed to the degradation of Ukrainian warfighting capabilities and civilian and industrial infrastructure, but they have also impacted the population's morale by causing regular civilian casualties. In the Middle East, Iran launched major missile strikes towards Israel in April and October 2024, while non-state actors, in particular the Houthis, have also extensively utilised ballistic missiles, against land targets during the Yemeni civil war, the war against the Saudi-led coalition, and against Israel, as well as against ships. While these manoeuvres have not had a very strong military effect, mostly because of the deployment of effective active defences, they have achieved very high visibility.

At the same time, the range of long-strike capabilities is becoming more diversified, due in particular to the use of long-range UAVs, weapons that can achieve significant military effects at a low cost. That said, the generalisation of UAVs on the battlefield does not serve as a replacement for ballistic strikes, since their efficiency is highly dependent on geography and on the nature of adversary defensive architectures. For many military powers, acquiring very long-range and high-velocity strike systems that can penetrate defences is a priority. Hypersonic missiles can be a preferred

[1] *Timothy Wright, 'Europe's missile renaissance',* Online Analysis*, IISS, 25 November 2025,* https://www.iiss.org/online-analysis/online-analysis/2024/11/europes-missile-renaissance/

solution to that end, but some countries also opt for the development of systems that vary slightly from traditional ballistic weapons, such as quasi-ballistic missiles, whose endo-atmospheric trajectory limits the effectiveness of certain missile defences. For longer-range missiles, developing technologies that allow the warhead to manoeuvre in the exo-atmosphere is also a solution to overcome defences. These new classes of ballistic missiles allow for sustainable deep strike capabilities in spite of the multiplication of defence systems. Quasi-ballistic technologies are being developed by a growing number of players, such as North Korea and Iran. In many cases, the guidance systems are based on a hybridisation of on-board components and external navigation devices (GNSS), which gives them increased precision.

Based on these experiences, many assessments can be made regarding the value of ballistic missiles as a warfighting tool, but also as a political weapon or means of deterrence. The intentions of dozens of countries to invest or continue their investments in these types of missiles are informed by these developments. It is therefore pivotal to list and understand the current drivers behind these acquisition efforts. Some may be consistent with the traditional role conferred to these weapons, such as delivering WMDs or serving as a deterrent. Others may be more precisely linked to specific military purposes. Finally, economic, technological, and political motivations may also exist. This paper looks at five very different case studies, in the Middle East, Asia, and Europe, in order to infer some of these drivers and assess their evolutions. It then proposes a typology of the various reasons that push countries and non-state actors to develop or buy this category of armament. Finally, it draws a few conclusions related to arms control and non-proliferation.

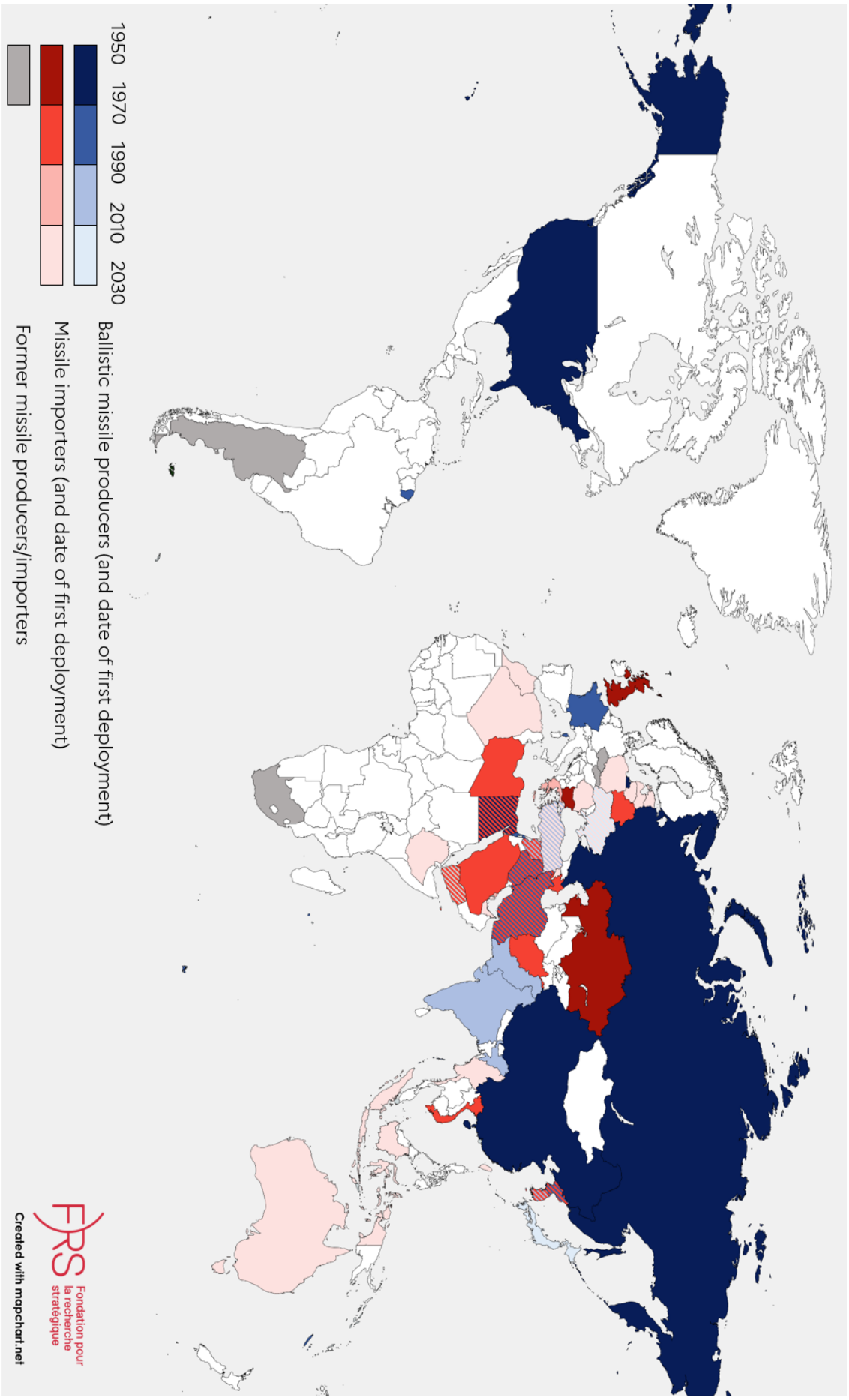

Figure 1: Ballistic missile acquisition and development programmes (Credit: FRS, mapchart.net)

CASE STUDIES

REPUBLIC OF KOREA

From 1961 to 1989, South Korea hosted American nuclear-capable ballistic missiles, in particular the surface-to-air and surface-to-surface Nike Hercules. Under the Park Chung-hee, Seoul judged that it needed to be more autonomous to take into account the threat posed by North Korea and the possible reduction of US support. In 1971, Park Chung-hee demanded the development of an autonomous short-range ballistic missile. Because of the lack of technological know-how and infrastructure in the country at the time, the South Koreans turned to the United States for help. Washington agreed to the transfer of conventional Nike Hercules missiles, which were used as the basis for the first missile produced in South Korea, the Baekgom. This system was known in the United States as the 'Nike Hercules Korea 1' or NHK-1, and its first flight took place in November 1978.

However, in exchange for its assistance, the United States required a commitment from the Korean government that the missiles produced would not have a range above 180 km or a payload over 454 kg. Official guidelines were agreed to that effect in 1979, reflecting US fears that South Korea might be interested in missile technology with the aim of using it for a potential nuclear programme, and that a longer-range missile capability in South Korea may create instability in the region.[2] Due to the increased threat from North Korea, the agreement was modified four times, to allow Seoul to extend the range of its missiles (in 2001, 2012, 2017, and 2020), and it was officially terminated in 2021.[3] Thanks to these developments, South Korea has developed new systems, such as the Hyunmoo-2, a missile with strong external similarities to the Russian SS-26/Iskander-M, and its variants (A; B, with a range of 500 km; C, with a range of 800 km; and 4-4, the first conventionally armed submarine-launched ballistic missile developed by a non-nuclear weapon state).

Figure 2: Hynmoo II and US MGM-140, 5 July 2017 (Credit: US Army)

The Hyunmoo-4, first tested in 2020, displayed an effort to dispose of a heavier warhead (2,000 kg) capable of destroying North Korea's underground military facilities.[4] In October 2024, South Korea displayed the launcher for a new system, the Hyunmoo-5, which is reputed to have a range of 600 km (and therefore could only target North Korea) but, given its size, may be able to reach beyond if coupled with a lighter warhead. As with the Hyunmoo-4, the payload is reputedly extremely heavy, around 8,000 kg, and should enable the destruction of deeply buried and hardened targets. South Korea is the first country to exhibit such a large and heavy intermediate-range missile with a strictly conventional mission.[5]

In parallel with these strategic developments, and in response to its needs in the field of artillery, South Korea has developed a tactical short-range missile for domestic use as well as export, the Ure/KTSSM, a cheaper and more accurate system than the similar MGM-140 ATACMS. Poland was the first country to bid for the missile in 2022.[6]

[2] *Decker Eveleth, 'Missile forces of the Republic of Korea,'* A Boy and His Blog*, 16 July 2021,* https://www.aboyandhis.blog/post/missile-forces-of-the-republic-of-korea

[3] *Timothy Wright, 'US and South Korea scrap ballistic-missile range limits,'* Online Analysis*, IISS, 2 June 2021,* https://www.iiss.org/online-analysis/online-analysis/2021/06/us-south-korea-ballistic-missile-range-limit/

[4] *Jeffrey Lewis, 'South Korea's Hyunmoo-4 and increasing missile capabilities across Northeast Asia,'* Open Nuclear Network*, 3 June 2020,* https://opennuclear.org/open-nuclear-network/publication/south-koreas-hyunmoo-4-and-increasing-missile-capabilities-across

[5] *Joseph Dempsey, 'South Korea's Hyunmoo-5 breaks cover,'* Missile Dialogue Initiative*, IISS, 22 October 2024,* https://www.iiss.org/online-analysis/missile-dialogue-initiative/2024/10/south-koreas-hyunmoo-5-breaks-cover/

[6] *Bartosz Głowacki, 'Poland buying Korean made MLRS, continuing Seoul spending spree,' Breaking Defense, 20 October 2022,* https://breakingdefense.com/2022/10/poland-buying-korean-made-mlrs-continuing-seoul-spending-spree/

Historically, during the Park Chung-hee era, South Korea made clear its desire to acquire nuclear weapons, which was abandoned under US pressure. As the North Korean threat remains strong, and as Pyongyang develops its nuclear capabilities, the debate over whether Seoul should follow suit and develop an indigenous military nuclear programme resurfaces regularly in the country. To this day, the South Korean leadership has refused to yield to the nuclear temptation, thanks in great part to US efforts to convince it of the solidity of US extended deterrence to South Korea. Awareness of the cost of carrying out this plan also played a role in curbing enthusiasm for a national military programme.

