

Ballistic-missile Proliferation and the Rise of Middle Eastern Space Programmes

Dr John B. Sheldon, Research Fellow, École supérieure des sciences commerciales d'Angers (ESSCA)

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Cover

Two satellite carriers (1st and 2nd L) and long-range surface-to-surface missiles are displayed in the Holy Defense Museum in Tehran during an exhibition to commemorate the Iran–Iraq War on 29 September 2020 (Photo by Morteza Nikoubazl/NurPhoto via Getty Images)

Executive Summary

The proliferation of ballistic missiles is now a global phenomenon, as is the dissemination of space and satellite technologies. The Middle East is no exception to these trends. Several regional actors, including non-state actors, have acquired ballistic-missile capabilities, which offer unique military advantages and are increasingly seen as complimentary to traditional missile forces. In parallel, over the past two decades, regional states have ramped up their space ambitions, including the development of space-launch vehicles (SLVs) and establishment of regional space ports. This IISS research paper focuses on the nexus of ballistic-missile proliferation and the spread of space technologies in the Middle East, its implications for further proliferation and regional security and stability, and the utility of diplomatic tools and measures for countering Middle Eastern ballistic-missile proliferation and achieving space security.

With a couple of exceptions, modern SLV development has now largely decoupled from ballistic-missile programmes as the space industry has become more commercialised and the two types of systems have grown increasingly technologically divergent. But other

dual-use space technologies, most notably satellite systems, are increasingly being adopted by regional states to enhance their military intelligence, surveillance and reconnaissance (ISR) capabilities. This shift could fuel the national pursuit of counter-space capabilities, of which the potential for conversion of ballistic missiles into direct-ascent anti-satellite (DA-ASAT) weapons is of particular concern for regional security and stability.

Existing international export-control regimes and monitoring mechanisms have historically helped to curb missile proliferation, but their efficacy in the Middle East has been limited and they are increasingly strained by technological advancements and geopolitical dynamics. However, the growing regional interest in the space domain has opened up new windows of opportunity for dialogue and confidence-building, with a view to eventually establishing a regional space-security architecture. Moving forward, policies should focus on encouraging legitimate space activities, fostering regional cooperation in space and maintaining robust monitoring mechanisms to detect deviations from this trajectory.

Introduction

The Middle East has been at the centre of international concerns about the proliferation of ballistic missiles since the Iran–Iraq War in the 1980s. As long-range weapons that are cheaper to acquire and maintain than traditional air forces, ballistic missiles appeal to many actors in the region – state and non-state alike – because they are perceived to advance and protect strategic interests through the threat or actual infliction of terror. Thanks to precision guidance systems such as Global Navigation Satellite Systems (GNSSs), ballistic missiles have become more accurate and can be increasingly used to strike military targets rather than fired indiscriminately at civilian population centres – although striking population centres is still viewed as a legitimate use of force by some actors in the region.

The proliferation of ballistic missiles takes many paths, including direct proliferation from countries that manufacture ballistic missiles – such as China, North Korea and Russia – to countries that cannot manufacture them, through to countries seeking to extend the range of their short-range ballistic missiles (SRBMs) to medium-range and even intercontinental ballistic missiles (MRBMs/ICBMs) by disguising their efforts as a civilian space-launch vehicle (SLV) programme. In the Middle East, Iran and Israel have undertaken or are currently undertaking such efforts to develop longer-range ballistic missiles under the guise of building SLVs.

Military personnel examine a Scud ballistic missile shot down by a MIM-104 Patriot air-defence missile during Operation Desert Storm



(Photo by Corbis Historical/Historical via Getty Images)

This IISS research paper focuses on the nexus of ballistic-missile proliferation and the dissemination of space and satellite technologies in the Middle East, and its implications for further proliferation and regional security and stability. This analysis is couched within the changing strategic context of missile proliferation globally as well as in emerging forms of regional economic and geostrategic competition. Fundamentally, outside Iran, ballistic-missile proliferation no longer has any relevance to SLV development because of the widespread availability of commercial SLVs developed in China, Europe, Japan, South Korea and the United States and the access to space they provide to most other countries. Iran’s continued conversion of ballistic missiles into SLVs is now no longer just a means for disguising MRBM and possibly intermediate-range ballistic missile (IRBM) or ICBM development but has also taken on a programmatic life of its own to meet the Islamic Republic’s growing space interests and requirements. Moreover, Iran’s development of Chabahar Spaceport indicates an emerging commercial space imperative among Iranian decision-makers. Arab Gulf states, especially Oman, Saudi Arabia and the United Arab Emirates (UAE), seek to develop their own SLVs – through co-development or commercial investment and acquisition – as part of their ongoing intra-regional rivalry and perceived need for assured sovereign access to space. The emerging use of dual-use satellite systems, such as high-resolution Earth-observation and satellite communications, by regional countries for national-security purposes could drive the regional development of counter-space capabilities, including the conversion of ballistic missiles into direct-ascent anti-satellite (DA-ASAT) weapons. The use of ballistic missiles, along with cruise and hypersonic missiles and other uncrewed aerial systems, is no longer exclusive to the Middle East but rather a global phenomenon. The same is also true for the widespread use of satellite systems for military and other national-security purposes.

Lastly, the global spread of ballistic, cruise and hypersonic missiles is driving, in part, the use of satellites so that actors can exercise adequate strategic early warning, targeting, precision-strike and command-and-control capabilities in a hyper-fast operational and strategic environment.

All of these trends mean that the current conceptual focus on Middle Eastern ballistic-missile proliferation and its causes, and the diplomatic solutions traditionally proposed by Western powers, may well miss the mark and strategic character of what is actually happening in the region.

1. Ballistic Missiles, Space-launch Vehicles and the Global Strategic Context

The Growing Global Development of Ballistic Missiles

The proliferation of ballistic and cruise missiles is now a global phenomenon. This shift is evident in the strategic priorities and military-modernisation efforts of countries worldwide that are investing heavily in these technologies and recognising their potential to reshape modern warfare and strategic deterrence. This global trend reflects a changing security landscape where precision-strike capabilities and the ability to penetrate advanced air-defence systems are increasingly valued.

The proliferation of ballistic and cruise missiles is driven by a combination of strategic, technological and economic factors that have collectively reshaped the landscape of modern warfare. At the core of this shift is the recognition that missiles offer a potent, flexible and cost-effective means of projecting power and influencing adversary behaviour across a wide range of scenarios.

As potential adversaries develop and deploy more capable integrated air-defence systems (IADS), traditional air power faces growing challenges in accessing denied areas.¹ Strategically, missiles – particularly those with advanced guidance systems and hypersonic capabilities – offer a potential means to overcome these defences, allowing for precision strikes against high-value targets without risking either pilots' lives or expensive and technologically advanced aircraft.

The economic rationale for missile proliferation is compelling when compared to the costs associated with maintaining and operating modern air forces. The growing expense of advanced fighter and bomber aircraft, in terms of initial procurement and ongoing maintenance, repair and overhaul (MRO) costs, has placed significant strain on military budgets. Missiles, while not cheap, often present a more cost-effective option for delivering payloads over long distances, especially when factoring in the life-cycle costs of crewed aircraft.²

Personnel considerations have also played a role in this shift. Many militaries face ongoing challenges with

pilot recruitment and retention. The intensive training required for combat pilots, coupled with competitive pressures from the commercial aviation sector, has made it increasingly difficult and expensive for militaries to maintain a robust cadre of experienced aviators and highly specialised maintenance crews.³ Missile systems, which can be operated by smaller crews that do not require the same level of specialised training as combat pilots, offer a partial solution to these personnel challenges.

Investment in missile technologies by potential adversaries of the West and Middle Eastern countries has created a form of arms competition. As countries such as Russia and China develop and deploy advanced missile systems, Western militaries and those in other regions, such as the Middle East, have felt compelled to respond in kind to maintain strategic parity and ensure their ability to deter or defeat these threats. This dynamic has accelerated research, development and deployment of new missile systems across the spectrum of global military powers.

The Growth and Spread of Military Space Systems

The adoption of satellite systems for military and national-security purposes has similarly transcended regional boundaries to become a global strategic imperative. Space-based assets are now integral to military operations, intelligence-gathering and national-security infrastructure worldwide. Advanced economies and emerging powers alike are investing in military satellite communications, high-resolution Earth-observation satellites and space-based early-warning systems. The US, with its extensive network of military satellites, exemplifies this trend, but countries across Europe, Asia and even Africa are rapidly developing or acquiring similar capabilities.⁴ This global militarisation of space reflects its growing importance as a strategic domain and the recognition of space-based assets as force multipliers in modern warfare.⁵

The dual-use nature of many satellite technologies has facilitated their rapid proliferation, as countries can develop ostensibly civilian space programmes with potential military applications. Countries such as India and Japan and members of the European Union are expanding their satellite constellations, citing civilian and commercial needs, while also enhancing their military capabilities.⁶ Even smaller countries are entering the field, often through partnerships with private companies or by leveraging commercial satellite services for military purposes.⁷ This global trend towards space-based military capabilities is reshaping strategic calculations, influencing arms-control discussions and raising new questions about space security and the potential for conflict in this domain.⁸ As more countries gain access to advanced satellite technologies, the international community faces growing challenges in managing space traffic, mitigating the risk of space debris and preventing the use of kinetic weapons in space.⁹

The Rise of Commercial Space-launch Vehicles

The landscape of SLVs has undergone a dramatic transformation since the early 2000s, shifting from a domain dominated by large national space agencies and established aerospace prime contractors to a more diverse and competitive field. Historically, access to space was primarily controlled by government entities, such as the US National Aeronautics and Space Administration (NASA), Russia's state space corporation Roscosmos and the European Space Agency (ESA), along with their industrial partners, such as Lockheed Martin, Boeing and Arianespace. These organisations developed and operated large, complex launch systems designed for various missions, from small satellites to heavy payloads and human spaceflight. While highly capable, these systems are often characterised by high costs and long lead times, limiting access to space to well-funded government programmes and major commercial satellite operators.

