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The Role of LEO Satellites for the (Cyber)Security Policies of Authoritarian States: The Case of Iran

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Introduction

In recent years, intensifying global geopolitical rivalries and rapid technological advancements have driven states to explore alternative ways to enhance their defense capabilities. As global tensions escalate, outer space has emerged as a critical domain for defense and security, particularly for authoritarian states like Iran, where satellite technology provides strategic advantages, including in defense (notably, cyber defense).[2]

Iran, as one of the countries involved in international space exploration efforts, has been pursuing an expansive space program for years, aligning with its broader security strategy. Since 1958, when Iran joined the United Nations Committee on the Peaceful Uses of Outer Space, up to its contemporary ambitions for autonomous satellite technology capabilities, the nation's determination to strengthen its position on the global stage is evident.

Tehran's pragmatic approach to international cooperation is highlighted by its signing—but not full ratification—of key space treaties, such as the 1967 Outer Space Treaty. This stance reflects Iran's interest in international cooperation while maintaining flexibility in shaping its policies. Such an approach presents both

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opportunities and challenges in the broader context of global security and oversight. Under constant international pressure and isolated from traditional global communication and technological structures, Iran has invested in its technologies for many years. This has raised concerns over the dual-use potential of these technologies, which could serve not only peaceful space exploration but also ballistic missile program development.

Recently, low Earth orbit (LEO) satellites have gained particular significance for the Iranian government. Their lower production and launch costs compared to geostationary satellites facilitate easier access to advanced telecommunications and observational infrastructure. The lower orbital altitudes of these satellites enable faster data transmission and more efficient regional coverage. In recent years, LEO satellites have become a cornerstone of Iran's (cyber)security strategy. These technologies are employed not only for environmental monitoring and scientific support but also for military, intelligence, and regime control purposes.

This article analyzes the evolution of Iran's space program, illustrating how LEO technologies integrate into the broader context of national security and international space law. Particular attention is given to Iran's strategy of leveraging space as a tool to build technological autonomy and safeguard the regime's interests on the global stage. Satellites play a pivotal role in the regime's efforts to protect sovereignty, develop intelligence capabilities, and enhance cyber defense mechanisms. By examining the technological and political implications of Iran's use of LEO satellites, the article explores how these assets contribute to the state's broader strategic goals in security and resilience, including cyber resilience. The discussion is framed within conceptual and problem-oriented areas, encompassing topics such as norms and principles of international law related to cyberspace, responsible state behavior, critical infrastructure, data governance, and cybersecurity.

Iran and International Space Law

Iran's interest in outer space dates back to 1958, when it joined 17 other countries to establish the Ad Hoc Committee on the Peaceful Uses of Outer Space under the United Nations.[3] Two years later, Iran became one of the 24 founding members of the successor organization, the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS), established by General Assembly Resolution 1472 (XIV).[4]

3 United Nations, *Committee on the Peaceful Uses of Outer Space: Membership Evolution*. Available at: https://www.unoosa.org/oosa/en/ourwork/copuos/members/evolution.html (accessed: 02/02/2025).

4 In 1959, the United Nations General Assembly established the Committee on the Peaceful Uses of Outer Space (COPUOS) as a permanent body, initially comprising 24 members, and affirmed its mandate in Resolution 1472 (XIV). Since then, COPUOS has served as the central hub for international cooperation in the peaceful exploration and use of outer space.

Iran has also signed the *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies* (Outer Space Treaty) of 1967,[5] although it has never ratified this agreement.[6] A similar status applies to the *Convention on Registration of Objects Launched into Outer Space* (Registration Convention) of 1975.[7] This indicates that Iran has expressed initial political and moral commitment to the issues covered by these documents but has not assumed the full legal obligations arising from them. If a treaty is not ratified, it cannot be automatically implemented within a country's domestic legal system. Consequently, the state is not formally a party to the agreement and cannot invoke its provisions or be held accountable for violating them.

However, the state is obligated to avoid actions contrary to the treaty's purpose and objectives until it clearly defines its stance on ratification. Only two of the five UN treaties on the use of outer space have been ratified by the Iranian government: the *Agreement on the Rescue of Astronauts, the Return of Astronauts, and the Return of Objects Launched into Outer Space* (1968)[8] and the *Convention on International Liability for Damage Caused by Space Objects* (1972).[9] Conversely, Tehran has not signed the *Agreement Governing the Activities of States on the Moon and Other Celestial Bodies* (1979).[10] The status of Iran's participation in these agreements is summarized in the table below.

It maintains close contacts with governmental and non-governmental organizations involved in space activities, facilitates the exchange of information on space-related activities, and assists in exploring measures to promote international cooperation in this field. United Nations, *Committee on the Peaceful Uses of Outer Space*. Available at: https://www.unoosa.org/oosa/en/ourwork/copuos/index.html (accessed: 02/02/2025).

5 United Nations, *Treaty 2222 (XXI) on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies*. Available at: https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/outerspacetreaty.html (accessed: 02/02/2025).

6 *Ratifications*. Available at: https://www.jus.uio.no/english/services/library/treaties/01/1-11/activities-exploration.html (accessed: 02/02/2025).

7 United Nations, *Convention on Registration of Objects Launched into Outer Space, General Assembly resolution 3235 (XXIX)*. Available at: https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/registration-convention.html (accessed: 02/02/2025).

8 United Nations, *Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space, General Assembly resolution 2345 (XXII)*. Available at: https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/rescueagreement.html (accessed: 02/02/2025).

9 United Nations, *Convention on International Liability for Damage Caused by Space Objects, General Assembly resolution 2777 (XXVI)*. Available at: https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/liability-convention.html (accessed: 02/02/2025).

10 United Nations, *Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, General Assembly resolution 34/68*. Available at: https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/moon-agreement.html (accessed: 02/02/2025).