For a number of years, the development of ballistic missile capabilities in South Korea has been closely associated with precisely defined conventional missions. In 2013, the Ministry of Defence mentioned for the first time the 'Kill Chain', which aims at conducting pre-emptive strikes on North Korea's nuclear and missile facilities if the country has strong information that the DPRK is preparing a strike.[7] This strategy was renamed 'Strategic Target Strike' in 2019. For these kinds of operations, ballistic missiles are a key asset, as they possess the responsiveness and accuracy needed to target potentially time-sensitive targets.

Moreover, in September 2016, the Park Geun-hye administration detailed a new strategy called 'Korea Massive Punishment and Retaliation' (KMPR). This plans for a massive retaliation in case of a North Korean attack, through precision strikes against Pyongyang's leadership as well as key military targets. One of the reasons why ballistic missiles are attractive to Seoul for this retaliatory mission is the fact that Pyongyang does not currently have any means of intercepting ballistic missiles. Moreover, the flight time across the peninsula is just a couple of minutes, and strike preparations are minimal compared to an air raid. In addition, ballistic missiles would be less subject to North Korean pre-emptive strikes, as they can be more easily dispersed or hidden than aircraft.[8] These two strategies are now part of the '3-axis' strategy (in addition to missile defence).

Ballistic missiles are key enablers in the implementation of pre-emptive strikes or the retaliation strategy, and they play a strong deterrent role, promising strategic damage through conventional strikes in the event of an attack. The development of a submarine-launched missile may follow this logic of conventional deterrence by ensuring the second-strike capability of the missile force, but its military value is debatable. It is also possible that South Korea intends to master underwater launching technology for export purposes, knowing that this technology would be necessary if a nuclear capability should be considered in the future.

The focus of the South Korean military has so far been to expand the range of its missiles to 800 km, enabling it to hold all of North Korea at risk, including the Chinese border, from any point of its territory, while avoiding creating an overreaction in China or Japan (leaving for instance Beijing and Tokyo out of reach of the deployed systems). The priority has been to develop payload capacity to allow the deployment of earth-penetrating warheads and hold at risk bunkers and other underground facilities. The presentation of the Hyunmoo-5 may raise questions for future planning and strategy, as Seoul may be tempted to take advantage of the size of the system to envisage longer-range strikes, if relations with neighbouring countries further deteriorated, for instance.

Finally, the development of tactical close-range ballistic missiles – guided rockets and heavy guided rockets – has been justified by the need to possess a system capable of accurately destroying adverse artillery systems hidden in caves across the border.[9] The fact that they can be exported according to MTCR regulations means that they represent an opportunity for the country to reap some economic benefits from its decades-long investment in missile technologies.

[7] *Clint Work, 'Navigating South Korea's plan for preemption, commentary,'* War on the Rocks, *9 June 2023, https://warontherocks.com/2023/06/south-koreas-plan-for-preemption/*

[8] *Daniel Pinkston, 'The new South Korean missile guidelines and future prospects for regional stability,'* International Crisis Group, *25 October 2012, https://www.crisisgroup.org/asia/north-east-asia/korean-peninsula/new-south-korean-missile-guidelines-and-future-prospects-regional-stability*

[9] *Chae Yun-hwan, 'S. Korea successfully test-fires modified version of ground-based tactical missile,'* Yonhap, *12 January 2024, https://en.yna.co.kr/view/AEN20240112005000315*

	Range	Estimated entry into service
ATACMS - Block 1 / MGM-140	165	2002
ATACMS - Block 1A / MGM-140	300	2002
Hyunmoo-2A	300	2008
Hyunmoo-2B	500 (around)	2009
Hyunmoo-2C	800	2017
Hyunmoo-4	Unknown	Under development
Hyunmoo 4-4	500	Under development
Hyunmoo-5	3000 (around)	Under development
KTSSM	180	2024

Table 1: South Korea's ballistic missiles

TÜRKIYE

Concerns that Türkiye might be targeted by ballistic missiles date back to the beginning of the Cold War, when US PGM-19 Jupiter nuclear-capable ballistic missiles were stationed near Izmir. However, Türkiye's own interest in missiles is more recent. In the 1980s, a period marked by the extensive use of ballistic missiles in combat during the Iran–Iraq War, this interest was expressed in two ways. First, Türkiye acquired some systems off the shelf from its partners, namely the United States. Thus, in November 1995, the US Congress approved the proposition to export 72 MGM-140 ATACMS missiles to Ankara, a deal finalised in May 1996, which were delivered in 1998, with the option of transferring 48 additional units.[10] However, the United States refused to grant a production licence, leading Ankara to develop an indigenous capability in parallel.

The company Roketsan was then established in 1988 as 'a leading institution in the country for designing, developing and manufacturing rockets and missiles'. It started to work with the Chinese company CPMIEC in 1997, first on rockets, and then on ballistic missiles. The contracts included the acquisition of some Chinese weapons, but also technology transfer that enabled the local production in Türkiye of some Chinese-designed missiles (BP-12). From 1998 to 2014, Ankara developed several models of long-range rockets and ballistic missiles with the help of China, increasing the range and performance with each new system, before managing to develop its own indigenous ballistic missile with a range of 280 km, the Bora.[11] A version of the Bora was specifically developed for export, under the name Khan. Indonesia expressed its interest in the missile in 2022.[12] At the same time, Roketsan has pursued its efforts to increase the range of the Bora, with two variants, the Tayfun (tested over 561 km in October 2022)[13] and the Cenk (expected to have a range of over 1,000 km).[14] President Erdoğan recently declared that Türkiye is developing missiles with a range of over 2,000 km.[15] A 'hypersonic' variant of the Tayfun is also in development, even though the Cenk might be more suitable for this project.[16]

Figure 3: New test launch of Tayfun in Turkiye's Rize, 23 May 2023 (Credit: Muhittin Sandıkçı-Anadolu Agency)

[10] George Bozikas, U.S. security assistance and regional balance of power: Greece and Turkey, a case study, *Strategy Research Project, U.S. Army War College, 17 April 1998,* https://apps.dtic.mil/sti/tr/pdf/ADA344973.pdf

[11] Sitki Egeli, 'Turkey embarks upon ballistic missiles: Why and how?,' Uluslararası İlişkiler, *Vol. 14, No. 56, 2017,* https://dergipark.org.tr/tr/download/article-file/631233

[12] *'Disaksikan Menhan Prabowo di Indo Defence 2022, RI dan Turki Teken Sejumlah Kontrak Kerja Sama' [Witnessed by Defense Minister Prabowo at Indo Defense 2022, RI and Türkiye sign several cooperation contracts],* Kementerian Pertahanan Republik Indonesia, *7 November 2022,* https://www.kemhan.go.id/2022/11/07/disaksikan-menhan-prabowo-di-indo-defence-2022-ri-dan-turki-teken-sejumlah-kontrak-kerja-sama.html

[13] *'Turkey tests short-range ballistic missile,'* Arms Control Today, *December 2022,* https://www.armscontrol.org/act/2022-12/news-briefs/turkey-tests-short-range-ballistic-missile

[14] Yesim Eraslan, *'Türkiye to test Tayfun, Cenk and Bora missiles in Somalia,'* hiraan.com, *26 November 2024,* https://www.hiiraan.com/news4/2024/Nov/199072/t%C3%BCrkiye_to_test_tayfun_cenk_and_bora_missiles_in_somalia.aspx

[15] Tony Osborne, *'Turkey developing missiles with 2,000-km range, Erdogan says,'* Aviation Week, *7 January 2025,* https://aviationweek.com/defense/missile-defense-weapons/turkey-developing-missiles-2000-km-range-erdogan-says

[16] *'Breaking news: Türkiye develops hypersonic missile based on Roketsan's Tayfun SRBM variant,'* Army Recognition, *24 September 2024,* https://armyrecognition.com/news/army-news/army-news-2024/breaking-news-tuerkiye-develops-hypersonic-missile-based-on-roketsans-tayfun-srbm-variant

The decision by the Turkish authorities to develop ballistic missiles has several justifications. First, since the 1950s, the country has been living under the threat of a ballistic attack, first from the Soviet Union and later from other states in its vicinity. In the 1970s and 1980s, a number of Türkiye's neighbours acquired or developed ballistic missiles, including countries that may use these capabilities to carry WMDs (Syria, Israel), or countries that may potentially have difficult relations with Ankara, including Iran, Greece (which acquired MGM-140 ATACMS missiles in 1999), Russia, and Armenia (which acquired SS-26/Iskander-E or -M missiles in the 2010s).[17]

Ankara's domestic programmes reflect the country's desire to be fully sovereign on its tactical strike weapons. While the American MGM-140 ATACMS may have been higher-performing than the BP-12 developed under Chinese licensing, the possibility to develop and use strike systems without foreign interference, including against asymmetric actors or the allies of major powers, was a clear Turkish objective. Given the superiority of the Turkish Air Force, the development of tactical strike systems also aimed at reinforcing the industrial base and enabling the conception of longer-range strike weapons.

