Heavy Thunder, No Rain

Defense AI in Iran

Mahmoud Javadi

About the Defense AI Observatory

The Defense AI Observatory (DAIO) at the Helmut Schmidt University in Hamburg monitors and analyzes the use of artificial intelligence by armed forces. DAIO comprises three interrelated work streams:

- Culture, concept development, and organizational transformation in the context of military innovation
- Current and future conflict pictures, conflict dynamics, and operational experience, especially related to the use of emerging technologies
- Defense industrial dynamics with a particular focus on the impact of emerging technologies on the nature and character of techno-industrial ecosystems

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1 Executive Summary

Iran's grand strategy revolves around three key pillars: regime survival, security, stability (S3). Viewing the United States, and to a lesser extent Israel, as enduring state threats aiming to disrupt S3, Tehran has increasingly prioritized asymmetric tactics in its defense doctrine. This approach aims to deter adversaries' kinetic and non-kinetic operations while also positioning Iran to attain regional power status. The integration of artificial intelligence (AI) into defense is seen as a force multiplier meant to contribute to both strategic missions.

Although Iran's incorporation of AI into its defense capabilities and infrastructure remains in progress and lacks clarity, the regime is extensively focusing on enhancing its missile systems, proxy forces, Uncrewed Aerial Vehicles (UAVs), and naval power with AI technologies. Beyond state deterrence, Iran's 360-degree defense doctrine places emphasis on safeguarding national critical infrastructure and ensuring domestic stability, both of which have recently been bolstered through AI.

The defense infrastructure in Iran operates through a multi-layered approach, predominantly involving the Islamic Revolutionary Guard Corps (IRGC), the Army, and the Ministry of Defense. Each entity maintains low-profile research and development (R&D) facilities aimed at advancing AI capabilities or integrating AI technologies into existing systems.

Given Iran's practice of denial and deception (D&D) techniques in its defense technology investments, the exact budget allocated for AI remains undisclosed.

Notwithstanding the opacity surrounding defense AI R&D and budgetary allocation, all defense academies currently engage in training students and recruiting researchers in military applications of AI, a testament to Iran's vision to progressively integrate AI into its arsenals in the future.

Overall, Iran is currently in the nascent phases of developing and deploying defense AI. The claimed recent strides made by Iran may consist of a mixture of genuine advancements and propaganda. Nonetheless, the Islamic Republic is deeply engaged in thinking about defense AI, spurred by incontrovertible evidence emphasizing the crucial necessity and pressing requirement to integrate AI into its 360-degree defense doctrine. This perspective may find resonance within the leadership in Tehran, especially considering that Iran's major state adversaries have effectively employed AI technologies to target Iran's proxies and partners in the Middle East since November 2023, when Israel commenced military operations against Hamas in Gaza.

2 Thinking About Defense AI

The application of AI in defense made its debut in Iranian discourse in 2005 through a research paper published by the War University, that explored the integration of AI-enabled autonomous weapons in naval operations.[1] The power of defense AI, however, became starkly evident in the Iranian media and political discourse almost 15 years later, in the aftermath of the assassination of Mohsen Fakhrizadeh on 27 November 2020, carried out by an autonomous weapon.[2] Shortly after the killing of Fakhrizadeh, the father of Iran's industrial nuclear program, who benefitted from a personal protection regime comparable to that of Iran's President, a senior commander of the Islamic Revolutionary Guard Corps (IRGC) openly acknowledged the use of AI in the assassination.[3]

One year later, Iran's Supreme Leader, Ali Khamenei—the singular authority responsible for defining Iran's strategies and serving as the Commander-in-Chief of the Iranian Armed Forces—addressed the topic of AI for the first time in a public speech. Khamenei outlined a vision for Iran to position itself among the top 10 nations in the realm of AI.[4] Since then, defense AI has emerged as a central theme in the statements of senior military commanders and government defense authorities in Iran.

AI is primarily viewed as a capability multiplier, injecting fresh blood into the defense doctrine. Iran's doctrine predominantly centers on deterrence, employing cost-effective asymmetric tactics and passive defense to counter both kinetic and non-kinetic threats. The focus is on addressing challenges from Tehran's long-standing major state adversaries, namely the United States and Israel which are perceived as proponents of regime change in Iran.

Iran takes pride in its past efforts to minimize the risk of ground invasions by adversaries. Despite the persistent territorial challenges posed by insurgent and terrorist groups in its peripheries, Tehran's military leadership is currently wary of potential threats emanating from the sea and air, perceiving these domains as vulnerable to kinetic military operations. In response, the Iranian armed forces have strategically prioritized the development of niche capabilities as deterrent measures. To realize this priority, Tehran appears to have shifted its focus towards harnessing AI to principally sustain the credibility of these measures considering the rapid technological advancements of its major adversaries and regional rivals.