Tab. 1. Status of Iran's ratification of international space treaties and agreements

Name of the treaty	Acronym	Admission Date	Status
United Nations treaties			
Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (Outer Space Treaty)	OST	1967	Signed
Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space	ARRA	1968	Ratified
Convention on International Liability for Damage Caused by Space Objects (Liability Convention)	LIAB	1972	Ratified
Convention on Registration of Objects Launched into Outer Space (Registration Convention)	REG	1975	Signed
Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (Moon Agreement)	MOON	1979	X
Other agreements			
Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and under Water	NTB	1963	Ratified
Agreement Relating to the International Telecommunications Satellite Organization (ITSO)	ITSO	1971	Ratified
Agreement on the Establishment of the INTERSPUTNIK International System and Organization of Space Communications	INTR	1971	X
Convention Relating to the Distribution of Programme-Carrying Signals Transmitted by Satellite	BRS	1974	X
Convention for the Establishment of a European Space Agency (ESA)	ESA	1975	X
Agreement of the Arab Corporation for Space Communications (ARABSAT)	ARB	1976	X

Name of the treaty	Acronym	Admission Date	Status
Agreement on Cooperation in the Exploration and Use of Outer Space for Peaceful Purposes (INTERCOSMOS)	INTC	1976	X
Convention on the International Mobile Satellite Organization	IMSO	1976	Ratified
Convention Establishing the European Telecommunications Satellite Organization (EUTELSAT)	EUTL	1982	X
Convention for the Establishment of a European Organization for the Exploitation of Meteorological Satellites (EUMETSAT)	EUM	1983	X
International Telecommunication Constitution and Convention	ITU	1992	Ratified

Source: Table presenting the status of Iran's ratification of international agreements on space activities as of January 1, 2024, prepared by the author based on: Status and application of the five United Nations treaties on outer space, and way and means, including capacity-building, to promote their implementation, Committee on the Peaceful Uses of Outer Space Legal Subcommittee, Vienna, 15–26 April 2024, https://www.unoosa.org/res/oosadoc/data/documents/2024/aac_105c_22024crp/aac_105c_22024crp_3_0_html/AC105_C2_2024_CRP03E.pdf (accessed: 02/02/2025).

Origins of Iran's Space Program

In 2005, Iran became the forty-third country in the world to possess satellites in outer space. However, the Iranian government's efforts in this area began much earlier. During the late 1940s and early 1950s, the Organization for Planning and Budget of the Country (*Sazeman-e Barname va Budje-ye Keshvar*) was established to oversee the development and strategic planning of Iran's economic and social systems. In 1974, within this framework, the Office for Satellite Data Collection was created to utilize satellite data and remote sensing technologies for infrastructure projects. Following preliminary research and successful outcomes from satellite imagery, the office was renamed the Iranian Remote Sensing Center (ITC),[11] marking the establishment of the nation's first space agency.

11 *Iranian Space Organization (Sazeman-e Fazayi Iran),* Ministry of Communications and Information Technology. Available at: https://web.archive.org/web/20080607133426/http://www.ict.gov.ir/companies-ministry-space-fa.html (accessed: 02/02/2025).

Shortly thereafter, the Iranian Remote Sensing Center initiated the Satellite Utilization Plan, which aimed to directly receive, process, reproduce, and distribute satellite data. To achieve this, three remote sensing satellite image reception stations were purchased and installed in Mahdasht Karaj. Simultaneously, under the rule of Shah Mohammad Reza Pahlavi, Iran became a member of the International Telecommunications Satellite Organization (ITSO).[12]

These developments marked the initial use of satellite technologies for civilian purposes, such as television signal transmission and telecommunications.[13] Iran became the fourth country globally to directly receive and process satellite images. However, Tehran's ambitious plans for space exploration were halted following the 1979 Islamic Revolution.

It was not until the 1990s that Iran's space program was revitalized. On October 6, 1991, a law was passed establishing the Iranian Remote Sensing Center. Under this law, the center became part of the Ministry of Post, Telegraph, and Telephone (now the Ministry of Communications and Information Technology) as a state-owned enterprise. Its primary objective was to prepare and utilize information derived from remote sensing technologies for research on land resources, meteorology, and oceanography to support macro-sectoral and regional development planning in production, infrastructure, and service sectors. Additionally, the center was tasked with conducting scientific research in remote sensing technology, promoting education, and encouraging the adoption and development of these technologies.[14]

The Iranian Remote Sensing Center also assumed responsibility for coordinating and monitoring space policy at the national level, covering both government and non-government sectors. Its specific tasks included:

- Developing remote sensing technologies to support the country's development and transformation;
- Minimizing dependence on foreign technology providers;
- Coordinating and supervising remote sensing activities conducted by other institutions, whether governmental, government-affiliated, or non-governmental, and proposing legislation and strategic documents in the field;
- Directly acquiring, processing, purchasing, producing, reproducing, selling, and distributing remote sensing data (including satellite and aerial imagery);
- Conducting research and studies to keep pace with technological advancements and promoting education and awareness in remote sensing technologies;
- Implementing joint projects with other domestic and international entities;

12 United Nations, *Agreement relating to the International Telecommunications Satellite Organization 'INTELSAT' (with annexes)*. Available at: https://treaties.un.org/Pages/showDetails.aspx?objid=08000002800e8e08&clang=_en (accessed: 02/02/2025).

13 *Iranian Space Agency*. Available at: https://www.undrr.org/organization/iranian-space-agency (accessed: 02/02/2025).

14 The Act on the Establishment of the Iranian Remote Sensing Center, 6 October 1991 (14 Mehr 1370 SH). Available at: https://rc.majlis.ir/fa/law/show/91955 (accessed: 02/02/2025).

- Establishing a national archive focused on maintaining, classifying, and updating remote sensing information;
- Researching the design, construction, and provision of equipment for acquiring, processing, interpreting, producing, and reproducing remote sensing information.[15]

The 1990s also witnessed intensified international cooperation in utilizing technologies to advance Iran's space program. In 1998, reports emerged of agreements with Russia and China for the design, construction, and launch of satellites. Notably, the Russo-Iranian agreement on technology transfer enabled Iran to develop its own research satellite named *Mesbah* ("Dawn," "Beacon," or "Lantern"). Although the purpose of *Mesbah* remains unclear, initial reports from 1999 described it as either a spy satellite, a communication satellite, or one intended solely for educational purposes.[16] The launch of *Mesbah* was planned for late 2005 aboard a Kosmos-3M rocket from the Plesetsk Cosmodrome, but the satellite was never sent into space.[17]

The structured development of Iran's space program gained momentum after 2004, when two key institutions were established: the Iranian Space Agency (ISA) and the Supreme Space Council (SSC). In addition, the Islamic Revolutionary Guard Corps (IRGC) operates its own space program. The roles and responsibilities of these entities will be described in the next section of the article.