Developing a short-range arsenal has proved useful for neutralising certain threats, especially those associated with regional countries or local armed groups. Thus, combined strikes (SRBMs, air strikes, and UAVs) against Syrian troops in February and March 2020 had devastating effects, allowing Türkiye to deter both Syria and Russia.

In addition, Ankara has been interested in anti-missile defensive strategies for a long time, both through NATO and with the acquisition of Russian S-400 systems to protect its own assets. However, the development of short- to medium-range offensive missiles seems to better fit a strategy of symmetric retaliatory response. With its strike capabilities, Türkiye can hope to deter some conventional missile attacks by threatening to retaliate in kind. This objective was underscored by a high-ranking Turkish official who indicated in 2016 that 'It is difficult for a country to be deterrent with defensive missiles only [...] This is why offensive [missile] systems too should be developed.'[18]

Nonetheless, short-range systems dedicated to tactical strikes and medium-range (1,000–2,000 km) ballistic missiles address distinct objectives. With medium-range ballistic missiles, Ankara could hold at risk major targets deep in the territory of neighbouring countries and potential adversaries. This is why the decision to pursue longer-range systems, announced at the highest political level, has raised questions.[19] The drivers behind such programmes can include political and military considerations. At the highest strategic level, while Türkiye has officially and consistently renounced the development of nuclear weapons, recent comments by President Erdoğan have given the impression that Ankara could see benefits in developing a hedging strategy.[20] In a regional environment where new countries may choose to proliferate, and confronted with an unfriendly nuclear possessor state and an active proliferating state in its neighbourhood, Ankara may deem it worthwhile to display capabilities in the ballistic domain and a degree of ambiguity in the nuclear domain.[21] Thus, Erdoğan noted as early as 2011 that 'Our neighbour Iran has built missiles with ranges of 2,000–2,200 kilometres. [...] The range of our own missiles [is] 150 kilometres. This is utterly unacceptable. We have to develop what our next-door neighbour Iran has got already.'[22] The prestige factor may also play a role in this decision, especially as the country's leadership does not hesitate to use nationalist rhetoric or to use the prowess of its defence industry to promote its achievements. The announcement of an upcoming 'hypersonic' system may feed into

[17] *Sitki Egeli*, op. cit.
[18] *Burak Ege Bekdil, 'Turkey eyes offensive missiles to boost deterrence,'* Defense News, *16 January 2016, https://www.defensenews.com/land/2016/01/16/turkey-eyes-offensive-missiles-to-boost-deterrence/*
[19] *Sitki Egeli*, op. cit.
[20] *Ece Toksabay, 'Erdogan says it's unacceptable that Turkey can't have nuclear weapons,'* Reuters, *5 September 2019, https://www.reuters.com/article/us-turkey-nuclear-erdogan/erdogan-says-its-unacceptable-that-turkey-cant-have-nuclear-weapons-idUSKCN1VP2QN/*
[21] *Shannon Bugos, 'Turkey shows nuclear weapons interest,'* Arms Control Today, *October 2019, https://www.armscontrol.org/act/2019-10/news/turkey-shows-nuclear-weapons-interest*
[22] *Bülent Aydemir, 'Türk füzesi: Hedef menzil 2500 km' [Turkish missile: Target range 2,500 km],* HT Gazete, *29 December 2011, https://www.haberturk.com/gundem/haber/701120-turk-fuzesi-hedef-menzil-2500-km*

that narrative of a sophisticated and cutting-edge defence industry.

Lastly, the drive to deploy intermediate-range or even longer-range missiles may reflect long-term considerations where threats may no longer come exclusively from regional countries. Occasional tensions with its Western partners and the framing of scenarios where the strategic landscape has changed considerably may push Ankara to hedge against all types of threats and ensure that it is able to conduct military operations in a number of regions and theatres.

	Range	Estimated entry into service
ATACMS - Block 1 / MGM-140	165 km	1991
J-600T Yildrim I	150 km	2001
J-600T Yildrim II	300 km	2008
Bora-1 / Khan	280 km	2017
Tayfun	500-800 km (at least)	2022
Bora-2	Unknown	In development
Cenk	1000 km (at least)	In development

Table 2: Türkiye's ballistic missiles

IRAN

Iran began its work on missiles in the 1970s, under Shah Reza Pahlavi, well before the establishment of the Islamic regime. The Shah launched a vast effort to modernise the country's defence in order to supplant the United Kingdom as protector of the Gulf monarchies and tried to obtain missile technology from the United States and from Israel. These partners abruptly withdrew their support following the Islamic revolution in 1979.

At the start of the Iran–Iraq War (September 1980–August 1988), Tehran had no ballistic strike systems. After Iran acquired its first Scud-Bs from Libya (26 missiles and 6 TELs delivered from December 1984), Syria provided it with training assistance. In October 1983, Iranian officials visited North Korea, probably in connection with the Hwasong-5 programme (the North Korean copy of the Scud-B). After the beginning of the 'War of the Cities' (which began on 5 March 1985), Iran quickly exhausted its stock of Libyan missiles and tried actively to widen its circle of suppliers. In 1985, a delegation led by the future president Rafsanjani visited China, Libya, Syria, and North Korea. In June 1987, Iran signed an agreement with North Korea for the purchase of 90 to 100 Hwasong-5s (Shahab-1s in Iranian nomenclature), which were delivered between July 1987 and February 1988, together with an integration plant. In all, 121 Shahab-1s (Scud-Bs) were fired by Iran against Iraq during the war. At the same time, as early as 1986, China transferred resources for the production of small- and medium-diameter rockets, which Iran started to develop gradually. In 1988, China also began transferring the equipment and know-how needed to develop and test medium-range missiles, a key step in the developments that followed.[23]

The 1990s saw intensified cooperation with North Korea on the Scud-C/Hwasong-6 (Shahab-2 in Iran) and Nodong (Shahab-3) programmes. At the end of the year 1990, Iran and North Korea signed a number of agreements concerning the Hwasong-6/Shahab-2 programme, which was to provide Iran with a domestic production capability. After the first test of the Nodong in North Korea in 1993, complete missiles, 4 TELs, and spare parts were delivered to Iran at the end of 1994. The first flight of the Shahab-3, the Iranian version of the missile, took place on 22 July 1998.

Receiving less attention from international observers, the Zelzal-1 heavy rocket programme, developed at the end of the war against Iraq, probably with assistance from China, was gradually improved and enabled the development of ballistic weapons. From 1998 onwards, the Fateh-110 was developed on the basis of the Zelzal-2 rocket (610 mm). It was initially defined as a heavy guided rocket but was subsequently requalified as a quasi-ballistic missile. The missile entered service around 2002, and it forms the basis of virtually all solid-propulsion short- and medium-range systems developed to date, including the so-called 'hypersonic' devices. The Fateh family of missiles today includes the Fateh-110, 110A, and 110D1, the Khalije Fars and Hormuz-2 anti-ship missiles, the

[23] *'Iran's ballistic missile programme,' in* Iran's strategic weapons programme, *IISS (New York: Routledge, 2005).*

more accurate Fateh-313 and Fateh Mobin (also anti-ship), as well as the Raad-500.[24]

The 2000s also saw the creation of the Iranian Space Agency and the appearance of the first space launchers developed by Iran. In 2007, the Ashura/Sejjil launcher, a two-stage, solid-propulsion missile developed by Iran, marked the emergence of a more autonomous production capability for medium-range solid-propulsion ballistic systems. The decade also saw the development of various derivatives of the Shahab-3, with multiple versions designated Ghadr (Ghadr-101, Ghadr-110, Ghadr-F, Ghadr-S), all of which featured modifications to the main propulsion, structure, guidance system, and warhead.

Since the 2010s, there has been a marked acceleration in programmes for both solid and liquid propulsion. Improved versions of the Fateh-110 have been developed, with range now reaching 5 to 7 times that of the original Fateh-110. With regard to liquid propulsion, developments have focused on manoeuvrability, notably with the Qiam-2 and Emad, derived respectively from the Shahab-2 and Shahab-3. Iran has also mastered liquid propulsion using storable propellants (UDMH/N2O2) with the Khorramshahr. This particular technology may lead to the development of intermediate-range ballistic missiles (IRBMs) or even intercontinental ballistic missiles (ICBMs), as it is the cornerstone of modern liquid-fuel ballistic missiles, notably in Russia.

In the space sector, the attempt to develop a launcher derived from the North Korean Unha-2, the Simorgh, turned out to be a failure, with only three satellites put into orbit out of a dozen launches. However, this is largely offset by developments in the field of solid-propulsion launchers, with the creation of large-diameter solid-propulsion stages, which are currently being developed for more reliable space launchers (Qased and Ghaem), but which are also paving the way for the rapid development of IRBM- and ICBM-type missiles.

This chronology of around forty years of missile development is a good starting point to understand the drivers behind missile development in Tehran. Most strikingly, Iran has focused on the range of systems, to the detriment of payload, for instance. This effort to acquire medium-range and intermediate-range systems is consistent with Iran's overall strategic interests. The country is involved in regional conflicts, in particular in Iraq, in Syria, and in Lebanon, and it describes Israel as a major adversary. Tehran feels the need to be able to strike over distances of at least 1,500 km and to threaten Israel. The combination of the desire to be able to conduct coercive or retaliatory strikes on key locations in the Middle East and the deployment of launchers deep into Iran's territory creates a push for increased range.