Despite the consistent discourse from Iranian leaders and strategists about the critical need to incorporate AI into Iran's defense strategy and posture, there appears to be limited tangible progress, as indicated by scant publicly available

1 Mahmoodi, "Target Automatic Identification in Marine Operations (شناسایی خودکار هدف در عملیات دریایی)."
2 Kirkpatrick/Fassihi/Bergman, "Killer Robot? Assassination of Iranian Scientist Feeds Conflicting Accounts."
3 Wintour, "Iran says AI and 'satellite-controlled' gun used to kill nuclear scientist."
4 "We should move on the path to making Iran a source of science within 50 years."

evidence of active projects. This slow development could be attributed to Iran's constraints in financial resources and technological access. Nevertheless, Tehran remains steadfast in its pursuit of this trajectory, whether or not it feels compelled to do so. Reports detailing how the United States is capitalizing on the advantages of Project Maven – the Pentagon's flagship initiative since 2017 aimed at integrating AI into the battlefield[5] – for targeting operations in Syria, Iraq, and Yemen in early February 2024,[6] following the October 2023 attack by Hamas against Israel, would undoubtedly prompt leadership in Tehran to intensify their efforts to narrow the military technology gap between Iran and its perceived adversaries[7] by enhancing the integration of AI into national defense capabilities and probably those of its proxies.[8] Thus, the Islamic Republic is opting to sanctify defense AI rather than vilify it.

2.1 The Islamic Republic's Grand Strategy in Defense

The Islamic Republic, a consequential product of the 1979 Revolution, has grappled with a persistent status of loneliness.[9] Its interests and priorities face constant challenges, often struggling for recognition. The leadership's foremost concern has been the ongoing protection of the nascent Islamic political regime against perceived threats from both state and non-state actors.[10] Thus, the context within which these perceived threats operate and the corresponding measures to counter them are crafted to fortify the Islamic Republic's triad grand strategy: survival, security, stability (S3).

Threat Perceptions

The ever-changing nature of the Islamic Republic, coupled with the inherent volatility in its surrounding regions, underscores the fluidity of Tehran's threat perceptions. However, the country's threat perception has changed between 2020 and 2024. For instance, ties with Saudi Arabia are warming up whereas the South Caucasus, traditionally aligned with Iranian interests, has become a new source of instability given resurfacing hostilities between Armenia and Azerbaijan.

Despite the changing nature of threat perceptions, the United States and, to a lesser extent, Israel are consistently viewed as the Islamic Republic's most endur-

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5   Manson, "AI Warfare Is Already Here."
6   Manson, "US Used AI to Help Find Middle East Targets for Airstrikes."
7   "Iran Military Power."
8   Barnes, "U.S. Says It Struck 5 Houthi Targets in Yemen, Including an Underwater Drone."
9   Tabatabai, "Iran in the Middle East: The Notion of "Strategic Loneliness."
10 Bahgat/Ehteshami, Defending Iran; From Revolutionary Guards to Ballistic Missiles.

ing state threats.[11] Both nations also wield formidable capabilities to mobilize non-state threat actors. Tehran believes that Washington and Tel Aviv profoundly seek to disrupt its S3. The U.S. invasions of Iraq and Afghanistan in the early 2000s, coupled with the securitization of Iran's nuclear program, heightened Tehran's fears of an eventual U.S.-led kinetic military intervention. Therefore, recognizing its inability to compete with the United States conventionally and aiming to alter Washington's military calculations, Tehran has prioritized defensive capabilities and installations,[12] emphasizing asymmetric tactics which are "difficult to deter and provide plausible deniability."[13]

As Iran has built up its asymmetric capabilities, it has concluded that ground warfare may be given less, if not zero, priority by its major adversaries.[14] This conclusion is rooted in various factors, including Washington's failure to achieve its goals in the invasions of Afghanistan and Iraq, America's Pivot to Asia and its subsequent efforts to right-size military postures in the Middle East[15] as well as the absence of a forward-deployed military posture by Israel in Iran's immediate neighborhood. These perceptions have shaped Tehran's overall understanding of the evolving nature of conflict and warfare, especially in situations where its major state adversaries, leveraging advanced technologies, can coordinate kinetic and non-kinetic operations against the country.

Future Conflicts Setting

In the context of kinetic warfare, the Iranian senior military strategists affirm that future military conflicts initiated by state adversaries against Iran are likely to encompass scenarios of sea-based and air-based combat.[16] Besides, the outcomes of these scenarios depend significantly on the technological supremacy wielded by either Tehran or its adversaries. According to Iranian military strategists, this superiority empowers either side to swiftly and efficiently gather and analyze vast amounts of data and information within a condensed timeframe.[17]

Iran's comprehension of the evolving conflicts orchestrated by its state adversaries extends beyond conventional military operations. Non-kinetic warfare also plays a role in shaping Iran's perceptions of threats and the conflict environment.[18]

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11 Martini et al., Deterring Russia and Iran; Improving Effectiveness and Finding Efficiencies.
12 "Iran Military Power."
13 Martini et al., Deterring Russia and Iran; Improving Effectiveness and Finding Efficiencies, p. 161.
14 "Enemy's likely threats against Iran to be through air, sea."
15 Barnes-Dacey/Lovatt, "Principled pragmatism: Europe's place in a multipolar Middle East."
16 "The nightmare of death does not leave the hearts of the officials of the Zionist regime/ The sea is a place to adapt the concepts of tactics, operations and strategy
(کابوس مرگ از قلب مسئولان رژیم صهیونیستی خارج نمی‌شود/ دریا جایی برای انطباق مفاهیم تاکتیک، عملیات و استراتژی است).”
17 "We have to go to the moon in space and in the sea to the north and south poles
(باید در فضا تا ماه و در دریا تا قطب شمال و جنوب پیش برویم).”
18 "Iran Military Power."