The rise of commercial SLVs began in earnest with the founding of SpaceX in 2002. SpaceX's approach of vertical integration and reusability and a focus on cost reduction has revolutionised the launch industry and demonstrated that private companies can not

SpaceX's Starship on the launch pad at Starbase in Texas on 19 November 2024. The rise of commercial space-launch providers since the 2000s has transformed the space industry.



(Photo by Chandan Khanna/AFP via Getty Images)

only compete with established players but also significantly reduce launch costs.¹⁰ This success inspired a wave of new entrants into the market, such as Rocket Lab, Firefly Aerospace and Skyrora, that offer smaller, more agile launch systems and are seeking to carve out a niche in the growing space economy.¹¹

This dissemination (as opposed to proliferation) of commercial launch providers has had several significant impacts on the space industry. Firstly, it has dramatically reduced the cost of accessing space, thereby making it more accessible to industry and less wealthy countries.¹² Secondly, it has increased the frequency and flexibility of launch opportunities, allowing satellite operators to deploy and replenish constellations more rapidly.¹³ Lastly, it has globalised the launch industry, with companies from countries not traditionally associated with space activities now developing indigenous launch capabilities.¹⁴

The rise of commercial SLVs has had a nuanced impact on concerns about ballistic-missile proliferation. On the one hand, the widespread development of launch-vehicle technology could potentially lower the barriers for countries seeking to develop ballistic-missile capabilities, as many components are dual-use.¹⁵ However, the commercial and international scope of the space-launch industry has also increased transparency and fostered international cooperation, potentially making it more difficult for covert missile programmes to operate under the guise of civilian space activities. Moreover, the divergence in design goals between modern commercial launchers (which prioritise efficiency, reusability and precise orbital insertion) and

ballistic missiles has reduced the direct applicability of many commercial space technologies to missile development. While caution is still required, the commercial space-launch revolution has, in many ways, shifted the focus away from missile-proliferation concerns to the challenges and opportunities presented by the democratisation of space access.¹⁶

Missile Technologies as a Global Driver for the Military Uses of Space

The global proliferation of ballistic, cruise and hypersonic (Mach 5+) missiles is fundamentally altering the strategic landscape, compelling countries to adapt their military capabilities to a new era of high-speed warfare.¹⁷ The Middle East is no different in this regard. This shift is driving an increased reliance on satellite systems, particularly for missile defence, as they are critical enablers that provide the early-warning, tracking, precision-targeting and command-and-control capabilities necessary to detect, track and potentially intercept missile threats as quickly as possible.

The precision-strike capabilities of modern missiles require equally precise targeting information, which satellites are uniquely positioned to provide. These space-based assets can operate in denied areas where traditional reconnaissance methods are either ineffective or too risky.¹⁸ Additionally, navigation satellites, such as the US Global Positioning System (GPS) or China's BeiDou systems, are essential for guiding precision-strike munitions to their targets, enabling the kind of accuracy that modern warfare demands.¹⁹

Navigation satellites, such as those that are part of China's BeiDou systems, are essential for guiding precision-strike munitions to their targets



(Photo by Ma Yue/VCG via Getty Images)

For real-time command-and-control, satellite communications enable rapid decision-making and coordinated responses in a compressed time frame. This is particularly crucial when dealing with hypersonic threats, due to their short flight times. The global reach of satellite communications also ensures that forces can maintain connectivity and coordination across vast distances.²⁰ As countries continue to invest in and deploy more advanced missile systems, the reliance on space-based assets for effective deterrence, defence and potential engagement against missiles will only grow, further underscoring the critical role of satellites in modern strategic operations.

Decoupling Space-launch Vehicles and Ballistic Missiles

The spread of commercial SLVs globally has largely decoupled from ballistic-missile development in most countries in recent decades, with the notable exceptions of Iran and North Korea. This shift can be attributed to the space industry's increasingly commercial and international scope and nature, where economic and scientific motivations now predominantly drive SLV programmes. These commercial endeavours are often undertaken in collaboration with established national space agencies or private companies, fostering a level of transparency and adherence to international norms that countries developing ballistic-missile technologies often eschew.

The technological divergence between modern SLVs and ballistic missiles has also contributed to this decoupling. Although one technology served as a foundation for developing the other, and there remain links between them, contemporary SLV designs often incorporate features that are suboptimal or unnecessary for ballistic-missile applications.²¹ For instance, the focus on reusability, precision orbital insertions and multi-payload deployment capabilities in commercial SLVs represents a significant departure from military requirements for ballistic missiles.²² Additionally, the international community has implemented robust export-control regimes and monitoring mechanisms, such as the Missile Technology Control Regime (MTCR), that have been largely effective in preventing the misuse of commercial space technologies for military purposes.

Iran and North Korea, however, remain outliers in this global trend. These countries continue to blur the lines between their SLV and ballistic-missile programmes, often using SLV development as a pretext for advancing their ballistic-missile capabilities. Their relative isolation from the international space sector and community, along with their limited access to commercial space technologies, has led them to pursue dual-use ballistic-missile/SLV technologies.²³ The international community remains vigilant regarding these

countries' space activities, as their SLV programmes are still considered potential pathways for longer-range ballistic missiles and the development and proliferation of associated technologies. This stands in stark contrast to most countries engaged in commercial space-launch activities, where the focus has shifted decisively towards economic and scientific objectives rather than military applications; it should be noted, though, that commercial SLVs can be, and are, used to launch satellites with military applications.

2. Middle East Ballistic-missile and Space Activities

Iran's Ballistic-missile and Space-launch Vehicle Development

Iran's ballistic-missile programme has its roots in the Iran–Iraq War of the 1980s, during which the country faced significant missile attacks. This experience spurred Iran to develop a robust indigenous-missile capability as a deterrent against regional adversaries.²⁴ The programme has since evolved to encompass a range of SRBMs, MRBMs and potentially IRBMs. Key systems in Iran's ballistic arsenal include the *Shahab* series, derived from North Korean *Scud* technology, the solid-fuelled *Sajjil* and the *Qiam*, a modified version of the *Shahab* with improved accuracy.²⁵

In recent years, Iran has made strides in converting some of these ballistic-missile technologies into SLVs.²⁶ The *Safir* SLV, first launched in 2008, is believed to be derived from the *Shahab-3* MRBM. This two-stage rocket has been used to place small satellites into low-Earth orbit (LEO), marking Iran's entry into the space-launch domain.²⁷ Following the *Safir*, Iran developed the more capable *Simorgh* SLV, which is assessed to be based on North Korean technology and potentially capable of delivering heavier payloads to orbit.²⁸

One of the most recent additions to Iran's SLV fleet is the *Qased*, which successfully launched the *Noor* Earth-observation satellite in April 2020.²⁹ The *Qased* is notable for its use of both liquid- and solid-fuel stages, representing an advance in Iran's space capabilities. This launch vehicle is believed to incorporate technologies from both the ballistic-missile programme and previous SLV efforts, showcasing Iran's ability to integrate and iterate upon its existing missile and space-launch knowledge.³⁰

The *Zoljanah* SLV, unveiled in February 2021, marks a technological leap for Iran's space programme. This three-stage rocket employs solid-fuel engines for its first two stages and a liquid-fuel engine for the third stage, demonstrating Iran's progress in solid-fuel technology. With a reported capability to place

Iran's *Qased* SLV, shown on a billboard in Tehran on 13 December 2023, uses both liquid- and solid-fuel stages, representing a technological advance



(Photo by Morteza Nikoubazl/NurPhoto via Getty Images)

a 220 kilogram payload into a 500 kilometre orbit, the *Zoljanah* enhances Iran's space-launch capacity. However, the rocket's design characteristics, particularly its powerful 67.1 tonne thrust first stage and claimed mobile-launch capability, suggest potential dual-use applications that extend beyond civilian space purposes. The development of such a large solid-fuel motor, surpassing even the *Sajjil* MRBM in diameter, indicates a technological progression that could enhance Iran's potential to develop solid-fuel ICBMs in the future.³¹

The institutional origins and development trajectory of the *Zoljanah* present intriguing questions about the potential division of labour and parallel development programmes within Iran's space and missile programmes. While previously associated with the Islamic Revolutionary Guard Corps (IRGC), the *Zoljanah* was unveiled by the Aerospace Industries Organization (AIO), a civilian entity. The continued development of the *Zoljanah* 'family', with plans for lighter motor casings, higher-performance propellants and advanced control systems, suggests an ongoing commitment to enhancing this technology. These advances, while ostensibly for space-launch

purposes, could be repurposed for ballistic-missile applications. The *Zoljanah* thus represents a challenge for international observers, blurring the lines between civilian space technology and potential military applications.³²

The AIO recently announced the development of three new SLVs that could also represent a further expansion of Iran's space-launch capabilities. The *Sarir*, an evolution of the *Simorgh* SLV, demonstrates Iran's commitment to enhancing its liquid-fuel technology, with a planned capability to launch 700 kg payloads into a 1,000 km orbit. The *Soroush* and the *Soroush-2* mark even more ambitious steps, with the former designed for geosynchronous-orbit launches and featuring parallel booster rockets, while the latter aims to use cryogenic fuels to place 2,500 kg payloads into geostationary Earth orbit (GEO). These developments, if realised, would improve Iran's ability to launch and operate a wide range of satellite types, from communications to Earth observation. The pursuit of cryogenic-engine technology, as evidenced by the development of the *Bahman* engine, is particularly noteworthy as it represents a leap forward for Iran's space programme.³³