It appears that the liquid- and solid-propulsion systems initially served two very different purposes. The deployment of liquid-fuel systems aimed to create a deterrent force that would generate a positive political balance of power with regional powers and with Israel. By focusing system development on range rather than military effect, the political dimension of the arsenal has largely prevailed over any other consideration. At the same time, the search for range is undeniably linked to the ambition to develop nuclear weapons. In this case, questions of weapon accuracy are less important than those of range, justifying the development of systems that may be old-fashioned but which would be capable of carrying out the mission as soon as a nuclear weapon has been developed. It is very likely that the development of the missile arsenal has been carried out with a view to serving a future nuclear deterrent, and although nuclear ambitions may have been kept in check with the signature of the JCPOA in 2015, it may still follow a hedging strategy today. By developing its capabilities, with regard to both delivery vehicles and nuclear technologies, the country has ensured that it could become a credible nuclear-armed state sooner rather than later should the decision be made.

Conversely, the development of solid-propulsion systems was immediately aimed at generating a military effect. The first systems presented were linked to operations on the battlefield and in its depths. Increased range has enabled the mission to evolve towards coercive strikes, justifying the search for precision as well as penetration of defences, which explains the choice of

[24] *Andrew Salerno-Garthwaite, 'Analysis: Iran's Fateh ballistic missile programmes,'* Army Technology, *17 April 2024, https://www.army-technology.com/features/irans-fateh-ballistic-missile-programmes/?cf-view*

terminal-guided quasi-ballistic systems such as the Fateh-313 or the Raad.

Since 2020, the use of many different systems in conflicts may lead to differing assessments of Iran's missile strategy. On the one hand, the strike on the US Al-Asad Airbase in Iraq on 8 January 2020 and the absence of a substantial American reaction may have been interpreted as positive signals for Iran. In effect, this episode may have enabled Iran to validate the concept of precision strikes in the theatre, as well as the value of ballistic delivery systems in the application of coercive strategies.

However, Operation True Promise, carried out by Iran on the night of 13–14 April 2024, in response to the Israeli attack on the consular section of the Iranian embassy in Damascus, may lead to a contrasting analysis. Indeed, the massive launch of various ballistic systems (120 missiles reportedly launched) led to only very minor damage in Israel. The combination of Iranian failures and Israeli interception capabilities led to an overall negative result for the strikes, raising questions around the performance of Iranian systems. It is impossible to assess whether the use of more modern systems, equipped with decoys or capable of initiating their manoeuvre at longer distances, would have led to a more favourable result.

In some respects, the attack of 1 October 2024, named Operation True Promise 2, leads to similar observations. Iran reportedly fired around 200 missiles, the vast majority of which were intercepted or failed to reach their target. The attack seems to have been organised to generate a saturation effect by using low-precision missiles, probably of the Ghadr type, alongside more accurate missiles, possibly with solid-propulsion systems, of the Kheibar Shekan type. The use of Fattah-2, a hypersonic medium-range missile, claimed by Iran, is denied by Israel. Strikes on the Nevatim Airbase may be proof of the greater penetrability of the most modern Iranian missiles. The media reported some 30 impacts on the site, leading the American expert Jeffrey Lewis to assert that as many missiles had hit the base, but also that Israel had been faced with a deficit of interceptors, leading it to prioritise defending urban centres, thus leaving the air base exposed.[25] A confusion between cluster munitions and warheads may have led to the conclusion of a partial failure of the defences, given that Nevatim was slightly impacted by the strike. Since the failure of the defences cannot be proved, the strike can be considered unsuccessful.

Figure 4: Remnants of an Iranian ballistic missile near the Dead Sea, 2 October 2024 (Credit: Zeev Stein)

The Iranian approach, which until the 2010s consisted of developing systems based on old technologies to keep costs down and encourage mass deployment, has now reached its limits, not so much because of these systems' vulnerability to interception, but because of their unreliability. It is likely, however, that the disappointing results of the operation against Israel will call into question the fundamental choices made by Iran over the last forty years, which have focused exclusively on the development of unmanned strike systems. These operations could reignite the debate on the acquisition of airborne platforms, since both aeroballistic systems and future hypersonic systems can be effective as air-launched strike systems. Nevertheless, the ballistic option is likely to remain a priority in Tehran, particularly if Russia or China increase technology transfers, and especially as quasi-ballistic or hypersonic systems offer a greater ability to penetrate defences. Inevitably, Iran will have to change its strategy and opt for high-quality systems rather than for a huge quantity of outdated weaponry. The failure of conventional deep strikes could potentially rekindle the quest for weapons systems that can generate a credible deterrent, in particular nuclear weapons.

[25] *Geoff Brumfiel, 'Satellite images show dozens of Iranian missiles struck near Israeli air base,'* NPR, *4 October 2024, https://www.npr.org/2024/10/04/nx-s1-5140058/satellite-images-dozens-iranian-missiles-struck-near-israeli-air-base*

	Range	Estimated entry into service
Shahab-1	300 km	1988
Shahab-2	500 km	1991
Tondar 69/ M-7	150 km	1992
Shahab-3	800-1300 km	1998
Fateh-110	200 km	2001
Fateh-110 A	250 km	2004
Ghadr-1	1800 km	2007
Sajjil	2000 km	2008
Qiam-1	800 km	2010
Fateh-110 B	300 km	2010
Fateh-110 C/D	300 km	2012
Khalij Fars	300 km	2014
Hormuz-1/2	250 km	2014
Fateh-313	500 km	2015
Emad	1800 km	2016
Zolfaghar / Zulfiqar	700 km	2016
Khorramshahr	2000 km	2017
Fateh Mobin	500 km	2018
Qiam-2	800 km	2018
Dezful	1000 km	2019
Khorramshahr-2	3000 km	2019
Raad 500	500 km	2020
Rezvan	1400 km	2020
Haj Qasem	1400 km	2020
Zolfaghar / Zulfiqar Basir	700 km	2020
Kheybar Shekan	1450 km	2022
Khorramshahr-4/ Kheibar	2000 km	2023
Etemad	1700 km	2025

Table 3: Iran's ballistic missiles

THE HOUTHIS

The effort of the Ansar Allah movement, or Houthi movement, to stockpile, assemble, and launch ballistic missiles is unique. Initially, this non-state actor started using missiles captured from official arsenals, before turning to other suppliers to gain power in the Yemeni civil war. After managing to seize and hold a significant part of the country, it has used ballistic strikes against a wide array of international opponents, in particular Saudi Arabia, the United Arab Emirates, and Israel. Finally, its decision to use anti-ship ballistic missiles in November 2023 is also a first. While none of these missions can be qualified as an unquestionable success, the Houthis seem to give great importance to their ballistic arsenal, and there appear to be several reasons behind their desire to develop it.

As is the case with other countries, the acquisition, development, and use of ballistic missiles by the Houthis cannot be viewed in isolation and must be considered alongside their procurement of cruise missiles and UAVs. However, the massive use of this technology and the rather unique strategy regarding ballistic strikes deserve specific attention. R-17 Elbrus (SS-1C) and OTR-21 Tochka (SS-21) missiles were bought from the Soviet Union in the 1980s and 1990s. While these initial stockpiles were largely exhausted by domestic conflicts, Sanaa imported Scud-Bs (Hwasong-5) and Scud-Cs (Hwasong-6) from North Korea beginning in 1999. These systems, alongside Soviet surface-to-air missiles, made up the initial arsenal possessed by the Ansar Allah movement when it took control of a large part of the Yemeni territory in 2011. Following that date, the Houthis claimed that they had started to design and produce missiles locally, at the 'Missile Research and Development Center'. However, it appears that the group has mostly relied on the transfer from Iran of various missile systems, components, and technologies.[26] Transfers have in particular been documented by the UN Panel of Experts tasked with assessing the implementation of sanctions against the group.[27]

Through cooperation with and direct acquisition from Iran, and despite efforts from the Saudi-led coalition to destroy the Houthis' offensive capabilities on the ground, the group has been in a position to develop a varied arsenal. The Burkan-1 is the first system it presented, a likely evolution of the Scud-C modified by Iran. The increased-range Burkan-2 and -2H, very similar to the

[26] *Jean Masson, 'Les missiles des Houthis : prolifération balistique et groupes armés non-étatiques' [Houthi missiles: Ballistic proliferation and non-state armed groups], Recherches & Documents, FRS, No. 11/2018, December 2018, https://www.frstrategie.org/sites/default/files/documents/publications/recherches-et-documents/2018/201811.pdf*

[27] *Final report of the Panel of Experts on Yemen, United Nations Security Council, S/2021/79, 25 January 2021, https://docs.un.org/en/S/2021/79*

Iranian Qiam, confirm the role played by Tehran in the development of the Houthi arsenal, either through direct export or through the export of components later assembled in Yemen.[28]

Figure 5: Zulfiqar ballistic missile debris used in the attack on Dubai International Airport, February 2022 (Credit: UN Panel of Experts on Yemen)

The Houthis have been regularly presenting upgraded versions of these initial systems, focusing primarily on increasing their range. Thus, in 2019, the Houthis launched the Burkan-3, also based on the Qiam, with a range of at least 1,200 km. A very similar system was presented in 2021 under the name Zulfiqar. In September 2023, the Toofan was exhibited during a military parade in Sanaa. This new system is similar to the Iranian Shahab-3 or Ghadr and could reach targets almost 2,000 km away.

In addition to these liquid-fuel systems, the Houthis have also imported solid-fuel technologies and in particular a model called the Hatem, displayed in 2022 and based on the Iranian Kheibar Shekan medium-range ballistic missile (MRBM). With a shorter range, the Karar, which appeared in the arsenal in 2022 as well, seems to be a variant of the Fateh-110. Finally, like Tehran, the Houthis have shown an interest in obtaining anti-ship ballistic missiles. The Asif/Asef was unveiled in 2022 and appears to be a copy of the Fateh-313, with a range announced at 400 km. The Tankeel was paraded in 2023 and seems to have an anti-ship version as well as a surface-to-surface version. It shares identical features with the Iranian Raad-500.[29] Three shorter-range systems have also been displayed, the Faleq, Mayun, and Bahr al-Ahmar. The most complex of these weapons are clearly derived from Iranian technologies, but some of them are sufficiently different to illustrate the advent of a domestic engineering capability.[30]

Due to the massive use of missiles in the various operations led by the Houthis between 2015 and 2022, it is possible to assume several drivers that have led the group to develop a ballistic arsenal. During the conflict with the Saudi-led coalition, ballistic strikes were conducted in retaliation to air bombings targeting the area controlled by the group, and therefore followed a political logic. But a number of strikes also had a military underpinning, targeting sites for tactical purposes.