Acknowledging the escalating threats of non-kinetic warfare infiltrating civilian domains, Iran always points to Israel and the United States as primary actors or supporters behind cyber-attacks on civilian critical infrastructure.[19] The Islamic Republic is deeply apprehensive that, depending on the magnitude of these operations, they may eventually interrupt national administration, undermine domestic stability, and wear off internal order; thus, to the detriment of Iran's S3.

The other significant facet of non-kinetic war threat, as perceived by Iran and attributed to its state adversaries, is what the regime terms 'cognitive warfare.'[20] The Islamic Republic asserts that nationwide protests and insurgencies from several ethnic opposition movements stem primarily from external influences, pointing fingers at Washington and Tel Aviv. The head of the IRGC's Intelligence Agency, for example, highlights how entities associated with foreign adversaries exploit cyberspace and social networks to disseminate anti-regime content to millions of Iranian users within seconds. It was notably evident in the recent wave of nationwide protests following the killing of Mahsa Amini by the morality police in September 2022 and the subsequent emergence of the 'Women, Life, Freedom' movement.[21]

Additionally, both internal and external dissidents, such as the People's Mojahedin Organization of Iran—a prominent dissident organization with a substantial network within the country—and, to a lesser extent, the monarchists, are perceived by the Islamic Republic as two key groups receiving support primarily from the United States and Israel.[22] The dissidents advocate for simultaneous top-down and bottom-up pressures, calling for civil unrest and regime change, all with the aim of challenging the Islamic Republic's S3, as conceived by the leadership in Tehran.

The dual nature of perceived threats faced by the Islamic Republic, encompassing both kinetic and non-kinetic warfare, has led to the formulation of fundamental national security priorities and the corresponding 360-degree defense doctrine.

National Security Priorities

The Islamic Republic has identified the physical withdrawal of its two principal enemies, the United States and Israel, from its vicinity as a paramount national security objective.[23] Although the Iranian leadership has consistently characterized America as the primary threat to Iran's S3, Supreme Leader Khamenei's assessment of the

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19 "Iran says Israel, U.S. likely behind cyberattack on gas stations."; "Iran fuel supplies cut by US, Israel 'cyber attack', oil minister says."
20 Mirzaei, "The key for actively dealing with cognitive warfare."
21 "Detailed analysis of the head of the IRGC intelligence agency on the enemy's hybrid warfare in the riots of 1401 (تحلیل تفصیلی رئیس سازمان اطلاعات سپاه از جنگ ترکیبی دشمن در اغتشاشات پاییز ۱۴۰۱)."
22 Motamedi, "Iran blacklists US officials for supporting 'terrorist' group MEK."
23 Martini et al., Deterring Russia and Iran; Improving Effectiveness and Finding Efficiencies.

United States' diminishing influence and isolation in the emerging world order[24] has intensified Tehran's advocacy for the United States retreat from Iran's immediate surroundings. A similar perspective, albeit expressed more assertively, is held regarding Israel. In 2015, Khamenei foresaw the collapse of Israel by 2040.[25]

The second national security priority underscores the Islamic Republic's aspiration to achieve regional power status. In November 2003, the Supreme Leader outlined the country's strategic vision for 2025, envisioning Iran as a developed nation occupying the foremost position in the economy, science, and technology across Southwest Asia, encompassing Central Asia, the Caucasus, the Middle East, and neighboring countries, as defined in the document. The objective also includes serving as a source of inspiration and a model for the Muslim world.[26] The Iranian leadership continually aspires for the Islamic Republic to be acknowledged as a leading state in the Middle East and globally.[27] This ambitious vision may be rooted in the desire to revive a glorified past.[28] However, the persistent sense of loneliness, despite having diplomatic relations with the neighboring states, and perceived threats to its S3 since the 1979 Revolution, have compelled the Iranian leadership to seek a regional power status.[29]

This pursuit is closely tied to Tehran's comprehension of its strategic depth, defined by the Office of the Supreme Leader as "any factor considered advantageous for a specific nation but recognized as a potential threat by adversaries, capable of serving as a deterrent for the nation in possession."[30] The correlation between the concept of strategic depth and the number of subregions outlined in the country's 2025 strategic vision has motivated the leadership to secure the Islamic Republic's S3 beyond the political borders of the nation. This strategy is apparently rooted in the collective historical memory of the Iranian leadership. "Historically, whenever Iran defined its national security within its political border, its independence and national sovereignty were violated, and its territorial integrity threatened … Therefore, Iran cannot counter external threats absent a robust regional or even extra-regional presence."[31]