Key Entities in Iran's Space Program

Supreme Space Council (SSC)

The Supreme Space Council was established under Articles 8 and 9 of Islamic Council Resolution No. 68159, dated December 13, 2003 (22 Azar 1382 SH). Its secretary is the head of the Iranian Space Agency (ISA). Although not an organization in itself, it functions as an auxiliary body at the ministerial level. Its members include:

- The President of the Islamic Republic of Iran, acting as the SSC's chairperson,
- Minister of Communications and Information Technology,
- Minister of Science, Research, and Technology,
- Minister of Defense,
- Minister of Foreign Affairs,
- Minister of Industry and Mining,
- Minister of Roads and Transportation,
- Director of Iran Broadcasting.[18]

15 *Ibidem*.

16 Y.S. Shapir, Iran's efforts to conquer space, *The Institute for National Security Studies Strategic Assessment*, 2005, 8(3), p. 8.

17 Mesbah 1, *Gunter's Space Page*. Available at: https://space.skyrocket.de/doc_sdat/mesbah-1.htm (accessed: 02/02/2025).

18 P. Tarikhi, Statutes of the Iranian Space Agency, *Journal of Space Law*, 2008, 34(2), pp. 3–7.

In 2007, the Supreme Administrative Council passed a resolution to consolidate all supreme councils in the country as part of the objectives of the Fourth National Development Plan. Consequently, the Supreme Council for Education, Research, and Technology (SCERT) was created but operated for only a few months. In February 2008, it was dissolved, and its responsibilities were transferred to the newly formed Science, Research, and Technology Commission (SRTC) under the government. However, on September 27, 2008, the Iranian Parliament (*Majles*) deemed the dissolution of 12 supreme councils unconstitutional and reinstated their operations, allowing the SSC to resume its activities.[19]

The SSC's primary objectives include formulating policies for the application of space technologies for peaceful purposes, overseeing the production, launch, and utilization of domestic research satellites, approving state-level and public sector programs related to space activities, encouraging private sector and cooperative partnerships in the effective use of space, and establishing guidelines for regional and international cooperation in space-related matters.[20]

Iranian Space Agency (ISA)

The Iranian Space Agency was established concurrently with the SSC under Articles 8 and 9 of Islamic Council Resolution No. 68159, dated December 10, 2003 (19 Azar 1382 SH),[21] and began its operations on February 1, 2004. According to its statute, adopted in 2008, ISA operates under the SSC's guidance and has a mandate to conduct all activities related to the peaceful utilization of space technologies. It engages in research, analysis, project management, engineering services, and space-related operations, including the application of remote sensing technologies.[22]

As an independent legal entity, the ISA is financially autonomous and affiliated with the Ministry of Communications and Information Technology.[23] It supports the ministry's Department of Satellite Communications Design, Engineering, and Installation and the Department of Satellite Communications Maintenance. It also collaborates closely with the Iranian Telecommunications Company.[24]

The agency's president, who also serves as the Deputy Minister of Communications and Information Technology and Secretary of the SSC, is appointed by the

19 *Ibidem*.

20 B. Harvey, H.H.F. Smid, T. Pirard, *Emerging Space Powers. The New Space Programs of Asia, the Middle East, and South America*, Chichester 2010, pp. 265–266.

21 Iranian Space Agency, *History of Iranian Space Agency*, 21 August 2019 (30 Mordad 1398 SH). Available at: https://web.archive.org/web/20210730123140/https://isa.ir/fa/general_content/41505-%D8%AA%D8%A7%D8%B1%DB%8C%D8%AE%DA%86%D9%87.html (accessed: 02/02/2025).

22 Article 1 of the Statute of the Iranian Space Agency, 13 June 2008 (24 Khordad 1387 SH). Available at: https://rc.majlis.ir/fa/law/show/134694 (accessed: 02/02/2025) (hereinafter referred to as the ISA Statute).

23 Article 2 of the ISA Statute.

24 Article 1 of the ISA Statute.

Minister of Communications and Information Technology.[25] The president is responsible for ensuring proper implementation of ISA's initiatives, safeguarding its rights and assets, managing the agency, and executing SSC-approved plans.[26]

The ISA's statute outlines 14 primary responsibilities, including:

- Developing and implementing medium- and long-term programs for the national space sector, in collaboration with related institutions, for submission to the SSC;
- Conducting research to shape policies for designing, producing, launching, and utilizing research and operational satellites, as well as delivering space services;
- Preparing plans for the peaceful use and development of space and space technologies;
- Strengthening national, regional, and international communication networks and monitoring their implementation in line with SSC policies;
- Conducting specialized studies, research, and education to advance space science and technology;
- Issuing permits and licenses for activities in space to ensure sustainable and coordinated use of space technologies and facilities, including satellites, direct reception stations, and satellite control centers.[27]

ISA also represents Iran in international and regional associations and unions related to space matters, advocating national interests in alignment with the regime's policies. It implements regional and international cooperative programs in space activities and maintains a national archive for centralizing, classifying, and updating space-related data.[28] All ISA activities must receive SSC approval, and its funding is derived from public budgets and allocated credits based on annual budgetary plans.[29]

Iranian Space Research Center (ISRC)

The Iranian Space Research Center (ISRC) was established in 2010 (1389 SH) with authorization from the Supreme Council for the Development of Higher Education to address the country's scientific and technological needs in space development. On January 28, 2015 (8 Bahman 1393 SH), the center was integrated into the Ministry of Communications and Information Technology. Alongside ISA, ISRC is one of the two primary organizations conducting space research and operations in Iran.[30]

25 Article 6 of the ISA Statute.

26 Article 7 of the ISA Statute.

27 Article 3 of the ISA Statute.

28 *Ibidem*.

29 Article 4 of the ISA Statute.

30 Iranian Space Research Center, *About*. Available at: https://web.archive.org/web/20220201170828/https://www.isrc.ac.ir/%D8%AF%D8%B1%D8%A8%D8%A7%D8%B1%D9%87-%D9%BE%DA%98%D9%87%D8%B4%DA%AF%D8%A7%D9%87 (accessed: 02/02/2025).

The ISRC's mission is to advance indigenous technologies, infrastructure, and systems for the peaceful utilization of space, enhancing human life in accordance with national priorities for sustainable scientific, technological, cultural, and economic development. It is a knowledge-based organization focused on innovative products in the realm of peaceful space technologies.