The *Saman-1* solid-fuel satellite apogee kick motor also adds another dimension to Iran's space capabilities. Designed to transfer 100 kg satellites from LEO to higher elliptical orbits, this technology could potentially enhance Iran's ability to position and manoeuvre satellites in space. When considered alongside Iran's renewed interest in human spaceflight and the development of the *Nahid-2* communications satellite for geosynchronous orbit, these new SLVs paint a picture of an advancing Iranian space programme. However, it is important to note that while these developments have ostensibly civilian purposes, the potential dual-use nature of space-launch technology means they could improve Iran's ballistic-missile capabilities.³⁴

Iran's motivation for converting ballistic missiles into SLVs is multifaceted. Primarily, it serves to advance the country's missile technology under the guise of a civilian space programme. The development of SLVs as a hedging strategy allows Iran to test and refine technologies critical to long-range missile systems, such as stage

separation, guidance systems and re-entry vehicles, while nominally adhering to self-imposed restrictions on the range of its ballistic missiles.³⁵

Moreover, achieving an indigenous space-launch capability is a matter of national pride and technological prestige for Iran. It demonstrates the country's scientific and engineering prowess to both domestic and international audiences, potentially strengthening the regime's legitimacy at home and standing abroad.³⁶ The ability to launch satellites also provides Iran with potential strategic benefits in terms of intelligence-gathering, communications and situational awareness. This capability also enhances Iran's deterrence posture. While current Iranian satellites are limited in their military utility, the mere demonstration of these capabilities sends a message to regional rivals and global powers about Iran's technological sophistication and potential reach.³⁷ As Iran continues to refine its space capabilities, it may develop more advanced reconnaissance and communications satellites that could significantly enhance its military effectiveness and strategic depth.

Iran's Civilian Space Programme Takes on a Life of its Own

Iran's civilian space programme, initially viewed primarily as a cover for ballistic-missile development as discussed above, has evolved in recent years. While the programme's origins in missile technology are undeniable, there is growing evidence that Iran has developed genuine space ambitions and capabilities. The Islamic Republic has demonstrated a commitment to expanding its presence in space, driven by a combination of scientific, economic and geopolitical motives. This shift is reflected in the diversification of Iran's space projects, including developing more sophisticated satellites, planning for human spaceflight and establishing a domestic, albeit nascent, space industry.³⁸

The transformation of Iran's ballistic missiles into SLVs has become self-sustaining, with specific goals and milestones extending beyond mere missile development. Iran has successfully launched several satellites into orbit, albeit with mixed results, and has announced plans for more advanced missions.³⁹ While modest by global standards, these achievements still represent progress for Iran's indigenous space capabilities.

Table 2.1: Known operational Iranian satellites as of November 2024

Satellite name	Operator/owner	Users	Purpose	Class of orbit	Date of launch	Launch site
<i>Sina-1</i>	ISA	Government/military	Technology demonstration (reportedly telecommunications)	LEO	27 October 2005	Plesetsk Cosmodrome, Russia
<i>Khayyam</i>	Unknown	Unknown	Earth observation (reportedly environmental monitoring)	LEO	9 August 2022	Baikonur Cosmodrome, Kazakhstan (operated by Russia)
<i>Suraya</i>	ISA	Government/military	Technology demonstration (reportedly SLV development)	LEO	20 January 2024	Shahroud Space Centre, Iran
<i>Hatef-1</i>	ISA; IEI	Government/military	Technology demonstration (reportedly communications)	LEO	28 January 2024	Semnan Space Centre, Iran
<i>Kaihan-2</i>	ISA	Government/military	Technology demonstration (reportedly space positioning and navigation)	LEO	28 January 2024	Semnan Space Centre, Iran
<i>Mehda</i>	ISA	Government/military	Technology demonstration (reportedly SLV development)	LEO	28 January 2024	Semnan Space Centre, Iran
<i>Pars-1</i>	ISA	Government/military	Earth observation (reportedly electro-optical)	LEO	29 February 2024	Vostochny Cosmodrome, Russia
<i>Chamran-1</i>	Unknown	Unknown	Technology demonstration (reportedly satellite development)	LEO	14 September 2024	Shahroud Space Centre, Iran
<i>Hodhod</i>	Unknown	Unknown	Communications (reportedly)	Unknown	4 November 2024	Vostochny Cosmodrome, Russia
<i>Kowsar</i>	Unknown	Unknown	Earth observation (reportedly environmental monitoring)	Unknown	4 November 2024	Vostochny Cosmodrome, Russia

IEI Iran Electronics Industries; ISA Iranian Space Agency; LEO low-Earth orbit; SLV space-launch vehicle
 Sources: Gunter's Space Page; IISS Military Balance+, milbalplus.iiss.org (accessed 15/11/24); Jonathan's Space Report

The country has also invested in ground infrastructure, including multiple launch sites and mission-control facilities.⁴⁰ This indicates a long-term commitment to its space programme that goes beyond the requirements for disguising missile development.

Moreover, Iran's space programme has begun to take on importance in its own right, separate from its military applications. The Islamic Republic views space capabilities as a source of national pride, scientific advancement and potential economic benefits. Iran is a member of the Asia-Pacific Space Cooperation Organization (APSCO),⁴¹ has expressed interest in joining other international space collaborations and signed space-cooperation agreements with countries such as Russia.⁴² Russia has even built and launched a high-resolution Earth-observation satellite, *Khayyam*, for Iran (see Table 2.1), with reports indicating that several others are in development for Tehran.⁴³ More recently, Western intelligence officials alleged in August 2024 that Iran has been in discussions with several Chinese satellite-manufacturing companies about acquiring additional high-resolution Earth-observation satellites.⁴⁴ While concerns about the dual-use nature of Iran's space technology persist in the international community, it is increasingly clear

that the country's space ambitions have a momentum of their own, driven by genuine, or at least plausible, civilian and commercial interests alongside continued military applications.

Israel's Full-spectrum Space Power

Israel has developed and deployed its own missile, missile-defence, SLV and satellite capabilities, with strategic implications for the Middle East. These capabilities, beyond underpinning Israeli strategic-deterrence efforts, are a defence against Iran's efforts to develop strategic capabilities (and those of Iran's regional proxies), but also provide the means for potential cooperation and security ties with Arab countries seeking an informal Israeli security umbrella against the regional threat posed by Tehran and its self-declared 'axis of resistance'.

Israel has developed one of the world's most sophisticated and multilayered missile-defence architectures that includes the *Iron Dome*, *David's Sling* and the *Arrow-2* and *Arrow-3*.⁴⁵ Of particular significance is the *Arrow-3* system, as it possesses latent DA-ASAT capabilities due to its ability to intercept targets in space. This dual-use potential adds a new dimension to Israel's strategic deterrence, as it could potentially

Israel's *Shavit* SLV, carrying the *Ofeq-7* military satellite, is launched from Palmachim Airbase on 10 June 2007. The *Shavit* is believed to be derived from the *Jericho* MRBM.



(Photo by Israel Aerospace Industries via Getty Images)

be used to target adversaries' military satellites in a conflict.⁴⁶

In terms of offensive capabilities, Israel is believed to possess a range of SRBMs and MRBMs, including the LORA and *Jericho* series. While official information is limited due to Israel's policy of strategic ambiguity, it is widely assessed that at least some of these missiles are capable of carrying either a conventional or nuclear warhead.⁴⁷

Israel's space programme is equally advanced. The country has developed its indigenous SLV, called *Shavit*, which is believed to be derived from the *Jericho* MRBM. This technological synergy between ballistic missiles and SLVs underscores the dual-use nature of these

technologies and Israel's strategic approach to maintaining technological superiority over its adversaries in both domains.⁴⁸

In terms of satellite capabilities, Israel operates a constellation of reconnaissance satellites, including the classified *Ofeq* series and commercial very-high resolution optical and synthetic aperture radar (SAR) Earth-observation satellites (see Table 2.2).⁴⁹ These satellites provide intelligence and early-warning capabilities. These assets enhance Israel's strategic situational awareness and its ability to monitor potential threats in the region.⁵⁰

The implications of Israel's advanced missile, missile-defence and space capabilities for Iran and regional Arab countries are profound. For Iran, Israel's multilayered missile-defence system presents a challenge to the effectiveness of its own missile arsenal, potentially undermining Iran's deterrence strategy. The latent DA-ASAT capability of the *Arrow-3* system also poses a potential threat to Iranian satellites, adding a further dimension to the strategic calculus between the two countries.

For Arab countries in the region, Israel's capabilities paradoxically serve as both a deterrent and a catalyst for their own military-modernisation efforts. While some Arab states have pursued informal cooperation with Israel in the face of shared regional threats, others may view Israel's technological edge as a driving factor in their own pursuit of advanced missile and space capabilities.⁵¹ This dynamic has the potential to fuel a regional arms race, particularly in the domains of missile technology and space-based assets, with significant implications for regional stability and security architectures.