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24 "Current world order will be replaced by a new order where US is isolated, Asia powerful, Resistance Front expanded."
25 Brodsky, "Iran gleefully eyes the protests in Israel, looking for weaknesses to exploit."
26 "Vision, Mission, and Strategy."
27 "With the efforts of talented young people, we present our country as an example
     (به همت جوانان تیزهوش،کشورمان را نمونه معرفی می کنیم)."
28 Javadi, "Iran's Emerging New 'Second Europe' Strategy May Be Doomed."
29 Raouf, "Iranian quest for regional hegemony: motivations, strategies and constrains."
30 "The strategic depth of the Islamic Republic of Iran, looking at the 20-year perspective
     (ایران با نگاه به چشم‌انداز 20ساله عمق استراتژیک جمهوری اسلامی)."
31 Alfoneh, "What Iran's Military Journals Reveal About the Goals of the Quds Force."

Defense Doctrine

The Iranian leadership's understanding of the nation's threats, the context in which conflicts may arise, and the strategic depth of the Islamic Republic acknowledge the necessity of adopting a comprehensive 360-degree defense approach.[32] It aims to address both external threats posed by Tehran's archenemies and internal threats, which, according to the Iranian leadership, are supported or orchestrated by the same adversaries.

In terms of deterring kinetic operations, Iran acknowledges its conventional military technology disadvantage compared to the United States and Israel.[33] Consequently, Iran has formulated a defense strategy centered around cost-effective asymmetric tactics and niche capabilities.[34] Focusing primarily on countering potential kinetic threats emanating from sea and air, and seeking to bolster its strategic depth, Tehran has prioritized the augmentation of missiles, proxy forces, UAVs, and naval power as the four critical deterrence capabilities:

- **Missiles**
  A crucial element of Iran's defense strategy centers on the development of a formidable arsenal, encompassing both cruise and ballistic missiles. These missiles primarily enhance Tehran's asymmetric capabilities. The Islamic Republic openly celebrates the progress in missile technology, considering it a source of prestige.[35] The Iranian missile arsenal is predominantly deployed from bases in western Iran.[36] These bases offer closeness to U.S. military forces in the region, proximity to Israel – in the event of an American or Israeli intervention –, and the insurgent and terrorist entities including the Kurdish armed groups and Islamic State of Iraq and Syria (ISIS).

- **Proxy Forces**
  Iran's imperative to deter kinetic operations, assert regional power status and exploit its strategic depth drives Tehran to cultivate proxy forces, predominantly in proximity to Israel.[37] These proxies provide Iran with plausible deniability. Their demonstrated capabilities and preparedness to confront Iran's adversaries serve as an additional deterrent.

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32 Black/Lynch/Gustafson/Blagden/Paillé/Quimbre, "Multi-Domain Integration in Defense; Conceptual Approaches and Lessons from Russia, China, Iran and North Korea," p. 20.
33 "We have to go to the moon in space and in the sea to the north and south poles
    (جنوب پیش برویم باید در فضا تا ماه و در دریا تا قطب شمال و)."
34 "Iran Military Power."
35 Satam, "After Hypersonic, Iran Says Its New Missile Is A.I-Enabled; Can Change Direction & Angle To Hit Targets."
36 "Bakhtaran Missile Base."
37 Martini et al., Deterring Russia and Iran; Improving Effectiveness and Finding Efficiencies.

- **Uncrewed Aerial Vehicles (UAVs)**
  Iran uses advanced UAVs to address gaps in its aging aircraft and enhance deterrence.[38] Throughout the 2010s, Tehran developed sophisticated UAVs, mostly through reverse engineering American drones.[39] The integration of ballistic missile launch capabilities into UAVs has enhanced Iran's deterrence capabilities. Tehran leverages UAVs technology to bolster deterrence against the United States and indirectly threaten Israel and, to a lesser extent, Saudi Arabia through proxy networks.[40]

- **Naval Power**
  The Islamic Republic strengthens its deterrence and power status through robust naval capabilities in the Persian Gulf and the Sea of Oman. The nation's maritime defenses incorporate a diverse range of platforms and weapons strategically designed to counter the United States Navy, primarily based in the Arab Gulf states, and regularly patrolled in the Persian Gulf and the Sea of Oman.[41] Iran places a significant emphasis on asymmetric tactics, notably the deployment of uncrewed surface vessels (USVs) and UAVs, as a crucial element of its naval strategy.[42] This approach aims to overwhelm the defenses of opposing warships. Additionally, in its quest for regional power status and the bolstering of strategic depth, Iran has showcased its naval capabilities by conducting out-of-area operations aimed at patrolling Iranian commercial vessels, reaching increasingly greater distances from Iranian shores.[43] A notable achievement was the first-ever circumnavigation of the globe by the 86th flotilla of the Iranian Navy, spanning from September 2022 to May 2023.[44] This accomplishment was lauded by the Supreme Leader as a significant milestone and a source of national pride.[45]