The center's three main objectives are:

- Conducting research to develop methods and techniques required by the Ministry of Industry, Communications, and Technology, aligned with the national space sector's vision;
- Creating infrastructure to promote education, research, and technological development in the space sector;
- Applying research achievements and space technologies to strengthen the space industry through commercialization or technology transfer and absorption in the private sector.[31]

To achieve these objectives, the ISRC is tasked with identifying research needs and developing plans to address the complete lifecycle of space technologies, conducting fundamental, applied, and developmental research on space telecommunications and remote sensing systems, and developing laboratory services and infrastructure for space-related activities. It also can run projects on advancing and refining operational software for space systems, collaborating with universities, research institutions, and both government and private scientific-industrial centers domestically and internationally, and promoting education and public awareness regarding the applications and achievements of domestic space technologies.[32]

The ISRC also operates five sectoral research institutes, focusing on satellite systems, propulsion systems, materials, energy, and mechanical research, distributed across Tehran, Tabriz, Isfahan, and Shiraz. In 2011 (1390 SH), the ISRC established the Space Systems Testing and Integration Center, supported by ISA, to aid in space product development and provide testing services to other industrial sectors, including aerospace, maritime, aviation, automotive, and telecommunications.[33]

Islamic Revolutionary Guard Corps (IRGC)

The Islamic Revolutionary Guard Corps (IRGC), established by Ayatollah Khomeini in May 1979, is one of the two components of Iran's armed forces alongside the regular military (*Artesh*).[34] Its constitutional mandate (Article 150) is to safeguard the Islamic Revolution and its achievements.[35] Unlike the military,

31 *Ibidem*.

32 *Ibidem*.

33 *Ibidem*.

34 K.M. Andrusiewicz, Korpus Strażników Rewolucji w systemie politycznym i polityce bezpieczeństwa Islamskiej Republiki Iranu, *Rocznik Bezpieczeństwa Wewnętrznego*, 2012/2013, pp. 361–362.

35 Islamic State of Iran, *The Constitution of the Islamic State of Iran*, Article 150 (*Qanun-e Asasi-ye Jomhuri-ye Eslami-ye Iran*). Available at: https://rc.majlis.ir/fa/law/show/132239 (accessed: 02/02/2025).

which adheres to a principle of non-interference in domestic affairs, the IRGC is a highly politicized institution with wide-ranging social, political, and economic influence.[36]

The IRGC's stated mission is "to protect the Islamic Revolution of Iran and its achievements, to persistently strive toward achieving divine goals, to promote the rule of divine law in accordance with the laws of the Islamic Republic of Iran, and to strengthen the foundations of the Islamic Republic through cooperation with other armed forces, military training, and organizing popular forces."[37] Unlike the regular Army, which adheres to a policy of non-interference in internal state affairs, the IRGC is a highly politicized institution due to its broad competencies.

Established shortly after the victory of the 1978–1979 Islamic Revolution, the IRGC was initially intended to serve as an ideological guard for the nascent regime. However, over the four decades of the Islamic Republic's existence, the IRGC's role has significantly evolved, far exceeding its original mandate. Today, in addition to performing typical counterintelligence duties, the IRGC functions as an expansive socio-political and economic conglomerate with influence in nearly every aspect of Iran's political and social life.[38] In practice, IRGC members represent a privileged and highly active group within Iranian society.

In addition to its political influence, the IRGC also plays a substantial role in the economy, encompassing nearly every sector of the Iranian market. Its economic involvement traces back to the Iran-Iraq War, during which the IRGC took control of confiscated factories and established the *Khatam al-Anbia* organization. This entity developed various companies operating in agriculture, industry, mining, transportation, road construction, import/export, and later education and culture. Over time, *Khatam al-Anbia* has become one of Iran's largest industrial and development contractors and is now regarded as the IRGC's primary engineering arm, undertaking contracts for constructing dams, water diversion systems, highways, water supply systems, and oil and gas pipelines.[39] Additionally, IRGC units are involved in the production of biological and chemical weapons and operate effectively in the oil, energy, and gas sectors. Their extensive network includes ties to various Iranian banks, further solidifying their pervasive role in the nation's economy.[40]

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36 Islamic State of Iran, *The Constitution of the Islamic Revolutionary Guard Corps* (Asasname-ye Sepah-e Pasdaran-e Enghelab-e Eslami), dated September 6, 1982 (15 Shahrivar 1361). Available at: https://rc.majlis.ir/fa/law/show/90595 (accessed: 02/02/2025) (hereinafter referred to as the IRGC Constitution).

37 Article 1 of the Iranian Constitution.

38 F. Wehrey, J.D. Green, B. Nichiporuk, A. Nader, L. Hansell, R. Nafisi, S.R. Bohandy, *The rise of the Pasdaran, Assessing the Domestic Roles of Iran's Islamic Revolutionary Guards Corps,* RAND Corporation 2009. Available at: https://www.rand.org/content/dam/rand/pubs/monographs/2008/RAND_MG821.pdf (accessed: 02/02/2025), p. XI–XVIII.

39 *Ibidem*.

40 K.M. Andrusiewicz, *op. cit*., pp. 366–369.

The Islamic Revolutionary Guard Corps (IRGC) operates its own space program, likely initiated in the mid-to-late 21st century, which functions independently of Iran's civilian space program. Due to the IRGC's unique role and position within the state structure, it is not subject to oversight by the Supreme Space Council. This program was founded by Hassan Tehrani Moghaddam, often referred to as the father of Iran's missile program, and has primarily served as a cover for the development of long-range missile technologies.[41]

The unit responsible for developing and managing the IRGC's space program, including its ballistic missile initiatives, is the Islamic Revolutionary Guard Corps Aerospace Force (IRGC-ASF). According to the U.S. Defense Intelligence Agency (DIA), the IRGC-ASF oversees Iran's air defense operations in collaboration with the regular Iranian Army and serves as the primary operator of Iran's fleet of unmanned aerial vehicles (UAVs). Media reports and intelligence assessments indicate that the IRGC-ASF supervises the IRGC's space program and successfully launched its first military satellite, Noor-1, into orbit in April 2020.[42]

The IRGC-ASF operates through two key entities: IRGC Aerospace Force Self-Sufficiency Jihad Organization and IRGC Aerospace Force al-Ghadir Missile Command. The first one, established in 1993, is an Iranian research and development unit, which has been involved in ballistic missile research, flight testing, and the development and production of radar systems such as the Qadir.[43] The second one was listed by the European Union in 2010 as an entity associated with Iran's nuclear activities, particularly those related to the development of nuclear weapon delivery systems. This unit is likely directly responsible for managing Iran's ballistic missile operations.[44]

Aerospace Research Institute (ARI)

The Aerospace Research Institute (ARI) is a scientific and academic organization affiliated with the Ministry of Technology. Established in 2000, it has been actively engaged in conducting aeronautical research at the national level. The primary objective of the Institute is to identify and conduct research on advanced

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41 J. Krzyzaniak, *Part 1: Explainer—Iran's Space Program*, *The Iran Primer*, United States Institute of Peace, 9 August 2022. Available at: https://iranprimer.usip.org/blog/2022/jun/03/explainer-irans-space-program (accessed: 02/02/2025).