Table 2.2: Known operational Israeli military satellites as of November 2024

Satellite name	Operator/owner	Users	Purpose	Class of orbit	Date of launch	Launch site
<i>Ofeq-7</i>	Ministry of Defense	Military	Earth observation (ISR)	LEO	10 June 2007	Palmachim Airbase, Israel
<i>Ofeq-9</i>	Ministry of Defense	Military	Earth observation (ISR)	LEO	22 June 2010	Palmachim Airbase, Israel
<i>Ofeq-16</i>	Ministry of Defense	Military	Earth observation (ISR)	LEO	6 July 2020	Palmachim Airbase, Israel
<i>Ofeq-13</i>	Ministry of Defense	Military	Earth observation (ISR)	LEO	28 March 2023	Palmachim Airbase, Israel

ISR intelligence, surveillance and reconnaissance; LEO low-Earth orbit

Sources: Gunter's Space Page; IISS Military Balance+, milbalplus.iiss.org (accessed 15/11/24); Jonathan's Space Report

The Rise and Consequences of Other Regional Space Programmes

The space programmes of the UAE, Saudi Arabia, Turkiye, Egypt and Oman have emerged as significant factors in the regional strategic landscape of the Middle East. While ostensibly civilian in nature, these programmes have both implications for regional competition and stability as well as potential military applications, including ballistic-missile development.

The UAE has made remarkable strides in its space programme, culminating in the successful Mars orbiter mission *Hope* in 2021.⁵² The UAE's space ambitions are part of its broader strategy to diversify its economy and position itself as a regional leader in advanced technologies.⁵³ The country has invested heavily in satellite technology, Earth-observation capabilities and now interplanetary exploration. More recently, the UAE seems to be aiming to manufacture satellites, with the UAE Space Agency announcing its *Sirb* high-resolution SAR Earth-observation satellite programme and selecting UAE defence company EDGE Group as the prime contractor.⁵⁴ This progress has boosted national pride and enhanced the UAE's regional and international standing. The success of the country's space programme so far has spurred other regional actors to accelerate their own space efforts, intensifying the competition for technological supremacy in the Gulf region.

Saudi Arabia's space programme, while less advanced than the UAE's, has seen developments in recent years. Riyadh has launched several satellites and established the Saudi Space Commission in 2018 to oversee its space

Engineers at the Mohammed Bin Rashid Space Centre watch the spacecraft carrying the *Rashid* rover as it attempts to land on the Moon's surface on 25 April 2023



(Photo by Andrea DiCenzo via Getty Images)

activities, before reorganising the commission into the Saudi Space Agency in 2023.⁵⁵ Saudi Arabia's space ambitions are closely tied to its *Vision 2030* economic and industrial-development plan.⁵⁶ The country's financial resources and strategic partnerships with countries such as China have positioned it to potentially become a significant player in the regional space sector.⁵⁷

To realise their space ambitions, Saudi Arabia and the UAE are leveraging their financial resources and partnerships, including by investing in satellite manufacturing, ground-station infrastructure and space-based services. The UAE's Mohammed Bin Rashid Space Centre and the Saudi Space Agency are pursuing collaborations with established space agencies and commercial entities worldwide.⁵⁸ These are not merely passive financial transactions but often involve strategic considerations, as this approach allows Saudi Arabia and the UAE to more quickly develop indigenous capabilities. Moreover, these countries are positioning themselves as attractive locations for international space companies, offering state-of-the-art facilities and favourable business environments. This aims to bring advanced technologies and expertise to the region and help create a local ecosystem of space-related industries and services.

The increasing influence of Saudi Arabia and the UAE in the commercial space sector is also evident in their growing role as customers and investors. Both are commissioning satellites, launch services and space-based applications from international providers, thereby influencing market trends and technological-development priorities. Additionally, sovereign-wealth funds from these states are making investments in space start-ups and established companies worldwide, giving them a stake in the industry's future direction.⁵⁹ As these Arab Gulf states continue to develop their capabilities and expand their influence, they could eventually play a significant role in shaping the commercial space landscape.

Turkiye's space programme has been characterised by an emphasis on indigenous development and strategic autonomy, as demonstrated by the national development of the IMECE high-resolution Earth-observation satellite and the recently launched *Türksat-6A* communications satellite in the operationally and technically

demanding GEO.⁶⁰ The country also has plans for satellite manufacturing and lunar exploration.⁶¹ Türkiye's space efforts are closely linked to its defence industry, with potential dual-use applications in missile technology.⁶² For example, Türkiye's Roketsan is developing a commercial SLV that it plans to launch from Somalia.⁶³ This has raised concerns among some of Türkiye's NATO allies and regional competitors about the potential military implications of its space capabilities.

Egypt, which has a longer history in space activities than Oman, Saudi Arabia, Türkiye and the UAE, dating back to the 1960s, has recently reinvigorated its space programme.⁶⁴ The country has launched several Earth-observation satellites and established the Egyptian Space Agency in 2018. Its space ambitions are driven by economic and security considerations, with applications ranging from agricultural monitoring to maritime surveillance. The programme is seen as a means to enhance Egypt's regional influence and technological capabilities.⁶⁵

Oman has been making steady progress in developing its space capabilities, focusing on satellite operations and ground infrastructure. The country launched its first satellite, *Aman-1*, in late 2023, marking its entry into the space domain.⁶⁶ Ambitious plans for further satellite development and manufacturing have followed this initial step. Oman is investing in building indigenous capabilities for small-satellite design and production, aiming to create a sustainable space industry that can serve national needs and export markets.⁶⁷ In the realm of downstream applications, Oman is focusing on leveraging satellite data for various sectors, including agriculture, urban planning and environmental monitoring. These efforts seek to create high-tech jobs and foster innovation in the space sector, and are therefore aligned with Oman's broader economic diversification strategy.⁶⁸

A cornerstone of Oman's space ambitions is the development of Etlaq Spaceport near the port city of Duqm. This project, still in its planning stages, aims to capitalise on Oman's advantageous location to create a launch facility capable of supporting a wide range of orbital insertions, including equatorial orbits and sun-synchronous orbits (SSOs).

While details of the spaceport's capabilities and timeline remain to be clarified, the project represents

a commitment by Oman to positioning itself as a key player in the commercial space-launch market. The development of Etlaq could deliver Oman a role in the Middle Eastern space landscape by providing launch services not only for its own future satellites but also for regional and international customers.⁶⁹

The rise of these space programmes has implications for regional competition and stability. On the one hand, the programmes could foster cooperation and economic development through shared space-based services and scientific collaboration. On the other hand, they could intensify the technology race in the region, potentially exacerbating existing tensions. For example, Iran has viewed the development of space capabilities by its regional rivals with concern.

Non-kinetic and Kinetic Counter-space Activities in the Middle East

A number of non-kinetic counter-space activities have been occurring for decades in the Middle East, centred on the disruption of satellite communications and navigation services.⁷⁰ Satellite jamming, particularly the targeting of satellite-television broadcasts, has been employed by various state actors in the region since the 1990s, with countries such as Egypt, Iran and Syria frequently accused of jamming foreign satellite broadcasts to control the flow of information to their populations. These actions have targeted political and news content and affected entertainment channels, demonstrating the broad application of such techniques for social and political control.⁷¹ Notable examples include Iran's jamming of foreign Persian-language broadcasts and various Arab Gulf states' efforts to block the satellite channels of Qatar's Al-Jazeera network during diplomatic crises.⁷²

More recently, there has been a significant increase in the sophistication and frequency of GNSS jamming and spoofing. These activities have implications far beyond mere signal disruption, potentially affecting critical infrastructure, financial systems and military operations that rely on precise positioning and timing.⁷³ Incidents include alleged Iranian jamming of GPS signals in the Strait of Hormuz and the Gulf,

which has affected commercial shipping and potentially military operations in the region.⁷⁴

Cyber attacks against ground-based space infrastructure represent another growing threat in the Middle East's counter-space landscape. Satellite-control centres, teleports and the networks of commercial satellite operators have all become targets.⁷⁵ These attacks can range from data theft and espionage to more disruptive actions that could potentially compromise satellite operations.⁷⁶

As regional actors become more dependent on satellites for their military and economic security, there is a risk of escalation in counter-space activities. The growing reliance on space-based assets for military command-and-control, intelligence-gathering and precision-guided munitions makes these systems increasingly attractive targets. There may be a shift from temporary, reversible jamming and spoofing attacks to more persistent and destructive cyber operations against space infrastructure.⁷⁷ There is also the potential for actors to develop and deploy ground-based directed-energy weapons, especially if they proliferate in the future, that are capable of temporarily or permanently disabling adversaries' satellites.⁷⁸

The most concerning potential escalation is a move towards kinetic ASAT capabilities. The threshold for regional actors to engage in kinetic counter-space operations is lowering. The perceived strategic value of denying adversaries access to space-based capabilities during a conflict could drive regional powers to develop and potentially employ kinetic ASAT weapons.⁷⁹

The Middle East's long history of non-kinetic counter-space activities provides a foundation for more destructive actions as the strategic value of space assets increases. Any escalation from jamming and cyber attacks to kinetic ASAT operations would represent a significant threat to regional stability and the global space environment. Regional planning must, and in some cases is beginning to, account for this evolving threat landscape by considering the establishing of both defensive measures to protect space assets and diplomatic initiatives to agree upon norms of responsible behaviour in space, as will be discussed.⁸⁰

Emerging Competition Between Gulf States for Access to Space

As more countries in the Middle East establish space programmes and commercial space industries, the issue of access to space has come to the fore. For many countries in the region, access to space, even for military satellites, is not a problem as they are able to use launch services in China, Europe, India, Japan, South Korea, the US and even Russia (despite international sanctions). Despite the availability of launch services however, Arab Gulf countries such as Oman, Saudi Arabia and the UAE are undertaking efforts to establish sovereign access to space through either collaborative commercial SLV developments or constructing their own space-launch sites. The expense and technological complexity involved in these efforts suggest that the primary motivations for these countries are prestige and perhaps even the belief that there is commercial gain available in the commercial launch industry.