The increase in the range of Iranian missiles enabled the Houthis to fire deep into their enemies' territory and to reach highly populated or symbolic cities, in particular Mecca, Jeddah, or Riyadh. These strikes did not lead to much damage, in particular due to anti-missile systems used to intercept the missiles. However, they had a psychological effect, showing the ability of the Houthis to strike deep into Saudi Arabia, and even the United Arab Emirates in January 2022. The retaliatory logic was fully present with a demonstration of the potential vulnerability of Saudi Arabia and its coalition, especially civilian areas, and as a response to air bombings in Yemen. The symbolic nature of some strikes has appeared clearly with the reduction of the payload of some missiles, aiming at increasing their range but logically limiting the amount of damage observed on the ground.[31] It can be assessed that this strategy was somewhat successful as a means of asymmetric warfare: The strikes, even those intercepted, received major media coverage and have been described by the UN experts as 'strategic propaganda'. They illustrated the inability of the coalition to destroy the Houthis' strike capabilities, as the group learnt to strike from rural areas of northwest Yemen or Sanaa itself, constantly changing the launch sites and moving launchers around, rendering their destruction difficult through the air. In 2018, the group started to launch from an underground site. The campaign forced

[28] *Jean Masson*, op. cit.
[29] *'Iran: Enabling Houthi attacks across the Middle East,'* Defense Intelligence Agency, *February 2024*, https://www.dia.mil/Portals/110/Documents/News/Military_Power_Publications/Iran_Houthi_Final2.pdf
[30] *Fabian Hinz, 'Houthi anti-ship missile systems: Getting better all the time,'* Military Balance Blog, *IISS, 8 January 2024*, https://www.iiss.org/online-analysis/military-balance/2024/01/houthi-anti-ship-missile-systems-getting-better-all-the-time/
[31] *Final report of the Panel of Experts on Yemen, United Nations Security Council, S/2018/68, 26 January 2018*, https://www.securitycouncilreport.org/atf/cf/%7B65BFCF9B-6D27-4E9C-8CD3-CF6E4FF96FF9%7D/s_2018_68.pdf

Saudi Arabia and its allies into a protracted conflict and to invest in costly defensive systems.[32]

In parallel, the Houthis led a persistent strike campaign against military assets of the coalition located closer to its border and in particular in the southern Saudi cities of Abha, Khamis Mushait, Najran, and Jizan. This campaign included ballistic missiles but also UAVs, cruise missiles, and guided rockets.

Following the ceasefire reached with Saudi Arabia in April 2022 and the truce that ensued, the number of missiles fired by the Houthis sharply diminished. Nonetheless, in reaction to the Israeli operations in Gaza in October 2023, the group launched a new campaign of strikes that illustrated another aspect of its concepts of use for missiles. For the first time, anti-ship ballistic missiles were fired in combat, in conjunction with other weapons. From November 2023 onwards, the group has regularly launched anti-ship missiles from its shores towards commercial cargo vessels passing through the Red Sea and the Gulf of Aden. A few of these missiles have been intercepted by US or allied naval defences. Many have failed to reach their target. Some have taken direct hits at ships, including a strike on the *Rubymar*, a cargo ship carrying fertiliser and other products, sunk on 2 March 2024.

Figure 6: USS Carney fires at Houthi missiles and unmanned aerial vehicles in the Red Sea, Oct. 19 (Credit: US Navy)

Striking commercial ships is not a new strategy in the region; it was observed during the Iran–Iraq War. On this occasion, Iraq targeted ships carrying Iran's oil exports and vice versa, Iraq using mostly airpower and cruise missiles for these missions and Iran redirecting air-to-surface missiles as anti-ship weapons.[33] Even if the actual damage was unequal, the 'Tanker War' caused disruption and pushed the United States to intervene to defend freedom of navigation.

In the case of the Houthis, the choice to target ships in this highly strategic region can be understood as a desire to display its alignment with the so-called 'Axis of Resistance', sending a message of vulnerability to the United States, which has not been able to prevent this disruption to maritime traffic, but also to strengthen its position domestically. Moreover, these strikes have been coupled with direct attacks on Israel, with several announcements of missiles launched towards Eilat in particular, all intercepted or failing to reach their target. The Houthis therefore showed their intention to play a role in regional conflict dynamics, including almost 2,000 km away from their bases.[34] The fact that they started to build up their arsenal of anti-ship weapons long before the beginning of the conflict between Israel and Hamas shows that the objective of using the strategic position on the Bab el-Mandeb Strait to attempt a scheme of naval coercion was already anticipated by the group and its supporters in Tehran.[35] If the success of the strategy is measured in terms of disruption, the operation can be qualified as successful; even though the deviation of traffic from the Red Sea has not led to major upheavals, it has still caused many issues, in particular for neighbouring countries.

However, resorting to ballistic missiles for naval strikes is more surprising, especially for an actor that does not possess the most up-to-date systems. Indeed, hitting a ship requires very high precision. China is known to have developed systems with the required precision to hit ship-sized targets, and it possesses target identification and localisation tools that may not be available to the Houthis or even Iran. Iranian anti-ship

[32] *Ron Christman, '"Lower end" missile threats: The case of Yemen,'* Missile Defense Review Issue Brief, *February 2017,* https://www.academia.edu/31708552/MISSILE_DEFENSE_REVIEW_ISSUE_BRIEF_YEMEN_Lower_End_Missile_Threats_The_Case_of_Yemen

[33] *Martin S. Navias and E. R. Hooton,* Tanker wars: The assault on merchant shipping during the Iran–Iraq crisis, 1980-1988 *(London: I. B. Tauris Publishers, 1996).*

[34] *Ibrahim Jalal, 'The Houthis' Red Sea missile and drone attack: Drivers and implications,'* Middle East Institute, *20 October 2023,* https://www.mei.edu/publications/houthis-red-sea-missile-and-drone-attack-drivers-and-implications

[35] *Fabian Hinz,* op. cit.

missiles possess electro-optical and infrared (EO/IR) seekers for terminal guidance.[36] It appears that the Houthis' systems also have these capabilities. Given the number of systems failing to hit the targeted ships, the guidance systems may be unreliable. The targeting procedure may also be too crude to expect success.[37] These limitations may explain why the group seems to have targeted mostly commercial tankers and cargo vessels, which are bigger than warships and much less able to deviate from their trajectory to avoid an impact.[38]

Whether on land or on sea, the use of short- and medium-range ballistic missiles by the Houthis, regularly but in small numbers and against hard-to-strike or well-defended targets, has had minor military effects. Most have failed to reach their target or have been intercepted. Given this lack of effectiveness, experts have wondered why Iran has seemed intent to pursue its strategy of export to the group and of potentially creating ballistic missile assembly plants in Yemen. Indeed, UAVs, or even cruise missiles, may be much cheaper while achieving comparable results.[39]

Several factors may contribute to explaining this strategy. First, both the Saudis and now the United States appear to have had difficulty destroying the launchers pre-emptively. The Saudis launched 600 airstrikes per month in 2021, and the United States Central Command announced the destruction of several launchers every month in 2024, and yet it does not seem to have affected the Houthis' missile production infrastructure or ability to strike, in particular due to their ability to use the mountainous nature of their territory, to hide in highly populated areas where allies cannot strike out of humanitarian concerns, and to build underground facilities.[40]

Second, forcing their adversaries to use expensive interceptors to destroy the missiles may be a tactic in itself to push them to waste resources and up the cost of opposing the Houthis, as it creates an asymmetry of stakes. In the long run, the Houthis' operations have proved very demanding for their opponents, notably for Saudi Arabia, which was obliged to acquire a large number of THAAD systems.[41]

	Range	Estimated entry into service
Qaher-1	250 km	2015
Qaher-M2	400 km	2017
Burkan-1	800 km	2016
Burkan-2	1000 km	2017
Burkan-2H	900 km	2017
Burkan-3/Zulfiqar	1200 km	2019
Toofan	1950 km	2023
Aqeel	1000 km	2023
Hatem	1450 km	2022
Karar	200-300 km	2022
Asif	300-400 km	2022
Mohit	300 km	2022
Tankeel	500 km	2023
Hatem-2	Unknown	2024

Table 4: Houthis' ballistic missiles

UKRAINE

As a Soviet Republic, Ukraine was deeply involved in missile production. Some major Soviet aerospace industries were located on its territory, in particular Yuzhmash and the Yuzhnoye Design Bureau in Dnipro, or Khartron in Kharkiv. For instance, the R-36/SS-28 Satan was designed and manufactured in Ukraine. Moreover, when the country gained independence in 1991, it inherited a large ballistic arsenal, namely SS-19/UR-100N and RT-23/SS-24 Soviet ICBMs, but also SS-1C/R-17 Scud and SS-21/OTR-21 Tochka short-range systems. ICBMs were shipped to Russia, along