While these four niche capabilities embody the Islamic Republic's asymmetric tactics to deter kinetic operations, the Iranian military has also predominantly developed electronic warfare (EW), mostly for defensive purposes.[46] EW is crafted and employed to optimize the functionality of defense assets and infrastructure, such as radar systems, and enhance their stealth connectivity with command and control (C2).[47] The integration of AI into defense systems would further bolster Iran's EW, aligning it with the four key deterrence capabilities. Moreover, Iran's

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38 "Iran Military Power."
39 "Shahed drone, symbol of Iranian creativity in reverse engineering RQ-170 drone."
40 Eisenstadt, "Iran's Gray Zone Strategy: Cornerstone of Its Asymmetric Way of War."
41 Black/Lynch/Gustafson/Blagden/Paillé/Quimbre, "Multi-Domain Integration in Defense; Conceptual Approaches and Lessons from Russia, China, Iran and North Korea."
42 "Iran Military Power."
43 Bailey, "The Iranian Maritime Challenge."
44 Akbari, "The West felt annoyed by Iran Navy's 86th flotilla circumnavigation."
45 "The 86th Flotilla's successful trip around the world proved high seas belong to everyone."
46 Tabatabai/Chandler/Frederick/Kavanagh, Iran's Military Interventions; Patterns, Drivers, and Signposts.
47 "C2, Tactical Communications, Ai, Cyber, 5G, EW, Cloud Computing And Homeland Security Update."

EW endeavors to identify and thwart state adversaries' intrusions into Iranian territories. The primary objective of Iran's EW military exercise in August 2023, for instance, was to counter intruding UAVs and micro air vehicles (MAVs).[48] This exercise held particular significance as one of the key defense facilities in southern Iran had been targeted by MAVs in January 2023, allegedly conducted by Israel.[49]

In response to non-kinetic threats, the Islamic Republic also employs asymmetric tactics, emphasizing a blend of deterrence, defense, and retaliation. In addressing perceived threats to its military and strategic assets, Iran actively engages in deterrence strategies while adhering to a passive defense doctrine.[50] As a comprehensive nationwide program, passive defense encompasses a range of tactics aimed at hindering foreign intelligence gathering and ensuring the resilience and protection of critical infrastructure, such as military equipment and nuclear facilities. Key measures include the use of camouflage, concealment, force dispersal, underground facilities, and the strategic deployment of highly mobile units.[51] Notably, grounded in the central tenets of Iran's passive defense doctrine, underground facilities have been constructed to bolster diverse facets of Iran's defense industries, crucial nuclear infrastructure, and military forces.[52] This includes support for naval sites, missile bases, and equipment storage.

Iran's passive defense doctrine extends to cyber defense strategies focused on safeguarding civilian critical infrastructure and networks from cyberattack, misuse and compromise.[53] The National Passive Defense Organization (NPDO), operating under the General Staff of the Armed Forces, whose constitution was ratified by Parliament in 2023, has evolved into an agency with the authority to issue legally binding decisions, marking a significant transformation two decades after its foundation.

One of the primary responsibilities of the NPDO is to leverage both national cyber and non-cyber resources to deter, prevent, identify, and effectively counter any cyberattacks on Iran's national infrastructure.[54] The NPDO plays a role in safeguarding the integrity and security of Iran's critical assets, ensuring resilience and survivability against cyber threats.

In addition to deterrence and defense, Iran has openly acknowledged its cyber offensive capabilities with the sole intention of retaliating against those responsible

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48 "Iran Army launches electronic warfare drills."
49 Chulov, "Drones target Iranian weapons factory in central city of Isfahan."
50 Nadimi, "Iran's Passive Defense Organization: Another Target for Sanctions."
51 "Iran Military Power."
52 Gambrell, "An Iranian nuclear facility is so deep underground that US airstrikes likely couldn't reach it."
53 Nazarinejad/Pourshasb, "Passive defense strategies to protect the critical infrastructure of the Islamic Republic of Iran (تدابیرو راهکارهای پدافندغیرعامل درحفاظت از زیرساخت های حیاتی جمهوری اسلامی ایران)."
54 "Iran thwarted 10 big cyberattacks in a year."

for cyberattacks aimed at its critical infrastructure.[55] Tehran often conceals its cyber operations through proxies to maintain plausible deniability. However, media and official reports frequently emerge linking these operations to Iran's security and intelligence apparatuses.[56]

As a multifaceted strategy in non-kinetic operations, the adversaries of the Islamic Republic are perceived to focus crucially on disrupting internal stability and stirring domestic upheaval inside Iran. Tehran contends that this cognitive warfare manifests through the cyber domain, encompassing social networks and satellite TVs stationed outside Iran.[57] In response, recognizing cyberspace operations as a pivotal instrument of internal security, Iran consistently bolsters its capabilities, deeming these operations a secure and cost-effective means of information collection and order maintenance. Internally, the Islamic Republic seeks to assert dominance in the cyberspace environment to counter non-kinetic threats through censorship, espionage, and ideological control over the nation.[58] Moreover, Tehran utilizes cyber capabilities to intimidate, harass, and influence Iranian dissidents abroad.[59]