Iran

For Iran, access to space is a challenge due to international sanctions against the regime in Tehran. Along with its strategic rationale for using SLV development as a guise for developing long-range ballistic missiles, the Iranian space-launch programme also fulfils a requirement for independent access to space, since Iran is unable to procure commercial launch services from abroad, except from China and Russia.

Iran's development of Chabahar Spaceport represents a shift in the country's space strategy, indicating a commercial imperative among Iranian decision-makers. Located in the southeast province of Sistan and Baluchestan, the spaceport is positioned to serve as a commercial launch site for both domestic and international customers. This move suggests that Iran is looking beyond its military-oriented space programme and recognises the economic potential of the growing global space industry. The choice of Chabahar, already an important national and regional economic hub due to its port facilities, underscores Iran's intention to integrate its space ambitions with broader economic-development goals.⁸¹

Iranian president Ebrahim Raisi inspects a mock-up of Chabahar Spaceport in 2021. Iran's development of the new spaceport represents a shift in the country's space strategy.



(Photo by Nurdiansyah Putra/Alamy Stock Photo via Alamy)

By creating infrastructure capable of supporting commercial launches, Iran may be seeking to attract investment and partnerships from countries looking for more affordable launch options. This could potentially include countries in Central Asia, the Indian subcontinent and even beyond, who might find Iran's geographical location and potentially competitive pricing attractive.⁸² However, the success of this venture will largely depend on Iran's ability to navigate international sanctions and build trust in its commercial space capabilities.

The Arab Gulf States

The Arab Gulf states' growing interest in developing their SLV capabilities is part of a broader trend of space ambitions in the region driven both by prestige and practical considerations regarding economic diversification, technological advancement and national security. The perceived need for assured sovereign access to space is a crucial factor, as these countries seek to reduce their reliance on foreign launch providers for their satellite programmes. This drive for self-sufficiency in space access is also seen as a way to enhance their geopolitical standing and leverage in regional affairs.⁸³

The pursuit of SLV capabilities by Arab Gulf states through co-development or commercial investment and acquisition reflects the complexities of intra-regional rivalry. Each country is striving to establish itself as a regional leader in space technology, viewing it as a marker of national progress and influence. The UAE's

successful Mars mission and Saudi Arabia's ambitious space programme underscore this competitive spirit. However, this rivalry also opens up opportunities for collaboration and knowledge-sharing within the region.⁸⁴

Arab Gulf states, particularly Oman, Saudi Arabia and the UAE, do not need to pursue the conversion of ballistic missiles into SLVs in order to access space, given their unique position in accessing the global commercial space market and attracting space technologies to the region. For example, Saudi Arabia and the UAE's financial resources, through their sovereign-wealth funds and state-backed investment vehicles, provide them with unparalleled access to the global commercial space market. These states can easily procure launch services from established commercial providers such as SpaceX and Arianespace or emerging players such as Rocket Lab. This approach allows them to benefit from the latest developments in launch technology without the need for costly and politically sensitive ballistic-missile conversions.

The Arab Gulf states' strategy of attracting commercial space companies to the region through investments and partnerships offers a more sophisticated and internationally acceptable path to developing cutting-edge satellite and launch capabilities than by converting ballistic missiles. This approach also contributes to their broader economic-diversification goals by building a domestic knowledge-based space industry.⁸⁵

Moreover, the diplomatic capital of Oman, Saudi Arabia and the UAE is better served by pursuing commercial space partnerships rather than engaging in activities that could be perceived as dual-use missile development. Their growing influence in the global space sector is built on commercial and scientific collaborations that enhance their soft power and technological prestige without incurring the diplomatic risks associated with missile-technology proliferation.⁸⁶

The progress in commercial space technologies, particularly in small satellites and dedicated small launch vehicles, aligns with the space aspirations of these Arab Gulf states. These technologies offer cost-effective and flexible access to space capabilities, negating the need for larger, converted ballistic-missile systems. Lastly, by focusing on commercial space access rather than

missile conversion, Oman, Saudi Arabia and the UAE can position themselves as responsible actors in the international space community. This stance facilitates their participation in wider space-governance discussions and potentially in international scientific collaborations, furthering their goals of becoming key players in the global space sector. It also allows them to advocate for peaceful uses of outer space from a position of credibility, enhancing their diplomatic standing.⁸⁷

Geographical Position and Regional Space Launches

Chabahar, located on Iran's southeast coast, and Etlaq, situated on Oman's Arabian Sea coast, are advantageous locations for satellite launches in the Middle East region (see Map 2.1). Both sites offer unique geographical and logistical benefits that make them suitable for launching satellites into equatorial orbits and SSOs. Their coastal positions provide launch paths over the Indian Ocean, minimising the risks associated with launching in highly populated areas and simplifying range-safety considerations.

Chabahar's location at a latitude of approximately 25° north makes it well suited for a variety of orbital inclinations. For SSOs, which typically require inclinations between 96 and 98°, Chabahar's position allows for efficient launches with minimal energy expenditure for plane changes. The site's proximity to the equator (relative to many other launch sites globally) also provides a natural velocity boost for equatorial orbits, reducing the fuel requirements for reaching geostationary positions. Additionally, Chabahar's existing port and airport infrastructure could be used to facilitate the transportation of rocket sub-sections and payloads.⁸⁸

The location of the future Etlaq Spaceport south of Duqm, at a latitude of about 18° north, offers even greater advantages than Chabahar for equatorial-orbit insertions, due to it being closer to the equator. This location in turn provides a more substantial velocity boost from the Earth's rotation, translating into increased payload capacity or reduced fuel requirements for launches. For SSOs, Etlaq's position still allows for efficient launches with moderate plane changes. The ongoing development of Etlaq

as a significant industrial and logistics hub further enhances its potential as a spaceport, with existing and planned infrastructure that could be adapted to support launch operations.⁸⁹

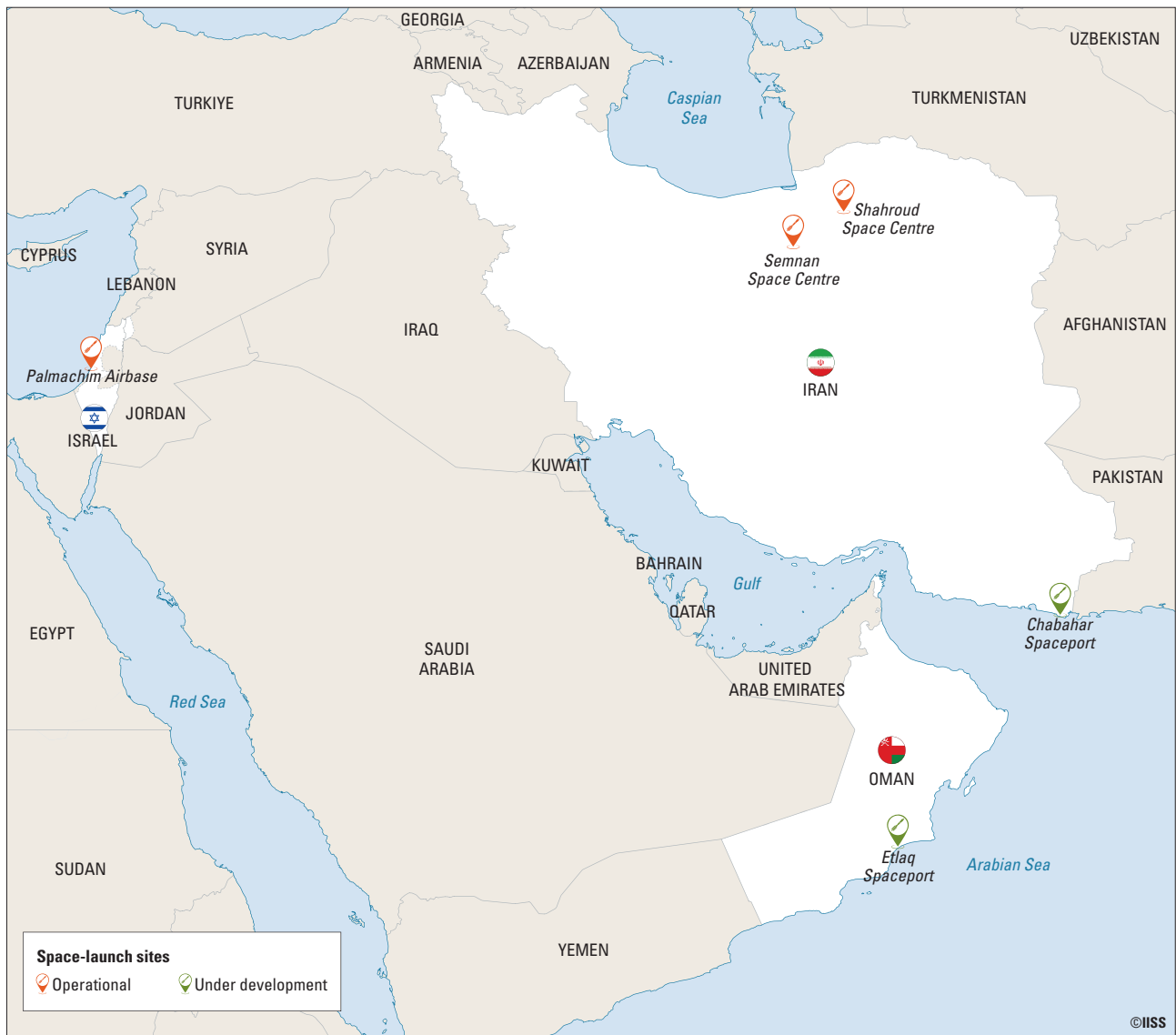
Etlaq also benefits from its coastal location which provides direct access to downrange tracking and telemetry stations in the Indian Ocean operated by India and the US. This enables comprehensive mission support and data collection throughout the launch sequence for Oman. Iran is unlikely to be able to rely on third-country tracking and telemetry and may have to develop a seaborne telemetry, tracking and command (TT&C) capability during launches from Chabahar.