42 Islamic Revolutionary Guard Corps (IRGC) Aerospace Force, *Iran Watch*, Wisconsin Project on Nuclear Arms Control, 24 August 2020. Available at: https://www.iranwatch.org/iranian-entities/islamic-revolutionary-guard-corps-irgc-aerospace-force (accessed: 02/02/2025).

43 Islamic Revolutionary Guard Corps (IRGC) Aerospace Force Self-Sufficiency Jihad Organization, *Iran Watch*, Wisconsin Project on Nuclear Arms Control, 24 February 2023, https://www.iranwatch.org/iranian-entities/islamic-revolutionary-guard-corps-irgc-aerospace-force-self-sufficiency-jihad-organization (accessed: 02/02/2025).

44 *IRGC-Air Force Al-Ghadir Missile Command*, Iran Watch, Wisconsin Project on Nuclear Arms Control, 2 March 2011. Available at: https://www.iranwatch.org/iranian-entities/irgc-air-force-al-ghadir-missile-command (accessed: 02/02/2025).

aeronautical and related technologies. ARI collaborates with private sector organizations to carry out innovative research in this field.

The Institute comprises three main departments: Aeronautical Sciences and Technologies, Space Sciences and Technologies, Law, Standards, and Management in the Aerospace Industry. ARI also oversees a Research Group on Aviation Physiology and a Think Tank focused on conducting strategic research in aerospace and planning for the future.[45]

ARI's core activities include designing and testing aerodynamic launch vehicles. It also has a dedicated group conducting research on suborbital rockets and their payloads. Additionally, ARI undertakes projects related to propulsion fundamentals and the performance of microsatellite propulsion systems, satellite software, public-private partnerships in space research, and the commercialization of space technologies. The Institute conducts and implements research projects in collaboration with the industrial sector, including the aviation industry, as well as the defense sector.[46]

Low Earth Orbit Satellites in Iran's Space Program

In 2005, Iran launched its first satellite into low Earth orbit (LEO). The *Sina-1* satellite was placed in space using a Russian Kosmos-3M rocket and was primarily intended for imaging and scientific research purposes. Subsequently, Iran achieved a significant milestone in 2009 by launching its first domestically manufactured satellite, *Omid*, using an indigenous launch vehicle, *Safir*. Table 2 provides an overview of low Earth orbit satellites launched by Iran since 2005, detailing the satellite name, year of launch, the launch vehicle used, and the satellite's primary application.

Tab. 2. A list of all Iranian low Earth orbit satellites, along with their launch vehicles and primary applications

LEO satellite	Launch vehicle	Main application
Sina-1 (2005)	Kosmos-3M (RU)	imaging and scientific research purposes
Mesbah (2005)	Kosmos-3M (RU)	environmental monitoring, data relay, and scientific experiments
Omid (2009)	Safir-1	data-processing, a store-and-forward communication mission
Rasad-1 (2011)	Safir-1B	imaging and reconnaissance, primarily environmental and topographical mapping

45 B. Harvey, H.H.F. Smid, T. Pirard, *op. cit.*, p. 268.
46 *Ibidem*.

Tab. 2 (cont.)

LEO satellite	Launch vehicle	Main application
Navid (2012)	Safir-1B	imaging and scientific research, primarily: atmospheric and weather studies, environmental monitoring, disaster management, and agricultural applications
Fajr (2015)	Safir-1B	remote sensing satellite, primarily: to capture high--resolution images for environmental monitoring, disaster management, and mapping.
Payam (2019)	Simorgh	environmental and agricultural monitoring, as well as for scientific and research purposes
Dousti (2019)	Safir-1B	remote sensing, with a focus on agricultural and geological data collection
Zafar 1 (2020)	Simorgh	monitoring natural disasters, forestry, and agricultural activities
Noor 1 (2020)	Qased	military satellite, for reconnaissance and surveillance purposes
Noor 2 (2022)	Qased	military satellite, for reconnaissance and surveillance purposes
Khayam (2022)	Soyuz (RU)	environmental monitoring, agricultural planning, and natural disaster management
Noor 3 (2023)	Qased	military satellite, for reconnaissance and surveillance purposes
Soraya (2024)	Qaem-100	research purposes
Mahda (2024)	Simorgh	test advanced satellite subsystems and monitor the performance of the multi-satellite release system
Keyhan-2 (2024)	Simorgh	improving the accuracy and functionality of Iran's satellite operations
Hatef-1 (2024)	Simorgh	enhancing Iran's communication capabilities
Pars-1 (2024)	Soyuz (RU)	environmental monitoring, including agricultural and geological studies

Source: prepared by the author based on media reports.

Over nearly two decades, the development of Iranian satellites highlights a clear shift in priorities and strategic goals. During the initial phase (2005–2012), missions predominantly focused on scientific research, environmental monitoring, and remote sensing (*Sina-1*, *Mesbah*, *Navid*). In this period, Iran primarily relied on Russian launch vehicles (Kosmos-3M), reflecting limited domestic capabilities in space technology.

Subsequently, a transitional phase (2015–2019) emerged, characterized by the deployment of more technologically advanced satellites, such as *Fajr*, which were capable of capturing high-resolution imagery critical for crisis management and mapping. This phase also marked a period of intensive development of indigenous launch vehicles (*Safir-1B*, *Simorgh*).

Since 2019, there has been a significant acceleration in Iran's low Earth orbit (LEO) satellite program, demonstrated by numerous satellite launches serving a variety of purposes. These include environmental imaging (*Khayam*, *Pars-1*), military applications (*Noor-1*, *Noor-2*, *Noor-3*), and technological testing (*Mahda*, *Keyhan-2*). This period clearly indicates that Iran is currently in an expansion phase, with the development of launch systems such as *Qased* and *Qaem-100* underscoring Iran's growing autonomy in space exploration.