In response to state adversaries, notably the United States and Israel, Iran has deployed various disinformation campaigns on social media (information operation) as a retaliatory measure against non-kinetic threats posed by them. These campaigns have not only gained momentum but have also evolved in technological sophistication, aiming to foster discord within the targeted countries. This trend becomes particularly evident during periods when these nations grapple with domestic challenges or approach national elections. However, this strategy is not limited to major adversaries, as instances of Iran's disinformation and cyber operations occasionally extend beyond these borders. An illustrative example occurred in July 2022 when Albania faced a nationwide cyberattack against its critical infrastructure supported and orchestrated by Iran. This incident was in response to Tirana's decade-long provision of sanctuary to the People's Mojahedin Organization of Iran, the Islamic Republic's strongest dissident group.[60]

55 Anderson/Sadjadpour, Iran's Cyber Threat. Espionage, Sabotage, and Revenge.
56 Watts, "Iran accelerates cyber ops against Israel from chaotic start."
57 "Reviewing foreign and domestic media's roles in the 1401 riot (بازخوانی رسانه های خارجی و داخلی در آشوب ۱۴۰۱)."
58 Cohoon, "Information Controls in Iranian Cyberspace: A Soft War Strategy."
59 "Iranian Regime Agents Threaten Dissident Expats In Europe."
60 Miller, "Albania weighed invoking NATO's Article 5 over Iranian cyberattack."

2.2 Defense AI

As argued, Iran's threat assessment prompts the country to follow a 360-degree defense strategy focused on deterrence and asymmetric responses to strategic challenges.[61] In this context, Commander-in-Chief Khamenei consistently underscores the imperative of integrating cutting-edge science and advanced technologies into the armed forces' arsenals and installations.[62] The ongoing modernization of Iran's defense assets and infrastructure equips the country with enhanced capabilities to safeguard its national security. However, the Islamic Republic has grappled with enduring challenges, notably long-standing restrictions on accessing the military technology market due to U.S. embargoes.[63] Consequently, the Iranian armed forces have been compelled to maintain technological momentum through strategies such as indigenous procurement, technology appropriation, illicit acquisition, and reverse engineering.[64]

Given these contexts and challenges, Iranian leadership and strategists have arguably recognized AI as a groundbreaking technology, applicable not only in defense but also in various facets of life. Supreme Leader Khamenei emphasizes the significance of AI as a crucial factor in shaping future global governance.[65] A consensus among Iranian thinkers and strategists regarding AI is articulated by a philosopher who is loyal to the Islamic Republic:

AI revolutionizes the production and distribution of goods, leading to substantial cost reduction and significantly expanding accessibility. In the contemporary landscape, a society's inability to master this technology poses a threat to economic viability and political competitiveness.[66]

This understanding broadly aligns with perspectives shared by renowned global thinkers. For instance, in his last scholarly endeavor, Henry Kissinger, in collaboration with Graham Allison, unveiled the findings of a group of technology leaders at the forefront of the AI revolution. Their conclusion suggests that, unlike other sophisticated technologies such as nuclear weapons, the development of AI is not solely within the control of states. Private entrepreneurs, technologists, and companies are spearheading breakthroughs in AI, where "major evolutions occur in the minds of human beings. Its applicability evolves in laboratories, and its deployment is difficult to observe."[67]

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61 Martini et al., Deterring Russia and Iran; Improving Effectiveness and Finding Efficiencies.; McInnis, "Iranian Concepts of Warfare: Understanding Tehran's Evolving Military Doctrines."
62 "Role of Arrogant Powers' policies in recent bitter events in Iran is obvious."
63 Ben Taleblu, Arsenal; Assessing the Islamic Republic of Iran's Ballistic Missile Program.
64 Boffey, "Revealed: Europe's role in the making of Russia killer drones."
65 "We should move on the path to making Iran a source of science within 50 years."
66 "Why do western leaders consider artificial intelligence dangerous? (می‌دانند؟ چرا سردمداران غرب، هوش مصنوعی را خطرناک)."
67 Kissinger/Allison, "The Path to AI Arms Control."