Finally, the relatively stable weather conditions in these regions, characterised by low precipitation and infrequent extreme weather events, are conducive to more frequent launches and greater equipment reliability at Chabahar and Etlaq than at other launch sites in the world.

By contrast, Saudi Arabia's Empty Quarter (Rub' al Khali) desert and the UAE face significant challenges as potential launch sites. The Empty Quarter, while offering vast uninhabited areas for launches, is located inland and would require launching over highly populated areas or neighbouring countries, complicating range safety and international agreements. Its latitude (roughly 20–23° north) is less optimal than Etlaq for equatorial orbits, and the lack of existing infrastructure in the remote desert region would necessitate substantial investment in transportation and support facilities.⁹⁰ Despite its advanced infrastructure, the UAE faces similar challenges with its inland position and the need to launch over the Gulf or populated areas. Additionally, its higher latitude (around 24–26° north) provides less of a velocity boost for equatorial orbits compared to more southerly locations.⁹¹ Both the Empty Quarter and the UAE also contend with extreme heat and sandstorms, which could affect launch operations and equipment reliability, making them less ideal for consistent, year-round launches compared to the coastal sites of Chabahar and Etlaq.

A May 2024 report suggests that Saudi Arabia has abandoned its plans to establish a launch site in the Empty Quarter and is now in talks with Etlaq

Map 2.1: **Selected operational and under-development space-launch sites in the Middle East**



Sources: Arms Control Wonk; CIA; Etlaq Spaceport; IISS research; Israel Defense Forces

Spaceport to lease a launch pad for the Kingdom’s critical launch needs. In keeping with the occasional rivalries that occur among Gulf Cooperation Council (GCC) member states, the UAE is wary of being involved in Etlaq given Saudi Arabia’s interest.⁹² Still, it is reported to be studying potential cooperation with Turkiye’s Roketsan to develop its proposed commercial SLV, most likely as the financing partner.⁹³

Middle East Space Technologies and the Role and Influence of External Powers

The role and influence of China, North Korea and Russia in the dissemination of space technologies and ballistic missiles in the Middle East has been

significant and often controversial. These countries have historically been more willing than others to transfer sensitive technologies, often with less regard for international non-proliferation norms. China, in particular, has been a critical player in this arena, providing complete missile systems, crucial components and technical know-how to countries such as Iran and Saudi Arabia, enabling them to rapidly advance their indigenous capabilities.⁹⁴ China’s approach has often been driven by the desire to expand its influence in the region while securing energy resources and economic partnerships.⁹⁵

North Korea, despite its international isolation, has been a notable historical proliferator of missile technology in the Middle East. Its willingness to share missile

China has provided missile systems, components and know-how to countries such as Iran and Saudi Arabia



(Photo by Pool/Bandar Algaloud/Anadolu Agency via Getty Images)

designs and provide technical assistance, particularly to Iran, has been a key factor in the region's missile proliferation. This cooperation has extended to the development of technologies that can be applied to both ballistic missiles and SLVs, blurring the lines between military and civilian applications. North Korea's motivations have been primarily economic, with technology transfers serving as a crucial source of hard currency for the regime.⁹⁶

Russia's role in proliferation has been more complex. While historically a source of missile technology for countries such as Syria and Iran, Russia has in recent years shown more restraint in proliferating advanced missile systems. However, it continues to engage in space cooperation with several Middle Eastern countries, especially Iran, thus potentially contributing to dual-use capabilities.⁹⁷ Russia's approach is often characterised by a balance between strategic interests, economic considerations and a desire to maintain influence in the region without overtly challenging international non-proliferation norms.⁹⁸

By contrast, the US, France and other Western countries have taken a markedly different approach to the dissemination of space technologies in the Middle East. Their focus has been primarily on commercial satellite technologies and civilian space applications, with strict adherence to international non-proliferation regimes.

The US, in particular, has been a leading provider of commercial satellites and launch services to Middle

Eastern countries, but with careful consideration of potential dual-use applications. This approach has included technology-transfer agreements with stringent safeguards and end-use monitoring to prevent the diversion of technologies for military purposes.⁹⁹

France, through companies such as Airbus and Thales Alenia Space, has also provided satellite technologies and services to Middle Eastern countries, particularly in the Gulf region. These engagements have focused on telecommunications and Earth observation for civilian, commercial and national-security applications. The French approach, like that of other Western countries, emphasises compliance with international export-control regimes and non-proliferation agreements.¹⁰⁰

Western involvement in the Middle Eastern space sector has also included efforts to promote responsible space practices and integration into the global space economy. This has involved creating partnerships for space-based services, joint scientific missions and capacity-building initiatives.¹⁰¹ The goal of these efforts has been to foster the development of indigenous space capabilities in a manner that is consistent with international norms and contributes to regional stability. However, this approach has sometimes been perceived as overly restrictive by Middle Eastern countries eager to develop more advanced space and missile capabilities, leading some to seek alternative partners with fewer restrictions.

Commercial Space Competition, Missile Defence and Counter-space

The increasing adoption of dual-use satellite systems by Middle Eastern countries for national-security purposes marks a significant shift in regional strategic capabilities. High-resolution Earth-observation satellites and advanced satellite-communication systems are being deployed not only for civilian applications but also to enhance military intelligence, surveillance and reconnaissance (ISR) capabilities. This is particularly evident in Israel, Iran and the UAE, which have made substantial investments in space-based assets. As these systems become increasingly integral to national-security infrastructures, they also become potential targets in future conflicts,

potentially catalysing the development of counter-space capabilities in the region.¹⁰²

The value of these dual-use satellite systems could drive regional actors to seek means of denying their adversaries access to space-based assets during crises and conflicts. This imperative may lead to the development of various counter-space capabilities, ranging from electronic warfare and cyber attacks to kinetic ASAT weapons.¹⁰³ The conversion of existing ballistic missiles into DA-ASAT weapons represents a particularly concerning possibility, as it leverages existing technological capabilities and infrastructure. Countries with advanced ballistic-missile programmes, such as Iran and Saudi Arabia, could potentially adapt these technologies for ASAT purposes with relatively modest additional investment.¹⁰⁴

The development of DA-ASAT capabilities from ballistic missiles would be technically challenging but not insurmountable for countries with established missile programmes. The primary modifications would have the aim of enhancing the missiles' altitude capabilities and improving their guidance systems for precision targeting of satellites in LEO, developing specialised warheads that are effective against satellite structures and enhancing upper-stage propulsion for reaching orbital altitudes.¹⁰⁵ The dual-use nature of many of these technologies could allow countries to pursue ASAT capabilities under the guise of SLV development or missile-defence programmes, complicating international monitoring-and-control efforts.¹⁰⁶ Critical to the effectiveness of these modified systems as DA-ASAT weapons would be the integration of powerful space-surveillance radars and advanced tracking systems. These are essential for detecting, identifying and precisely tracking targeted satellites in LEO. Additionally, upgrades to command-and-control systems would be necessary to process the complex orbital data and compute intercept solutions for DA-ASATs.

The operational deployment of such modified systems by Middle Eastern states could have profound implications for regional security and stability. The ability to threaten or neutralise adversaries' satellite assets would introduce a new dimension to regional conflicts and deterrence strategies.

Regional Non-state Actors, Ballistic Missiles and Space

While this report's primary focus is on regional state actors at the intersection of ballistic missiles and space technologies, the current yet nascent role of regional non-state actors in this area should not be overlooked. While these groups' activities remain low-key for now, given current technological and political trends their threat profile could grow.

Non-state actors such as Hamas, Hizbullah and Ansarullah (Houthis) have demonstrated increasing sophistication in their operations, and it is plausible that they could leverage commercial-satellite services to enhance their capabilities. These groups could potentially establish front companies or utilise sympathetic businesses to purchase high-resolution satellite imagery and communication services from commercial providers. The global presence of satellite-service resellers and the competitive nature of the market create opportunities for these actors to obscure their true identities and intentions. Unscrupulous resellers, motivated by profit or ideological alignment, might be willing to turn a blind eye to the end-users of their services, particularly if transactions are structured to appear legitimate.¹⁰⁷

State sponsors could play a crucial role in this scenario. Countries such as Iran, which has known ties to these groups, could facilitate access to satellite services either directly through their own national capabilities or by acting as an intermediary with commercial providers. Iran's growing space programme and its strategic

Ansarullah (Houthis) launch what was later claimed to be a hypersonic ballistic missile targeting Israel on 16 September 2024



(Photo by Houthi Media Center via Getty Images)

relationships with Russia and China potentially open up additional avenues for these non-state actors to access satellite imagery and communications. Similarly, other state actors with interests in the region might see the provision of satellite services to these groups as a means of advancing their strategic objectives while maintaining plausible deniability.¹⁰⁸

It is worth carefully considering the potential for these groups to access satellite imagery and communications directly from countries such as China, Iran and Russia. China and Russia in particular have their own constellations of Earth-observation and communications satellites, some with very high resolutions rivalling those of Western commercial systems. While these countries might be cautious about directly providing such services to non-state actors, the complex web of geopolitical relationships and proxy conflicts in the Middle East could create scenarios where such capabilities are shared, either openly or covertly. This

could significantly enhance the intelligence-gathering and command-and-control capabilities of these non-state actors, potentially altering the balance of power in regional conflicts.¹⁰⁹

In light of these possibilities, regional and international partners must monitor satellite-service acquisitions in the region and work closely to strengthen controls on the dissemination of high-resolution imagery and advanced communication services.