Iran's LEO satellite program plays a significant role in advancing the country's strategic technological capabilities, integrating civilian, scientific, and military objectives. A comprehensive analysis of this program necessitates understanding how individual LEO satellites are utilized. By classifying these satellites, one can discern Iran's technological priorities and strategic directions shaping the development.

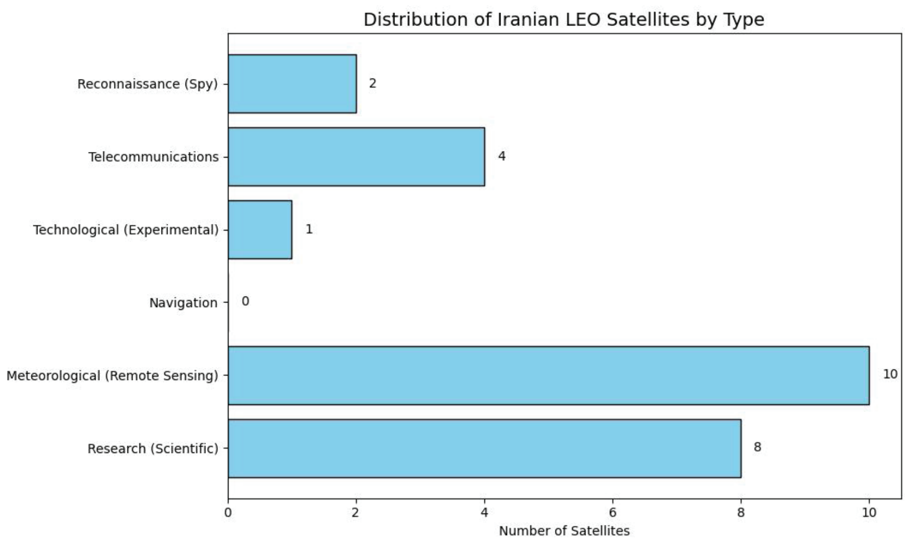

Fig. 1. A chart illustrating the distribution of purposes for which LEO satellites are utilized by Iran
Source: prepared by the author.

An analysis of Iranian low Earth orbit (LEO) satellites launched between 2005 and 2024 reveals five main categories of applications, differentiated by the number of units launched and their functions.

The most numerous category comprises meteorological and remote sensing satellites, accounting for a total of nine units. These satellites are critical for monitoring climate change, analyzing natural resources, and supporting crisis management, including disaster response. It can be inferred that Iran, as a nation vulnerable to the effects of climate change and grappling with water scarcity, is investing in space technologies to facilitate sustainable resource management. Examples of such satellites include *Payam* and *Pars-1*, which are utilized for environmental monitoring, agricultural management, and geological resource mapping.

The second-largest group, comprising eight units, highlights the importance of Iran's space program for scientific research. These satellites are used for atmospheric observations, geodetic studies, and biological and astronomical experiments. The launch of units such as *Navid* and *Khayam* underscores Iran's aspirations to advance its scientific capabilities and technological innovation, which could enhance the country's prestige within the international scientific community.

In summary, during the initial phase of Iran's space program (2005–2012), the focus was predominantly on scientific research, environmental monitoring, and remote sensing. Since 2019, there has been a clear diversification in satellite applications, encompassing both civilian and military objectives. This period marks a significant acceleration in space-related activities, indicating Iran's growing technological capabilities and recognition of the strategic role its space program plays in national security.

Iran is gradually developing autonomous capabilities in satellite design and launch, reducing its dependence on countries like Russia. Simultaneously, the use of external technologies demonstrates deepened international collaboration in space technology, which may raise concerns about the dual-use potential of these technologies. In recent years, Iran has placed greater emphasis on the deployment of military satellites, likely in response to increasing geopolitical tensions and the need to enhance its surveillance capabilities.

Discussion: Benefits of the Space Program for Iran's Security Strategy

Iran's space program plays a critical role in achieving the nation's strategic goals, integrating political, economic, military, and scientific dimensions. It represents Tehran's ambitions to reduce dependence on foreign technologies, build national technological capabilities, and bolster its position on the international stage. The development of space technologies enables Iran to enhance its capabilities in communication, Earth observation, and navigation, directly impacting national security and intelligence operations. Furthermore, investments in the space sector drive economic growth by fostering innovation, creating jobs, and promoting collaboration between industry and academia.

Several key aspects of Iran's space program are essential for understanding its contributions to the country's security strategy. These include not only military security but also broader areas such as internal, political, environmental, and technological security.

Environmental Security

Low Earth orbit (LEO) satellites, due to their lower costs and greater accessibility, are a key tool for Iran in building a system to monitor its natural environment. They provide independence from external providers and facilitate the development of domestic technological infrastructure, which is crucial for the nation's strategic security.[47]

Climate change poses undeniable challenges for Middle Eastern countries, particularly Iran. In terms of total greenhouse gas (GHG) emissions, Iran ranks as the largest contributor to climate change in the Middle East and seventh globally.[48] Iran's high GHG emissions are driven by extensive oil and gas production and rapid urbanization.[49] Over the coming decades, the country is projected to experience a 2.6°C increase in average temperatures and a 35% reduction in precipitation.[50] Furthermore, several researchers predict that by the end of the century, heatwaves in Iran and Western Asia will intensify by 30%.[51]

Iran's recent focus on research and the use of remote sensing for environmental monitoring is pivotal for ensuring environmental security. LEO satellites provide regular data on climate changes, such as droughts, floods, and rainfall patterns. This data is critical for managing water resources, forecasting droughts, and optimizing irrigation systems in a country grappling with water scarcity and agricultural degradation.[52] Satellites can also monitor air, water, and soil pollution, enabling the identification of contamination sources and assessing their environmental impact. For a nation battling urban smog and water pollution, these capabilities are vital for policymaking and industrial regulation.[53]

Furthermore, LEO satellites facilitate rapid detection and analysis of natural disasters, such as earthquakes, floods, landslides, and sandstorms, which frequently

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47 See more: J.L. Awange, *Environmental Monitoring using GNSS*, New York 2012; V Tramutoli, *Robust Satellite Techniques (RST) for Natural and Environmental Hazards Monitoring and Mitigation: Theory and Applications*, International Workshop on the Analysis of Multi-temporal Remote Sensing Images, Leuven, Belgium 2007, pp. 1–6.