Thus, the Iranian defense and military leadership acknowledge the transformative potential of AI, considering it a key force multiplier that elevates the effectiveness of the Islamic Republic's defense doctrine and strengthens the resilience of defense capabilities.[68] This is of paramount importance for Iran, given that strategic considerations, influenced partly by the nation's isolation and constrained access to the global market imposed by Tehran's major adversaries, have consistently prioritized the goal of achieving self-sufficiency in developing indigenous defense capabilities[69] with a focus on technological comparative advantages. In 2012, the Supreme Leader issued a comprehensive decree that forbade the procurement of foreign goods and services for defense purposes. The objective was to mitigate reliance on external entities during actual conflicts, thereby ensuring a self-sufficient and secure defense supply.[70]

Iran is driven to invest in defense AI by a compelling factor: the continuous integration of advanced technology into the defense and military capabilities of its major adversaries, notably the United States and Israel, along with key regional rivals such as Turkey and Saudi Arabia. The technological advancements of these nations pose a potential threat to Iran's asymmetric defense doctrine if it neglects the adoption of technological upgrades. Ideally, Tehran aspires to secure a leading position in the high-stakes military technology race, recognizing the potential for enhanced power and prestige for the Islamic regime in Tehran.[71] However, numerous challenges such as insufficient financial and skilled human resources as well as limited access to the global high technology market have impeded the realization of this vision. Therefore, Tehran strategically emphasizes the crucial role of cutting-edge military technology, including AI, as a means to sustain the credibility of its deterrence stance.

Since the entry of defense AI into Iran's mainstream discourse, military leaders have consistently emphasized the pivotal role of AI in streamlining data collection and analysis processes.[72] However, there is skepticism regarding whether Iranian leaders possess a thorough understanding of the appropriate level of AI involvement in decision-making during actual conflict scenarios. Despite this uncertainty, incidents stemming from human errors, exemplified by the downing of Ukraine International Airlines Flight 752 over Tehran by Russian-made anti-aircraft missiles in January 2020[73] may propel Iran towards the adoption of AI-enabled autonomy

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68 "Future threats against Iran are sea-based and air-based (تهدیدات آینده علیه ایران دریا پایه و هوا پایه است)."
69 Tabatabai, No Conquest, No Defeat; Iran's National Security Strategy.
70 "Communicating the general policies of the establishment on defense and security self-sufficiency (ابلاغ سیاست‌های کلی نظام در موضوع خودکفایی دفاعی و امنیتی)."
71 "It is disgraceful to remain a student of westerners forever."
72 "The nightmare of death does not leave the hearts of the officials of the Zionist regime/ The sea is a place to adapt the concepts of tactics, operations and strategy (کابوس مرگ از قلب مسئولان رژیم صهیونیستی خارج نمی‌شود/ دریا جایی برای انطباق مفاهیم تاکتیک، عملیات و استراتژی است)."
73 "Plane Shot Down Because of Human Error, Iran Says."

in defense capabilities and installations. This strategic shift is aimed at mitigating the impact of human errors and enhancing overall operational efficiency.

Notwithstanding the potential benefits and incentives for autonomy in defense AI, the Islamic Republic is likely to maintain a cautious stance. The defensive posture of Iran's armed forces requires a strategy to avoid inadvertently targeting adversary's assets and forces when humans are not fully in the loop of decision-making. Iran maintains this stance even when supporting its partners and proxies across the region or undertaking retaliatory actions. For example, reports from both Iraqi and American sources indicate that Tehran indirectly communicated its specific retaliatory measures to Washington following the killing of IRGC Major General Qasem Soleimani, key architect of Iran's defense doctrine, by American forces in January 2020.[74] With the integration of AI into its defense capabilities, the Islamic Republic faces the critical challenge of striking a calibrated balance between autonomy and strategic restraint.

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74 Ayash/Davison, "Hours of forewarning saved U.S., Iraqi lives from Iran's missile attack." Despite media reports indicating Iran's indirect notification to the United States, Iran's then-National Security Advisor Ali Shamkhani rejected the notion of direct communication between Tehran and Washington. Instead, he added that Iran only informed the Iraqi premier half an hour before the missile strikes, aiming to catch U.S. forces off-guard and prevent them from implementing any safety measures. "Shamkhani: Iran's contact with the US before missile attack on Ain Al-Asad an outright lie."

3 Developing Defense AI

Iran's development of defense AI remains in its nascent phase, shrouded in strategic ambiguity yet occasionally characterized as loud weapons.[75] Nevertheless, the incorporation of AI into defense capabilities is in line with Iran's defense doctrine, which revolves around three key objectives: deterring threats posed by state adversaries, ensuring the survivability and resilience of critical infrastructure, and ensuring domestic stability.

3.1 State Deterrence

Based on its strategic assessment discussed above, Iran has dedicated time and resources to bolstering its asymmetric sea and air capabilities, concurrently expanding its proxy network to enhance its strategic depth. AI emerges as a new enabling factor in Tehran's enhanced deterrence strategy.