[36] Ibid.
[37] *Sam Cranny-Evans and Sidharth Kaushal, 'Securing the Red Sea: How can Houthi maritime strikes be countered?,'* Commentary, *RUSI, 10 January 2024, https://rusi.org/explore-our-research/publications/commentary/securing-red-sea-how-can-houthi-maritime-strikes-be-countered*
[38] *Sébastien Roblin, 'We might have just seen the world's first anti-ship ballistic missile attack,'* Popular Mechanics, *1 December 2023, https://www.popularmechanics.com/military/navy-ships/a45964460/first-anti-ship-ballistic-missile-attack-houthi-rebels/*
[39] *Sidharth Kaushal, 'Lessons from the Houthi missile attacks on the UAE,'* Commentary, *RUSI, 3 February 2022, https://rusi.org/explore-our-research/publications/commentary/lessons-houthi-missile-attacks-uae*
[40] *Sam Cranny-Evans and Sidharth Kaushal,* op. cit.
[41] *Shervin Taheran, 'THAAD sale to Saudi Arabia moves forward,'* Arms Control Today, *April 2019, https://www.armscontrol.org/act/2019-04/news-briefs/thaad-sale-saudi-arabia-moves-forward*

with nuclear warheads. However, Kyiv kept two brigades of tactical short-range missiles. While some of the launchers were destroyed, retired from service, or possibly sold, a few remained operational until the Russian aggression in 2022 and were fired in the early days of the conflict. Ever since its independence, Ukraine has attempted to develop a new system to replace the outdated Tochka and Scud, in particular since the United States kept asking the government to destroy those systems because of their ability to carry WMDs. Under various names (Borysfen, Grom, Sapsan), the Ukrainian missile industry kept working on a programme that met with very little success, mostly due to a lack of funding. The interest in the programme almost vanished during the presidency of the pro-Russian Viktor Yanukovych and was 'suspended' in 2013. However, it re-emerged in 2015, when President Petro Poroshenko evoked the signature of a new contract for Yuzhmash, and in a context of conflict with Russia. This appeared to refer to a deal signed with Saudi Arabia for the development of the Grom or Hrim-2. The Saudis are reputed to have contributed financially to the production costs in exchange for a promise that they would receive a batch of the new weapon.[42] Deliveries should have occurred from 2022 onwards, but in the context of the war, no public information has been available to confirm that the export was still scheduled. In the short term, Kyiv may want to keep all available missiles for its armed forces. Funding issues seem to have delayed the programme substantially. Moreover, the efforts of Russia to target the Yuzhmash complex in Dnipro may have seriously damaged production facilities. It was hit at least three times, in July 2022,[43] November 2022,[44] and very visibly on 21 November 2024, with the use of the Russian intermediate-range missile Oreshnik.[45] Therefore, rumours of the use of an indigenous Ukraine missile on the ground, since 2022, mostly found on Russian social media, have been impossible to confirm.[46]

Figure 7: Grom / Hrim-2 tactical missile mockup

Despite these difficulties, President Volodymyr Zelenskyy announced in August 2024 that Ukraine had tested its first domestic short-range ballistic missile, presumably the Grom.[47] In October 2024, Ukrainian officials indicated that they were expecting 'concrete results' from their ballistic missiles very soon.[48] In November 2024, President Zelenskyy mentioned that the country had produced 'its first 100 missiles'.[49] On both occurrences, the name of the system was not confirmed. From its previous exhibition at an arms show in 2018, the Grom appears very similar to the SS-

[42] *Norman Cigar, 'Missiles, money, and power politics: The Riyadh–Moscow–Kiev triangle,'* The Journal of Slavic Military Studies*, Vol. 30, No. 2, April 2017.*
[43] *Laurence Peter, 'Missile strike on Ukraine space plant in Dnipro kills three,'* BBC News*, 16 July 2022,* https://www.bbc.com/news/world-europe-62189844
[44] *Pavel Polityuk, 'Russian missiles pound Ukrainian energy facilities and defence plant,'* Reuters*, 17 November 2022,* https://www.reuters.com/world/russian-missile-strikes-target-ukrainian-gas-production-facilities-ukraines-pm-2022-11-17/
[45] *'Putin says Russia attacked Ukraine with a new missile that he claims the West can't stop,'* AP News*, 22 November 2024,* https://apnews.com/article/russia-ukraine-icbm-attackddnipro-38b0faf6eed2cef98bdbc9be18f58244
[46] *'Russia claimed for the first time that Ukraine used Hrim-2 TBM,'* Militarnyi*, 30 March 2023,* https://mil.in.ua/en/news/russia-claimed-for-the-first-time-that-ukraine-used-hrim-2-tbm/
[47] *Joseph Trevithick, 'Ukraine says it has tested a new domestically-designed ballistic missile,'* The War Zone*, 27 August 2024,* https://www.twz.com/air/ukraine-says-it-has-tested-a-new-domestically-designed-ballistic-missile
[48] *David Axe, 'Ukraine is about to get a missile that could kill Putin,'* The Telegraph*, 1 November 2024,* https://www.telegraph.co.uk/news/2024/11/01/ukraine-war-ballistic-missile-hrim-2-putin-moscow-strike/
[49] *'Ukraine has produced its first 100 missiles, Zelensky says,'* The Kyiv Independent*, 9 November 2024,* https://kyivindependent.com/ukraine-has-produced-its-first-100-missiles-zelensky-says/

26/Iskander-M, is mobile, and could have a range of between 300 and 500 km.[50]

In parallel, Ukraine has actively sought since the beginning of the Russian aggression to obtain ballistic missiles from its partners. Initially hesitant, the United States eventually agreed to send a small number of short-range MGM-140 ATACMS missiles in October 2023, used in theatre soon after. In April 2024, Washington officially confirmed the delivery of ATACMS missiles capable of hitting targets 300 km away, in a context where Ukraine was being regularly hit not only by the Russian Iskander but also by the North Korean KN-23 or KN-24. These transfers came with limitations, however, since Ukraine was not allowed to strike in Russian territory. In November 2024, this restriction was lifted by President Biden, which has led to a few strikes recorded on Russian territory and in particular in Kursk Oblast.[51]

Since 2022, the Ukrainian authorities have been very open about why they believe ballistic missiles could help them win the war. In particular, they have insisted on the tactical use that these weapons could have, striking Russian military capacities stationed across the border, such as air bases, supply depots, or communication centres. According to the Ukrainian government, they would be especially useful for eroding Russia's air superiority and diminishing Moscow's ability to conduct destructive missile and air raids over the country.[52] Upon delivery, some high-level officials displayed great optimism and confidence in the system's ability to modify the dynamic of the war, noting that 'a new chapter of the war has begun' and that in the medium term, Russia would not be able to 'retain the south, Crimea, and the Black Sea Fleet'. While this assessment may have reflected a need to boost morale among Ukrainian fighters, there is at least a recognition that the missile forced Russia to move its logistical hubs as well as some bases further away from the frontline, complicating the way it deploys its forces.[53]

In addition to their operational use on the ground, ballistic missiles, even coupled with conventional warheads, may have a deterrent effect in the eyes of Ukrainian leaders. Thus, Ukrainian Air Force press secretary Yurii Ihnat stated in 2022 that had Ukraine possessed 'a thousand [Hrim-2] missiles, there would have been no cause for war.'[54] War rhetoric may be prone to exaggeration, but there is probably a political role associated with these weapons, and the ability to hold at risk targets deep within Russian territory seems very attractive to the authorities as a way of offsetting the current imbalance on the ground. It appears as the kind of weapon that could 'increase the cost of aggression exponentially'.[55] For more than two years, the country has been the target of widespread missile attacks that have killed hundreds and destroyed a great number of military and civilian assets. Ballistic missiles have not been the most frequently used weapons for these raids (compared to UAVs or cruise missiles), but they are the ones that have most systematically found their mark. Being able to strike back on Russian territory, overcoming defences, is therefore an explicit motivation, both for military and political reasons.

Lastly, it should be noted that there were also economic and technological drivers behind Ukraine's desire to maintain a missile capability after independence. Given the weight of the missile production industry in some communities, there was a real incentive to preserve some activity in the biggest job-providers, especially around Dnipro. This led to efforts to redirect production lines and guide offices' efforts towards space launch vehicles. This push also satisfied the objective of preserving a rare expertise on rocket engineering and manufacturing, a source of pride and prestige for the young nation. The personal connection of many Ukrainian

[50] *'Ukraine unveils new Hrim-2 short-range ballistic missile (Photos, video),'* Unian.info, *3 January 2018,* https://www.unian.info/economics/2329504-ukraine-unveils-new-hrim-2-short-range-ballistic-missile-photos.html

[51] *Claire Mills, 'Military assistance to Ukraine since the Russian invasion,'* House of Commons Library, *25 November 2024,* https://researchbriefings.files.parliament.uk/documents/CBP-9477/CBP-9477.pdf

[52] *'Why Ukraine wants to use Western long-range missiles inside Russia,'* AP, *13 September 2024,* https://apnews.com/article/ukraine-russia-missiles-war-nato-zelenskyy-b8039dcdd5b5f03415acd757fbead8e6

[53] *Peter Dickinson, 'Ukraine receives potentially game-changing long-range US missiles,'* Atlantic Council, *17 October 2023,* https://www.atlanticcouncil.org/blogs/ukrainealert/ukraine-receives-potentially-game-changing-long-range-us-missiles/

[54] *Miles Pomper and Vasilii Tuganov, 'Role of missiles in Russia's war on Ukraine and its implications for the future of warfare', in Adérito Vicente, Polina Sinovets, and Julien Théron, eds.*, Russia's war on Ukraine: The implications for the global nuclear order *(Cham: Springer, 2023).*

[55] *Norman Cigar,* op. cit.

leaders since independence with the Dnipropetrovsk region and the industry in particular may have contributed to reinforcing this desire to maintain skills and know-how.[56] The foray into the civilian launcher market has met with some success with the continuation of the Zenit and Tsyklon programmes, the launching of 22 Dnepr rockets converted from SS-18 ICBMs, and the commercialisation of engines for the fourth stage of the European Vega or the American Alpha. A few months before the invasion, New Space start-ups such as Skyrora and Firefly Aerospace were investing in Dnipro for the production of their launchers.