48 M.R.M. Daneshvar, M. Ebrahimi, H. Nejadsoleymani, An overview of climate change in Iran: Facts and statistics, *Environmental Systems Research*, 2019, 8(7), p. 3.

49 V. Karimi, E. Karami, M Keshavarz, Climate change and agriculture: Impacts and adaptive responses in Iran, *Journal of Integrative Agriculture*, 2018, 17(1), p. 5.

50 Iran's Third National Communication to United Nations Framework Convention on Climate Change (UNFCCC), 2017, https://unfccc.int/sites/default/files/resource/Third%20National%20communication%20IRAN.pdf (accessed: 02/02/2025).

51 X. Zhang (et. al), Trends in Middle East climate extremes indices during 1930–2003, *Geophysical Research*, pp. 1–12; F. Rahimzadeh, A. Asgari, E. Fattahi, Variability of extreme temperature and precipitation in Iran during recent decades, *International Journal of Climatology*, 2009, 29(3), pp. 329–343.

52 M.J. Amiri, S.S. Eslamian, Investigation of climate change in Iran, *Journal of Environmental Science and Technology*, 2010, 3(4), pp. 210–212.

53 K.C. Abbaspour, M. Faramarzi, S.S. Ghasemi, H. Yang, Assessing the impact of climate change on water resources in Iran, *Water Resources Research*, 2009, 45(10), https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2008WR007615 (accessed: 02/02/2025).

affect Iran.[54] This capability enables quicker responses, minimizing human and material losses. Satellites also support biodiversity management by monitoring deforestation, crop conditions, and soil erosion, essential for a country where agriculture plays a significant economic role.

Technological Security and Critical Infrastructure Resilience

Since the 1979 Islamic Revolution, Iran's prolonged exposure to international sanctions has compelled the nation to explore alternative paths for economic and technological development. One prominent example of Iran's technological resilience is the National Information Network (*Shabake-ye Melli-ye Ettelāʿāt*, SME), a domestic intranet designed to ensure independent communication and internet access.[55]

Iran has also developed a suite of domestic software and hardware solutions to circumvent restrictions on international applications. These include indigenous operating systems (*Ghasedak*, *Sharif Linux*), email services (*Chaapaar*), search engines (*Fajr*, *Parsijoo*), e-commerce platforms (*Digikala*), and social media networks (*Cloob*). The country produces essential IT components, including data centers, routers, microprocessors, and communication devices.[56]

The space program plays a crucial role in bolstering Iran's technological security by reducing reliance on foreign suppliers, fostering the domestic technology sector, and mitigating international pressures. Developing a space program requires mastery of key components such as launch vehicles, satellites, communication systems, and ground stations. This enables Iran to establish independent

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54 H. Bahrainy, Natural Disaster Management in Iran during the 1990s—Need for a New Structure, *Journal of Urban Planning and Development*, 2003, 129(3); K. Jahangiri, Y.O. Izadkhah, S.J. Tabibi, A comparative study on community-based disaster management in selected countries and designing a model for Iran, *Disaster Prevention and Management,* 2011, 20(1); K. Zarea, S. Beiranvand, P. Sheini-Jaberi, A. Nikbakht-Nasrabadi, Disaster nursing in Iran: Challenges and opportunities, *Australasian Emergency Nursing Journal*, 2014, 17(4).

55 See also: B. Rahimi, Censorship and the Islamic Republic: Two modes of regulatory measures for media in Iran, *The Middle East Journal*, 2015, 69(3); N. Bajoghli, *Digital Technology as Surveillance*, Routledge 2014; A. Yalcintas, N. Alizadeh, *Digital Protectionism and National Planning in the Age of the Internet: The Case of Iran*, Cambridge University Press 2020; C. Anderson, *The Hidden Internet of Iran: Private Address Allocations on a National Network*, 2012, https://arxiv.org/abs/1209.6398; R. Taghipour, M. Ramek, The strategic model of security analysis in the national information network of I.R. Iran, *Quarterly Journal Strategic Studies in Cyberspace*, 2022, 2(3).

56 M. Stachoń, Iranian cyber capabilities as a tool of domestic and foreign policy, *Scientific Reports of Fire University*, 2024, 2(89), pp. 278–279.

technological standards and reduce the need to import technology subject to export controls or sanctions.

Additionally, the program stimulates private sector growth and strengthens collaboration between universities and research institutions, driving advancements in engineering, electronics, materials science, and IT systems. This enhances national technological capacity, generates employment, and supports overall economic development.

By achieving advanced technological capabilities, Iran could potentially offer its space technologies to other countries, thereby fostering diplomatic and economic relations. Such achievements enhance Iran's negotiating position on the global stage, demonstrating its ability to thrive despite sanctions and isolation.

Political Security and Regime Stability

A key determinant of Iran's security strategy, both domestically and internationally, is the regime's concern for survival. Guided by the ideological principles of the Islamic Revolution, Iranian authorities perceive constant threats from internal factors, such as social unrest, economic crises, and opposition movements, as well as external pressures, including international sanctions, military threats, and geopolitical rivalries. The regime's drive for survival shapes Tehran's strategic decisions, focusing on strengthening its security apparatus, societal control, and the development of asymmetric capabilities such as cyber operations and its missile program.[57]

The development of the space program enhances the state's ability to address challenges posed by opposition activities, providing tools for more effective societal control. Already, under the pretext of combating heresy, anti-Islamism, or defending state interests and the virtues of its citizens, the Iranian government is active in the digital sphere. One method of controlling information is the harassment of activists online and conducting cyberattacks on their social media accounts.[58] Additionally, the government uses information against dissidents to dominate social and political discourses and discredit them in the eyes of the global public.

A relatively new method employed by the Iranian government to manage outbreaks of social unrest and counter anti-government activities online is mass internet shutdowns.[59] The regime also possesses far more precise and sophisticated tools for controlling public opinion. In 2022, evidence surfaced indicating that

57 *Ibidem*.

58 S. Kargar, A. Rauchfleisch, State-aligned trolling in Iran and the double-edged affordances of Instagram, *New Media & Society*, 2019, 21(7), pp. 1510–1511.