It also remains possible, albeit unlikely, that non-state actors such as Hamas, Hizbullah and the Houthis might attempt to leverage their existing ballistic-missile technology to gain rudimentary satellite-launch capabilities. These groups have demonstrated increasing sophistication in their missile programmes, often with support from Iran as their state sponsor. It is at least conceivable that they could adapt these technologies to create makeshift SLVs capable of placing small payloads, such as CubeSats, into LEO.¹¹⁰

3. The Utility of Diplomatic Tools and Measures for Countering Middle Eastern Ballistic-missile Proliferation and Achieving Space Security

The growing prevalence of ballistic-missile systems, outlined at the beginning of this report, continues to present challenges to existing international agreements and export-control regimes, particularly the MTCR, the Wassenaar Arrangement and the Hague Code of Conduct against Ballistic Missile Proliferation (HCoC). These frameworks, while historically important in curbing proliferation, are now increasingly strained by technological advances and geopolitical dynamics.

The MTCR, established in 1987, faces pressure due to the evolution of missile technologies. Originally designed to control exports of missile systems capable of delivering nuclear weapons, it now grapples with the proliferation of advanced conventional missiles and dual-use technologies. The regime's categorical approach, based on range and payload capabilities, struggles to adequately address the nuances of modern missile systems, particularly those with dual-use potential in both military and civilian space applications.¹¹¹ Additionally, the MTCR's voluntary nature and limited membership (currently 35 countries) leave gaps in its global coverage, allowing non-members to develop and transfer missile technologies with relative impunity.¹¹²

The Wassenaar Arrangement, while broader in scope and membership than the MTCR, also faces challenges in effectively controlling the proliferation of missile-related technologies. Its focus on 'promoting transparency and greater responsibility in transfers of conventional arms and dual-use goods and technologies' is commendable, but the pace of technological change often outstrips the agreement's ability to update its export-control lists. Moreover, its consensus-based decision-making process can lead to delays in implementing new export controls, potentially allowing critical technologies to proliferate before effective measures are put in place.¹¹³

The HCoC, aimed at bolstering efforts to curb ballistic-missile proliferation, is constrained by its non-binding nature and limited scope. While it has achieved widespread subscription (145 states as of March 2024), its effectiveness is hampered by the absence of verification mechanisms and the lack of participation from key missile-possessing states such as Iran.¹¹⁴ The HCoC's focus on ballistic missiles also means it does not address the growing challenges posed by very-high-speed cruise missiles and glide vehicles, leaving a gap in the international control regime.

The Missile Technology Control Regime, the Wassenaar Arrangement and the Hague Code of Conduct against Ballistic Missile Proliferation in the Middle East

The MTCR, the Wassenaar Arrangement and the HCoC are diplomatic tools to manage the spread of missiles and their supporting and related technologies. However, their efficacy in the Middle East has been limited, largely due to the region's complex security dynamics and the technological aspirations of multiple countries.¹¹⁵ The Middle East presents an acute case study in missile-proliferation trends due to its compact geography and a complex web of regional rivalries. This regional arms dynamic is further complicated by the capabilities of non-state actors, such as Hizbullah and Ansarullah (Houthis). The prevalence of missiles in the Middle East is not merely a reflection of global trends but an amplification of them. The perceived existential threats faced by several regional actors have led to a prioritisation of missile capabilities.¹¹⁶

Advanced weapons and lethal aid from Iran, destined for Houthi-controlled areas of Yemen, seized by the US in the Arabian Sea on 28 January 2024



(Photo by Centcom/Anadolu via Getty Images)

This regional context has contributed to deep scepticism among Middle Eastern states regarding international missile-control measures. These agreements are often viewed in the region as instruments that disproportionately benefit established powers while constraining the defensive capabilities of smaller states. Their scepticism is further fuelled by the ineffectiveness of these measures in constraining Iran's ballistic-missile programme. Despite being the target of numerous international sanctions and export-control regimes, Iran has developed a diverse and capable missile arsenal. Moreover, Tehran's ability to transfer missile technologies to non-state actors such as Hizbullah and the Houthis has demonstrated the limitations of existing non-proliferation efforts.¹¹⁷ This failure to prevent Iran's missile advancements has had a cascading effect on regional attitudes towards international control measures. It has contributed to a cycle of proliferation that existing international frameworks seem ill equipped to address.

The Middle East's unique geographical and geopolitical characteristics have created a particularly challenging environment for missile non-proliferation efforts. To better remedy this, Western states must reconsider their approach to regional security and stability, and recognise that traditional non-proliferation strategies may have limited efficacy in the Middle East. Instead, the West and its regional and international partners may need to explore more regionally tailored approaches that address the specific security concerns and

strategic calculations of Middle Eastern states while still working towards the broader goal of preventing destabilising arms competitions.

Firstly, offering these states enhanced access to advanced Western military technologies could serve as a powerful incentive. Many Arab states seek to modernise their armed forces and maintain a technological edge in the region. By linking membership of regimes such as the MTCR, the Wassenaar Arrangement and the HCoC to preferential access to cutting-edge defence systems, international partners could make participation more attractive.¹¹⁸

Secondly, greater collaboration between the West and Middle Eastern states in space technology and greater access to civilian space capabilities could also be an incentive for the latter to engage with these frameworks. This could include joint satellite-development projects, technology transfer in areas such as Earth-observation and communications satellites, and capacity-building initiatives to develop indigenous space industries and expertise.¹¹⁹

Thirdly, security guarantees or enhanced defence-cooperation agreements between the West and Middle Eastern states could address the underlying security concerns that drive missile proliferation in the Middle East. While formal defence pacts might be politically challenging, softer security arrangements such as increased joint military exercises, intelligence-sharing and strategic dialogues could provide reassurance.¹²⁰ Additionally, further commitments to regional missile-defence cooperation, including the potential integration of Arab states into broader missile-defence networks, could offer a defensive alternative to the development of offensive missile capabilities.¹²¹

Fourthly, economic incentives offered by Western countries that are tied to non-proliferation commitments could appeal to Arab states seeking to diversify their economies. This could involve preferential trade agreements, investment in advanced technology sectors or support for economic-diversification initiatives.

Fifthly, offering a seat at the table in shaping future non-proliferation and arms-control initiatives could be a diplomatic incentive. Many Arab states feel that existing regimes do not adequately address their security concerns or regional dynamics.

Lastly, addressing the Iranian missile threat through diplomatic means, with the active involvement of Arab states, could help alleviate some of the security concerns driving scepticism towards non-proliferation measures. This could involve supporting regional dialogue on missile limitations, potentially as part of broader security discussions, and ensuring that any future negotiations with Iran on its missile programme include substantive consultation with its Arab neighbours.

Capacity-building in the Middle East

Incentivising Arab countries to join international missile-control and non-proliferation measures will require a multifaceted approach by the West that addresses their security concerns, economic interests and desire for access to technology. By offering a combination of military, economic and diplomatic incentives, international partners could create a better case for participation in these regimes.

These efforts should also address the internal challenges faced by many Arab governments in joining international missile-control and non-proliferation measures. Engaging with these agreements requires a deep understanding of complex technical issues related to missile technology, dual-use goods and space capabilities, and the lack of indigenous subject-matter expertise in these areas presents a significant hurdle for many Arab countries considering membership in these regimes. Many Arab states have historically focused their technical expertise on other areas, leaving them with a limited pool of specialists who can effectively engage with the intricacies of these control regimes. This knowledge gap can lead to hesitation in joining agreements that they may not fully comprehend or feel equipped to implement effectively.

The limited capacity of foreign-affairs ministries in many Arab countries further compounds this challenge. These ministries often operate with constrained resources and personnel, making it difficult to dedicate the necessary time and manpower to fully engage with the requirements and processes of international missile-control regimes. The complex reporting, information-sharing and compliance mechanisms associated with these agreements can overwhelm smaller diplomatic corps, potentially discouraging participation or leading to incomplete implementation after joining.

Additionally, there is the sensitive issue of a perceived loss of face that could result from seeking assistance from third countries in meeting the requirements of these measures. In a region where national pride and the appearance of self-reliance are highly valued, the prospect of publicly acknowledging a need for external help in understanding and implementing international agreements can be politically unpalatable. To address these challenges, several approaches could be considered by Western states.

Firstly, a regional capacity-building initiative could be established, potentially under the auspices of the Arab League, the GCC or another respected regional body. This initiative could focus on developing a cadre of regional experts in missile-technology control and non-proliferation, drawing on expertise from regime-member states with more advanced capabilities in these areas.

Secondly, partnerships with academic institutions in the Arab world could be fostered to develop curricula and research programmes focused on international-security regimes and non-proliferation. This would help build a sustainable pipeline of local expertise over time. Additionally, secondment programmes could be established, allowing officials from Arab countries to gain experience working within the secretariats of these international regimes or in the relevant departments of more experienced member states.

Thirdly, a phased approach to joining these regimes could be considered, allowing countries to gradually build their capacity and expertise. This could involve creating or them applying for observer or associate status within these agreements, permitting Arab states to participate in discussions and capacity-building activities without immediately taking on full compliance responsibilities.

Fourthly, regional workshops and training sessions could be organised, led by experts from current member states of these regimes. By conducting these activities within the Arab region and potentially in Arabic, this could make the knowledge-transfer process more culturally sensitive and accessible.

Lastly, the development of a regional support network or secretariat to assist Arab countries in implementing these regimes could be considered. This body could provide technical assistance, help with reporting

requirements and facilitate information-sharing among Arab states.

While the challenges facing Arab governments in joining these international control regimes are significant, they are not insurmountable. By focusing on regional solutions, gradual engagement and capacity-building, international partners can create pathways for increased Arab participation in these important non-proliferation efforts.