	Range	Entry into service
ATACMS - Block 1A / MGM-140	300 km	2023
Hrim-2 / Grom	480 km	Under development

Table 5: Ukraine's ballistic missiles

DRIVERS BEHIND BALLISTIC MISSILE ACQUISITION TODAY

DELIVERY VEHICLES FOR WMDS

Although the increasingly systematic use of ballistic missiles for conventional strikes represents one of the major technological evolutions of the last twenty years, it would be a mistake to neglect the question of their coupling with WMDs.

First of all, conventional strike represents a considerable industrial challenge, requiring a large mass of munitions to achieve lasting military effects. The use of low-cost munitions capable of operating over long distances is certainly an important development in the current typology of conflicts, but ensuring an operational strike capability over time by these means alone requires major investment in equipment that is constantly exposed to obsolescence. In most cases, countries deploying ballistic missiles have only an occasional capability to strike in the depth and must use them sparingly, limiting their military impact.

The resurgence of the nuclear factor in international relations, epitomised by the ambiguity of Russian discourse since the invasion of Ukraine, has several implications, recalling that the threat of the use of nuclear weapons remains a strong factor of deterrence but also of coercion. In Asia, through the development of their arsenals, both China and North Korea are gradually undermining the credibility of the United States' extended deterrence, provoking in some countries more open debates on the desirability of developing a nuclear programme. The dramatic failure of the Iranian strikes against Israel will probably have the same effect on Tehran, which has seen its conventional deterrent collapse and may wish to explore the nuclear option even more aggressively. In this context, the invasion of Ukraine, which has been denuclearised in exchange for ineffective guarantees, may represent a clear call to proliferation for a number of states that belong to ad hoc alliances whose reliability is highly dependent on the military resources of a potential aggressor.

With the exception of the Ukrainian and Houthi cases, which are relatively specific, the examples studied above all show a more or less strong interest in nuclear weapons on the part of states developing a ballistic capability, past or present. Although it is sometimes circumstantial, there is a correlation between the move for states to develop ballistic strike capabilities and an unstable security environment, which could lead them to opt for nuclear weapons. This is the case for Iran, where the build-up of a stockpile of highly enriched fissile material goes hand in hand with a desire to strengthen its deterrent capability. With no alliance mechanism, Iran has been compelled to think about its deterrent both in terms of weapon and delivery system, and the link between the development of ballistic and nuclear capabilities is naturally more obvious.

[56] *'Redirecting Ukraine's missile industries,'* The Adelphi Papers, *Vol. 37, No. 309, 1997.*

This model could very well be applied to Ukraine, even if the conditions for such a development are difficult to imagine at this time. The case of Türkiye is undoubtedly the most emblematic, as the search for a long-range strike capability is not only rational in conventional terms but could also become a prerequisite for more strategic programmes.

However, the usefulness of long-range weapons systems (i.e., MRBMs or even IRBMs) for conventional strikes means that they can no longer be systematically associated with a WMD programme. This dissociation is not new but is increasingly obvious, since missiles such as the Chinese DF-26 (4,000 km) are now defined as having both nuclear and conventional strike capabilities.

FACTORS RELATING TO CONVENTIONAL DEEP AND VERY DEEP STRIKE

A brief examination of the defence programmes of European countries, Japan, or South Korea shows that the issue of deep and even very deep strike (i.e., equivalent to strategic or quasi-strategic ranges) has become an absolute priority. Surprisingly enough, many of these programmes have been launched in the absence of defined concepts of use, with a number of states adopting a capabilities-based approach based on concepts developed in the United States or deduced from observations of the war in Ukraine.

As pointed out, deep strike raises the issue of stockpiles and therefore, implicitly, may lead to the massive dissemination of technologies. The military effect of the strike can only be guaranteed by the massive use of relatively precise devices. Since they have to overcome active countermeasures (missile defences, electronic warfare systems, etc.), the missiles used are subject to constant modernisation, both in terms of propulsion (more energetic propellants, long propulsion phases associated with complex trajectories) and guidance systems, which must be capable of acting autonomously over longer phases. In order to maximise the effect of the weapon system, missiles tend to be combined with munitions that generate area effects (sub-munitions, fuel-air munitions) but also, in the very near future, with drones and loitering munitions. The latter will soon be required to act in complete autonomy, raising an ethical issue linked to the use of autonomous weapons. At the same time, ballistic systems continue to be preponderant and effective elements in anti-access strategies, forcing an aggressor to distance and/or disperse its military resources, thereby eroding its offensive potential.

This spiral seems irreversible, since it is already coupled with the massive development of ISR (intelligence, surveillance, and reconnaissance) resources designed not only to facilitate deep strike but also to produce in a very short operational timeframe decapitation effects on critical parts of opposing forces. The combination of resilient ISR tools and robust deep strike systems gives some countries hope of building a conventional deterrent capability to complement their nuclear deterrent. While it is doubtful that such a capability could be achieved without close association with US assets, the belief that being able to conduct strikes deep into enemy territory could be politically dissuasive remains widespread, especially as weapons are getting more precise. Iran successfully capitalised on its capabilities before the confrontation with Israeli defences largely undermined its deterrent ability.

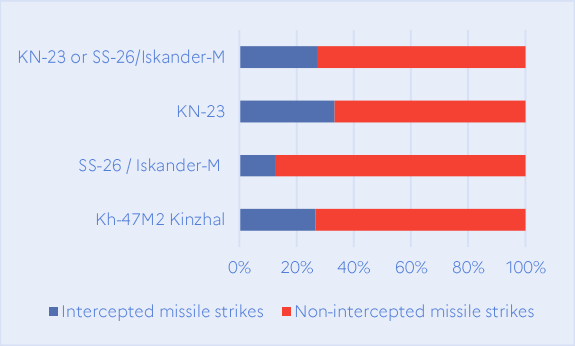

Figure 8: Russian ballistic missile strikes over Ukraine since 2022 (Credit: FRS, Sources: Ukranian Air Force)

There is however a thin line between a strike capability that enables the destruction of the opposing force system and the use of this arsenal to strike civilian infrastructures, in a logic of terror. From this point of view, the Russian example in Ukraine is merely an explicit confirmation of this evolution, knowing that the extension of strikes to non-military objectives is not the sole prerogative of authoritarian regimes. During NATO's operations in Kosovo in 1999, the lack of political effect of air strikes against the Serbian forces led to a broadening of the

targets to include certain economic infrastructures.[57] Consequently, while the development of a deep strike capability may, in qualitative terms, be part of a logic of deterrence by denial, aimed above all at military objectives, it tends to degrade rapidly towards a strategy of retaliation or even reprisals, which exposes civilian populations. The only positive point is that, compared with the massive use of airpower for retaliation or reprisals, the lethality of ballistic systems is often lower, as the stockpile of weapons available is generally smaller.

ARMS RACE

As was amply demonstrated in the debates on strategic defences in the 1970s, missile defence is a factor in the arms race, both qualitatively and quantitatively. However, contrary to the very optimistic estimates of the time, while defences accelerate the arms race, their absence does not prevent it. Therefore, while defences are an explanatory factor in the proliferation and dissemination of ballistic technologies and generate, in absolute terms, a tangible arms race, their withdrawal or limitation will have only a marginal effect, more perceptible in budgetary terms.

The destruction caused by a ballistic missile against an undefended target is no different from that achieved against a target whose defences have been penetrated. Conversely, as shown by the Israeli examples, at both the tactical and strategic levels, defences can play a positive role in protecting both the population and military infrastructures, which is likely to call into question any initiative aimed at regulating them. As shown in this case but also in Ukraine, defences have a positive impact on the outcome of a conflict and are now perceived as a crucial asset to protect troops, infrastructure, and the population.

Clearly, they induce a constant modernisation of offensive weapons systems, notably ballistic and hypersonic missiles, which remain particularly well suited to destroy defensive systems. They provoke a massive dissemination of technologies, as shown by the emergence of programmes in a wide array of states. The need for persistent ISR, i.e., space-based ISR systems and advanced communication networks, is boosting demand for sovereign responsive space capabilities and notably for small space launchers whose technology is almost identical to ballistic technology. Distinguishing civilian space technology from military space technology is now almost impossible, since numerous civilian technologies are dual-use and needed to develop a space economy. It is therefore impossible to forbid their transfer on the sole ground of ballistic proliferation.

PRESTIGE

The acquisition of ballistic missiles for prestige purposes has long been an argument for denouncing the programmes of countries seeking to develop a national capability. The underlying idea was that for the majority of countries, the programmes were of little use and that their leaders intended to use them for propaganda purposes. Fundamentally, the political instrumentalisation of ballistic programmes is a reality, and it historically applies to the vast majority of states that have developed such a capability, including Western states. From this point of view, there is a stigmatisation of emerging ballistic powers by historical ballistic powers, generally on the grounds that the programmes do not meet a real military need but are rather an expensive extravagance of local power.

This bias also leads to a certain myopia, with the international community focusing on the development of long-range ballistic programmes (IRBMs, ICBMs) and neglecting short-range system programmes, which are nevertheless an excellent gateway for the proliferation of ballistic technologies, particularly for solid propulsion.

We have briefly observed the same disdain for hypersonic technologies, which some would have sought to reserve for 'responsible' powers only, i.e., either members of the P5 or Western powers.[58]

[57] *Benjamin S. Lambeth,* NATO's air war for Kosovo: A strategic and operational assessment *(Santa Monica: Rand Corporation, 2001),* https://www.rand.org/content/dam/rand/pubs/monograph_reports/MR1365/RAND_MR1365.pdf

[58] *Richard H. Speier, George Nacouzi, Carrie Lee, and Richard M. Moore, 'Hypersonic missile nonproliferation,'*

However, while there is a real notion of prestige associated with mastering these technologies, the multiplication of defences gives their development real military significance.[59]

CONSEQUENCES ON ARMS CONTROL, NON-PROLIFERATION, AND EXPORT CONTROL

ACCESS TO TECHNOLOGY

The issue of legitimate access to technology, which was highlighted in the drafting of the HCoC, remains as complex today as it ever has been. The development of space and ballistic launch capabilities is intrinsically linked, and the international community has tried, both through the HCoC and the MTCR, to avoid confusing the two, so as not to deprive states of legitimate technologies in their quest for access to space. For a long time theoretical, since it was limited to a few very specific cases that were ultimately clearly discernible, this issue has become much more complex and concrete.