59 M. Kazemi, *#Internet Shutdown Trends in Iran: November 2019 to July 2021,* Filterwatch. https://filter.watch/en/2021/09/03/internet-shutdown-trendsin-iran-from-november-2019-to-july-2021/ (accessed: 02/02/2025).

Iran uses surveillance software (*Samane-je Yekparche-je Este'lamat-e Muchabarati*, SIEM) to track and control its citizens, particularly during public protests.[60]

The development of the space program could significantly enhance the regime's societal control capabilities by equipping the government with technological tools to monitor, manage, and suppress opposition activities as well as the general populace. Low Earth orbit (LEO) satellites enable the tracking of population movements, public gatherings, protests, and activities in critical urban and rural areas. This data can be used to rapidly identify and counter opposition activities. High-resolution imaging allows the authorities to monitor strategic sites, such as universities, workplaces, or places of worship, which may serve as hubs for organizing protests.

Moreover, proprietary satellites give the government control over communication systems, including television, radio, and the internet. This control enables the regime to restrict access to content deemed unfavorable while promoting official propaganda and eliminating narratives from independent sources. Satellites can also be used to jam signals from foreign media and satellite internet providers, further limiting citizens' access to alternative viewpoints.

Additionally, satellites can integrate with electronic surveillance systems, enabling geolocation of individuals and devices targeted by operational activities. This is particularly useful for identifying opposition leaders and their supporters.

The space program can also serve as a tool for regime legitimacy and propaganda. Successes in the space program can be used as evidence of the regime's strength and efficiency, reinforcing public belief in the necessity of the current government. Furthermore, showcasing achievements in this area can foster a sense of national pride, diverting attention from internal problems and consolidating support for the ruling authorities.

National Security

As highlighted earlier, Iran's recent focus on military LEO satellites underscores its growing awareness of the strategic advantages offered by space technology in regional and global rivalries. This may indicate a growing awareness within the government of the benefits of leveraging the space program primarily as a strategic advantage over regional and global adversaries.

Preliminary research conducted by the author, yet to be published, indicates that cyber espionage has been the dominant motivation for Iran's advanced persistent threat (APT) groups. Between 2009 and 2024, 41 out of 55 analyzed groups engaged in malicious activities aimed at collecting high-value or classified information. These

60 *Samane-je Yekparcze -je Este'lamat-e Muchabarati* (SIEM), https://www.documentcloud.org/documents/23199209-irans-siam-manual-in-persian-for-tracking-and-controlling-mobile-phones (accessed: 02/02/2025).

cyberattacks targeted critical sectors such as defense, industry, energy, diplomacy, and public administration, encompassing both state entities and private companies, NGOs, and international organizations. The primary objective was to gain intelligence, economic, political, or military advantages, ultimately strengthening Iran's geopolitical position. Cyber espionage also serves as a key tool in the technological race, enabling the theft of advanced technologies, military plans, and industrial innovations, thereby narrowing Iran's technological gap with its competitors.[61]

The development of the space program enhances Iran's intelligence capabilities by providing advanced technologies and tools for data collection and analysis. LEO satellites equipped with optical, radar, or multispectral sensors enable real-time monitoring of ground activities, including troop movements, strategic infrastructure development, and adversarial operations.[62]

Furthermore, in the context of escalating cyber threats and the shift of modern warfare to cyberspace, satellites facilitate the construction of independent, resilient communication systems for the government and military. These systems, integrated with ground infrastructure, can detect cyberattack sources and map adversarial activities in cyberspace. Satellites can also intercept radio signals and satellite communications, supporting sophisticated cyber espionage campaigns.

In summary, Iran's space program significantly bolsters its national security by enhancing intelligence capabilities, ensuring independent communications, and providing tools to counter external and internal threats effectively.

Summary

This article examines the significance of low Earth orbit (LEO) satellites in the (cyber)security strategies of authoritarian states, using Iran as a case study. It focuses on the role of these technologies in areas such as national, technological, environmental, and political security. The study highlights how space technologies, particularly LEO satellites, have become a critical component of authoritarian regimes' security strategies, enabling enhanced internal control, intelligence operations, and the development of independent capabilities in cyberspace.

The article outlines the evolution of Iran's space program, from its inception in the 1950s through the development phases of LEO satellites to contemporary priorities centered on technological autonomy and military capabilities. In Iran's case, the development of the space program aligns with a broader strategy to reduce dependence on foreign technology and data providers, thereby enhancing strategic autonomy.

61 Research conducted by the author as part of their doctoral dissertation.

62 See more: C.N. Stevens, Technology in Foreign Intelligence Gathering, *American Intelligence Journal*, 2017, 34(1); J.T. Richelson, *The technical collection of intelligence*, [in:] *Handbook of Intelligence Studies*, Routledge 2006; A. Dupont, *Intelligence for the twenty-first century*, [in:] W.K. Wark (ed.), *Twenty-First Century Intelligence*, Routledge 2005.

LEO satellites play a pivotal role in Iran's security strategy by ensuring independence from foreign suppliers, facilitating environmental monitoring, managing natural resources, and enabling disaster response. They also support technological advancements with dual-use applications in both civilian and military contexts. The article emphasizes the importance of military satellites in bolstering Iran's intelligence capabilities, including monitoring adversaries' troop movements and infrastructure, as well as conducting cyberespionage operations.

Additionally, LEO satellites are integral to maintaining regime security. In the context of political security, they aid the regime in societal control, monitoring protests, and curbing opposition activities. These technologies also enable faster responses to threats such as protests, sabotage, or cyberattacks. Furthermore, LEO satellites support disinformation and propaganda efforts, reinforcing the regime's legitimacy by showcasing technological achievements and restricting access to external information.

The author underscores that the development of domestic space technologies reduces Iran's vulnerability to international sanctions and restrictions on access to foreign satellite services. This strengthens its defensive and offensive capabilities in a rapidly evolving international environment. From a cybersecurity perspective, LEO satellites enable Iran to secure communications, monitor network activity, and conduct offensive operations against adversaries.

In conclusion, the development of Iran's space program represents a vital element of its security strategy. LEO satellites play a critical role in Iran's (cyber) security policies, integrating technological capabilities with the regime's strategic goals in technological, military, and political domains. The article suggests that LEO satellites enhance the regime's control mechanisms, contribute to technological self-sufficiency, and support the realization of long-term strategic objectives. However, they also raise concerns regarding their potential use in escalating regional and global conflicts.

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