Achieving Regional Space Security

Given the complex regional dynamics, technology spread and ongoing missile proliferation in the Middle East, approaches to introducing confidence-building measures with a view to building a regional space-security architecture should also be considered.¹²²

Firstly, Middle Eastern countries could explore the establishment of a regional space-cooperation forum. This platform would serve as a venue for dialogue on space activities, fostering transparency and building trust among participating states. Such a forum could facilitate information-sharing on space policies, civilian space programmes and upcoming satellite launches.

Secondly, the development of a regional code of conduct for space activities could be pursued. Such a voluntary, non-binding agreement could outline principles for responsible behaviour in space, addressing issues such as debris mitigation, non-interference with space assets and the peaceful use of outer space. While potentially similar to international initiatives, a regional code could be tailored to address specific Middle Eastern concerns and realities.¹²³

Thirdly, countries in the region could consider implementing a system of pre-launch notifications for space launches. This measure would increase transparency and reduce the risk of misinterpretation of space launches as potential missile tests or attacks. Such a system could start with voluntary notifications and gradually evolve into a more formalised arrangement as trust builds among participating countries. This approach could be particularly valuable in a region where the line between SLVs and ballistic missiles is often perceived as blurred.¹²⁴

Fourthly, collaborative space projects could be initiated as confidence-building measures. Joint satellite missions for purposes such as environmental

monitoring, disaster management or scientific research could foster cooperation and interdependence among regional space actors. These projects would not only serve practical purposes but also create a shared interest in maintaining a stable and secure space environment.¹²⁵

Lastly, regional countries could work towards establishing shared situational-awareness capabilities for space. This could involve the creation of a regional space-traffic-management system or a shared space-debris-monitoring network. By pooling resources and sharing data on space objects and potential collisions, countries could enhance their collective space security while building trust through practical cooperation. This approach could also help address the growing challenge of space debris, which poses risks to all space actors regardless of national boundaries.¹²⁶

These approaches to regional space security and confidence-building measures offer potential pathways for Middle Eastern countries to address the challenges posed by the evolving space landscape. However, implementing such measures will require sustained diplomatic effort, political will and a willingness even among countries with long-standing rivalries to engage in dialogue. The success of these initiatives could not only enhance space security but also contribute to broader regional stability and cooperation.

Norms of Space Behaviour Versus Treaties Banning Space Weapons

As regional states consider the evolving space-security landscape in the Middle East, they should be encouraged to adhere to responsible norms of behaviour in space and join the growing international consensus against destructive ASAT-weapons testing. Firstly, Middle Eastern states should be encouraged to publicly endorse and adhere to the existing United Nations-backed guidelines for the long-term sustainability of outer-space activities.¹²⁷ By demonstrating compliance with these guidelines and also actively participating in international forums such as the UN Committee on the Peaceful Uses of Outer Space (COPUOS), Middle Eastern countries can position themselves as responsible actors in the global space community. Bahrain, Egypt, Saudi Arabia and the UAE are at the forefront of regional efforts on this matter, but more regional countries could engage.¹²⁸

Secondly, regional states should be encouraged to join the growing number of countries that are declaring a moratorium on testing destructive ASAT weapons, including DA-ASAT weapons. The recent US-led initiative to stop such tests has gained support, with a total of 35 countries joining, in recognition of the international risks posed by space debris generated from these weapons.¹²⁹ For Middle Eastern countries, joining this moratorium would demonstrate their commitment to space-security sustainability and could potentially ease concerns about the dual-use nature of their space and missile programmes. A multifaceted approach combining diplomatic outreach, capacity-building and positive incentives should be employed to promote these objectives. This could include organising regional workshops on space security, providing technical assistance on space situational awareness and offering collaborative opportunities in civilian space projects. Additionally, the establishment of a regional space-dialogue mechanism could provide a forum for discussing space-security concerns and building consensus on norms of behaviour.

However, while promoting norms and moratoriums is important, the limitations of pursuing a comprehensive treaty banning space weapons also need to be recognised. The primary challenge lies in defining what constitutes a 'space weapon'. Many space technologies are inherently dual-use, capable of both peaceful and potentially weaponised applications. This ambiguity makes it extremely difficult to craft a definition of space weapons that is both comprehensive and practically enforceable.¹³⁰

Furthermore, verification of compliance with a space-weapons-ban treaty would pose technical and political challenges. The vast expanse of space, combined with

The Vienna International Centre, which hosts the headquarters of the UN Office for Outer Space Affairs (UNOOSA)



(Photo by UCG/Universal Images Group Editorial via Getty Images)

the miniaturisation of satellite technologies, makes it extremely difficult to monitor and verify the absence of weapons in orbit. Identifying and monitoring ground-based weapons capable of targeting satellites would be even more challenging, as they could be concealed or rapidly deployed, or could appear to be a ballistic missile. The level of intrusiveness required for effective verification would likely be politically unacceptable to many states, particularly in a region as sensitive to sovereignty concerns as the Middle East.¹³¹

While regional and international partners should actively promote adherence to responsible norms of behaviour in space and encourage Middle Eastern states to join moratoriums on destructive ASAT testing, all parties should be realistic about the limitations of formal treaty-based approaches to space weapons. Their focus should be on building a common understanding of responsible behaviour, enhancing transparency and fostering cooperation in space activities.

Conclusion

This paper has discussed the relationship between ballistic-missile proliferation and SLV development in the Middle East and other ballistic-missile-proliferation pathways that have implications for regional space developments. It is evident that the landscape has evolved over the past two decades. While still requiring monitoring, the growing divergence between ballistic missiles and SLVs presents a less concerning picture than it did at the turn of the century.

The availability of commercial space-launch services has reduced the incentive for many Middle Eastern states to develop indigenous SLV capabilities that could also be used as a cover for ballistic-missile programmes. Countries such as the UAE and Saudi Arabia can now access space through working with commercial providers or joining international partnerships, thus satisfying their space ambitions without raising proliferation concerns. This shift has helped decouple space-launch activities from missile development.

The technological trajectories of modern SLVs and ballistic missiles have also diverged. Contemporary SLVs increasingly prioritise reusability, precision orbital insertion and multi-payload-deployment capabilities – all of which are suboptimal or unnecessary features for ballistic-missile applications. This technological divergence makes it more challenging and less economically viable to repurpose SLV technology for missile development, reducing proliferation risks.

Increasing transparency in space activities, driven by commercial imperatives and international cooperation, has made it more difficult to disguise missile development as civilian space programmes. The global space community's interconnectedness and the need for adherence to evolving international space-traffic-management norms have created an environment where suspicious activities are more likely to be detected and scrutinised.

Many Arab states in the Middle East have recognised the economic and scientific benefits of participating in the global space economy. Their focus has shifted towards developing space capabilities for Earth observation,

telecommunications and scientific research, rather than pursuing technologies with overtly military applications.

Iran remains an exception to this trend, as it continues to blur the lines between its ballistic-missile programme and space-launch activities. However, Iran's approach is increasingly viewed as an outlier rather than as a model for other regional states. The international community's focused concern on Iran's activities has not led to a broader trend of SLV development as a cover for missile programmes in the region.

The establishment of more robust international export-control regimes and monitoring mechanisms, such as the MTCR and the HCoC, has made it more challenging to transfer sensitive technologies that could contribute to both SLV and missile development. While not perfect, these mechanisms have helped contain the most concerning proliferation activities.

The growing recognition of space as a critical domain for economic development and national prestige has led many Middle Eastern states to prioritise legitimate space capabilities over covert missile programmes. The potential economic benefits and international-cooperation opportunities associated with peaceful space activities provide strong incentives for compliance with emerging international norms.

While ballistic missiles remain a concern in the Middle East, they are no longer viewed as a challenge that is exclusive to the region. Diplomatic measures such as the MTCR, the Wassenaar Arrangement and the HCoC will continue to play some part in stemming missile proliferation but are in need of revision and modernisation.

Lastly, the increasing participation of Middle Eastern states in international space-governance forums and their growing stake in maintaining a stable space environment have created new avenues for dialogue and confidence-building. These engagements provide opportunities to address security concerns and promote responsible space behaviour, potentially reducing the incentives for covert missile development under the guise of civilian space programmes. That said, it must

be recognised that some proposed measures to bring about space security may have unforeseen and even detrimental consequences.

The changing technological, economic and strategic landscape has altered the calculus for many regional actors, making the development of SLVs as

a cover for missile programmes less attractive and less feasible. Moving forward, policies should focus on encouraging legitimate space activities, fostering regional cooperation in space and maintaining robust monitoring mechanisms to detect deviations from this trajectory.

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The International Institute for Strategic Studies – UK

Arundel House | 6 Temple Place | London | WC2R 2PG | UK

t. +44 (0) 20 7379 7676 **e.** iiss@iiss.org www.iiss.org

The International Institute for Strategic Studies – Americas

2121 K Street, NW | Suite 600 | Washington DC 20037 | USA

t. +1 202 659 1490 **e.** iiss-americas@iiss.org

The International Institute for Strategic Studies – Asia

9 Raffles Place | #49-01 Republic Plaza | Singapore 048619

t. +65 6499 0055 **e.** iiss-asia@iiss.org

The International Institute for Strategic Studies – Europe

Pariser Platz 6A | 10117 Berlin | Germany

t. +49 30 311 99 300 **e.** iiss-europe@iiss.org

The International Institute for Strategic Studies – Middle East

14th floor, GFH Tower | Bahrain Financial Harbour | Manama | Kingdom of Bahrain

t. +973 1718 1155 **e.** iiss-middleeast@iiss.org