The 'New Space' approach, characterised by the emergence of a very large number of state and non-state players developing means of access to space, is generating a massive dissemination of propulsion, navigation, and guidance technologies. The multiplication of small launcher programmes, which correspond de facto to IRBM- or ICBM-type devices capable of positioning clusters of small satellites in precisely defined orbits, technologies that are close to MIRV technologies, is creating a landscape in which most of the ballistic value chain is standardised and is no longer a protected military technology.

In addition, a second trend shows the desire on the part of a growing number of states to master civilian or military hypersonic technologies. Civilian applications are based on efforts to develop single-stage-to-orbit (SSTO) vehicles, leading to the development of super-ramjets, but also suborbital flight, which can be associated with in-space service strategies. These technologies have obvious military applications in the development of hypersonic strike capabilities, the development of which can respond to serious national security considerations. Indeed, with the development of increasingly effective anti-missile systems, the diversification of strike systems, and in particular the deployment of hypersonic missiles, has become an imperative for states fielding these systems. The idea of restricting hypersonic technologies to nuclear powers alone, which was mooted a few years ago, has become completely unrealistic, and in any case is now technically impracticable. While North Korea's development of hypersonic strike capabilities seems to use derived technologies, Iran's systems appear to be essentially of national design. Yet, it cannot be ruled out that Iran has received assistance in the development of manoeuvrability technologies, which represent a gateway to hypersonic glide systems, and the majority of ballistic systems currently designed by the country are manoeuvrable. Ballistic powers unbound by non-proliferation mechanisms or that demonstrate a certain ambivalence in their application are therefore likely to transfer them in the years to come. At the same time, the mastery of capsule or space shuttle re-entry technologies represents a second area of dissemination, which again should lead to their gradual standardisation.

OFFENCE VS. DEFENCE

Highlighting the effectiveness of defences, demonstrated recently, raises a fundamental

Rand Corporation, 27 September 2017, https://www.rand.org/pubs/research_reports/RR2137.html

[59] *Emmanuelle Maitre and Stéphane Delory, 'Hypersonic missiles: Evolution or revolution for missile non-proliferation and arms control instruments?,'* HCoC Research Papers, *No. 12, FRS, February 2023,* https://www.nonproliferation.eu/hcoc/hypersonic-missiles-evolution-or-revolution-for-missile-non-proliferation-and-arms-control-instruments/

problem. Their expected proliferation can only accentuate an already existing quantitative and qualitative arms race between major military powers and regional powers. More specifically, the limits set by the MTCR are gradually losing their relevance, as the penetration of defences can be associated with a variation in trajectory, as is the case for quasi-ballistic missiles, but also with an increase in velocity and therefore, mechanically, in range. Purely ballistic (as opposed to quasi-ballistic) missiles with a range of 300 km are extremely vulnerable to current interceptors, and it is expected that this will be the case for quasi-ballistic systems, where the probability of interception depends more on the performance of engagement radars, the majority of which are still unsuited to this type of threat, than on the performance of the interceptors currently produced. In this sense, although the MTCR remains an effective regulatory system, it needs to be adapted, lest its effectiveness gradually diminish.

Figure 9: An Iron Dome launcher launching a missile, 2021. (Credit: IDF Spokesperson's Unit)

More generally, the existence of defences leads to a deregulation of the non-proliferation regime, which must be taken into account. While the MTCR issue leads us to consider the problem from the point of view of short- and medium-range missiles, the effectiveness of strategic defences, as demonstrated by Israel, means that a number of states will seek to move towards complex technological solutions, hitherto associated with strategic strike systems. The example of North Korea has long represented a unique case, but it could become the norm. Russia is a likely candidate for the proliferation of strategic systems or components, but, more generally, the existence of a civilian market developing similar or identical technologies suggests a phenomenon of dissemination that seems difficult to curb. In the absence of possible regulation, it is likely that the constitution of very robust defences, making full use of the potential offered by the space component, will remain the only means of decommissioning the most obsolete ballistic systems but also of forcing certain states to make rational choices, as the maintenance of a robust offensive component becomes financially unsustainable. In the short to medium term, this does not bode well for stability.

CBMS AND TRANSPARENCY MEASURES

The development of ballistic missiles but also of space assets in a number of countries is increasing the urgency of adopting and implementing several types of confidence-building measures (CBMs) and transparency measures. While these measures may take different forms and have various scopes (bilateral, regional, multilateral), they have a similar objective, which is to decrease the risk of misunderstanding.

Regarding the growth of arsenals, some form of communication on the type of systems deployed and their strategic rationale can avoid worst-case assessments that can fuel arms race dynamics. In particular, some level of transparency on the concepts of use of certain systems can dispel in some situations the fears associated with the acquisition of offensive weapons in other countries. It is interesting to note for instance that the lack of a clearly articulated rationale for the acquisition of long-range ballistic missiles in Pakistan has led the United States to assess that these weapons pose a threat to the security of the country and to react accordingly with the adoption of sanctions. While Islamabad denies that it considers the United States a potential opponent, its inability to provide other explanations deemed satisfactory by Washington for the development of missiles of this particular

range has led to the current stalemate.[60] Beyond the question of motivation, a lack of knowledge on stockpiles and production patterns can also bring instability if it leads other countries to sharply increase their offensive but also defensive arsenals, as mentioned above.

Another important element of insecurity is the lack of information on the type of payload deployed on missiles, and in particular the confusion between systems carrying conventional and (often potentially) nuclear weapons. This confusion can be entertained by the co-location of both types of systems. CBMs can be designed to clarify where both types are stored and which is used, to avoid a misunderstanding that could lead to escalation.

In peacetime, missiles are tested regularly to ensure their operational readiness and performance. Using CBMs to inform of these tests has long been seen as a simple but important step to limit the risk of confusion between missile tests and an actual attack. It is at the heart of the HCoC in particular. During testing but also when they are deployed, missiles can malfunction and lead to incidents in third countries. Channels of communication are essential to discuss these incidents and avoid escalation.

The increase of players in the missile sphere may add new risks in itself, in particular the potential difficulty of attributing a missile attack and confusion between possible operators that may possess similar capabilities. This confusion may increase since non-state actors are also deploying and using those weapons autonomously. In this context, CBMs have the potential to bring clarity and limit the risk of escalation.

CONCLUSION

The attractiveness of ballistic missiles to meet national security requirements has increased significantly in recent years, with dozens of new countries launching domestic missile programmes or acquiring ballistic or quasi-ballistic systems off the shelf. The drivers behind these programmes have evolved over the years as technology has matured. In particular, missiles' increased accuracy has enabled the conception of deep precision strike strategies based on ballistic assets. On the other hand, the improvement of defences has also limited the utility of missiles in some circumstances, necessitating constant modernisation to offset obsolescence or vulnerability to defences. These case studies allow us to highlight a variety of situations: Some countries have been developing ballistic technologies for decades, while others recently embarked on this path; some are responding to immediate security concerns, while others are shaping a long-term capability; some may connect their ballistic arsenal with potential WMD acquisition, while others may not; and, finally, some may emphasise the deterrent role, while others have clearly incorporated these capabilities into their warfighting strategies.

These various strategic considerations impact arsenals: In particular, the integration of ballistic missiles among other deep strike assets may lead to a sharp growth in stockpiles, as missiles may be considered efficient weapons in a defended environment only if hundreds of them can be used. Efforts may also lead to the diversification of penetration modes. In particular, countries may try to develop quasi-ballistic as well as manoeuvring warheads to increase the chance of their strike overcoming defences. Finally, the accuracy enabled by modern guidance systems can only be of use if countries benefit from elaborate ISR tools, which points to the need to integrate ballistic missiles into a complex targeting ecosystem. These evolutions are noteworthy and impact the way ballistic missiles are perceived and can be regulated through arms control and export control.

[60] *Emmanuelle Maitre, 'Développements balistiques au Pakistan' [Ballistic developments in Pakistan],* Bulletin, *No. 127, Observatoire de la Dissuasion, FRS, February 2025, https://frstrategie.org/programmes/observatoire-de-la-dissuasion/developpements-balistiques-pakistan-2025*

However, recent developments prove that more rudimentary functions are still associated with these weapons and must therefore still be taken into consideration. First, ballistic missiles can still be developed as potential – or even obvious – means of delivery for WMDs, in the context of an actual programme or as a hedging strategy. Second, while accuracy can enable precision strikes on military assets, missiles can be and still are used for strikes on highly populated areas in a strategy of terror on populations.

In this context, confidence-building measures such as the HCoC remain extremely pertinent and need to be developed, in particular to provide transparency on the role of these weapons and to regulate some practices in order to avoid misinterpretation and escalation.

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PREVIOUSLY PULISHED

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ABOUT THE HAGUE CODE OF CONDUCT

The objective of the HCoC is to prevent and curb the proliferation of ballistic missiles systems capable of delivering weapons of mass destruction and related technologies. Although non-binding, the Code is the only universal instrument addressing this issue today. Multilateral instrument of political nature, it proposes a set of transparency and confidence-building measures. Subscribing States are committed not to proliferate ballistic missiles and to exercise the maximum degree of restraint possible regarding the development, the testing and the deployment of these systems.

The Fondation pour la Recherche Stratégique, with the support of the Council of the European Union, has been implementing activities which aim at promoting the implementation of the Code, contributing to its universal subscription, and offering a platform for conducting discussions on how to further enhance multilateral efforts against missile proliferation.

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