As of March 2024, Major General Safavi, the senior military aide to Khamenei and head of the Defense-Security Commission within Iran's Strategic Council on Foreign Relations—an advisory body to the Supreme Leader— stands as the sole senior strategist elucidating Iran's three-fold rationale for integrating AI into naval and air force operations: (1) enhancing agility, (2) accelerating decision-making processes, and (3) reducing reliance on human forces.[76]

In November 2023, the IRGC organized its first-ever national conference on emerging opportunities and threats in the maritime domain. Rear Admiral Alireza Tangsiri, the commander of the IRGC Navy, identified four areas in which Iran has arguably incorporated AI into its military capabilities: USV, UAV, missile, and submersible. According to Tangsiri:[77]

- Iranian USVs are autonomous speed boats with extended coverage capabilities, excelling in mission execution through AI-guided missiles for precise and effective target engagement, combining autonomy and strategic firepower.
- Iranian UAVs have advanced with improved AI-driven capabilities, extended range, heightened precision, and stealth technology. Increased flight time, enlarged warheads, and the ability to confront EW tactics enhance offensive capabilities, allowing engagement of moving and maritime targets in diverse military scenarios.
- Iranian missiles feature extended range, adaptive navigation, and multi-system launch capability, with dynamic evasion options. They provide strategic advan-

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75 Handler/Wolff/Loomis, "US-Iran in crisis: Strategic ambiguity and loud weapons in cyberspace."
76 "Future threats against Iran are sea-based and air-based (تهدیدات آینده علیه ایران دریا پایه و هوا پایه است)."
77 "Our missiles are equipped with artificial intelligence (موشک‌های ما مجهز به هوش مصنوعی است)."

tages with reduced preparation time, rotational shooting, and counteraction measures against adversaries' EW. AI-enhanced sea-based missiles demonstrate remarkable precision, targeting objectives up to 2,000 kilometers away.

- Iranian submersibles showcase versatility in AI-enabled autonomous navigation, executing missions, and contributing to Intelligence, Surveillance & Reconnaissance (ISR) operations. Whether for military or scientific purposes, they navigate challenging underwater environments, playing a pivotal role in advancing technological capabilities beneath the ocean's surface.

On a different front, Iran has incorporated AI into its border control operations. Brigadier General Alireza Sheikh, Deputy of Training and Education of the Army, reveals that AI-enabled portals are now responsible for analyzing and transmitting real-time images and data pertaining to border movements directly to the Army's headquarters in Tehran.[78] This marks a notable departure from the past, where data collection, up until at least 2020, predominantly relied on human resources.[79]

In the realm of C2, senior military commanders underscore the significance of AI in both air and sea domains. The Commander of the IRGC Aerospace Force's Passive Air Defense, for instance, emphasized that "the integration of AI-driven C2 offers crucial decision support to effectively counter extensive and intricate threats. It plays a key role in guiding air defense personnel, enabling them to respond to threats swiftly and appropriately."[80]

In addition to defensive capabilities, Iran's network of proxies serves as a formidable asymmetric asset, not only countering potential kinetic operations but also functioning as a crucial enabler for Tehran to maintain its strategic depth. Publicly available data does not confirm Iran providing AI-driven capabilities to its proxies. Nonetheless, Iranian authorities have openly admitted Tehran's support to both state and non-state actors.[81] Describing Iran's relationship with groups that Tehran calls the Axis of Resistance, Iran's envoy to the United Nations said in February 2024 that Tehran has something akin to a defense pact with the groups that he compared to the NATO alliance.

This assistance primarily entails technology transfer and training more than direct procurement of military equipment,[82] particularly in situations where ongoing

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78 "The war in Ukraine is monitored daily / The focus on the drone was with a view to recent wars
   (جنگ اوکراین روزانه رصد می‌شود/ تمرکز بر پهپاد با نگاه به جنگ‌های اخیر بود)."
79 "Flight PS752 Accident Investigation; Final Report."
80 "For the first time, we used artificial intelligence technology in the exercise
   (برای نخستین مرتبه از فناوری هوش مصنوعی در رزمایش استفاده کردیم)."
81 "We have no qualms about transferring rocket manufacturing technology to Palestine
   (هیچ ابایی از انتقال فناوری ساخت موشک به فلسطین نداریم)."
82 Tabatabai/Clarke, "Iran's Proxies Are More Powerful Than Ever."

resupply poses significant challenges.[83] This approach is also affirmed by Iran's top diplomat at the United Nations. When queried about Iran's support for proxy networks in the Middle East, he affirmed, "Regarding Palestine, we are providing arms, conducting training, and empowering them. However, in other parts of the region, where resistance factions exist, we engage in coordination, cooperation, consultation, and possibly some financing as well."[84]

In this context, proxies, especially those in proximity to Israel, may acquire knowledge and technology from Tehran to enhance their AI capabilities. This holds particular significance given Tel Aviv's utilization of AI for ISR and carrying out strikes against Hamas in Gaza during the military conflict that began in October 2023.[85] The IRGC may consider supplying AI-based technologies primarily aimed at countering Israel's ISR capabilities, despite Tehran's own defense AI development being in its early stages.

3.2 Critical Infrastructure Protection

Critical infrastructure remains a prime target in non-kinetic operations. Iran's significant challenges with the Stuxnet virus in its nuclear facilities during the late 2000s[86] have prompted a reassessment and refinement of strategies aimed at securing military and civilian critical infrastructure.

Denial and deception (D&D) techniques are instrumental in reducing vulnerability and bolstering the resilience of Iran's strategic assets and installations.[87] Simultaneously, Iran employs a multi-layered passive defense strategy to safeguard civilian critical infrastructure from cyberattacks and external intrusions.[88] This defensive approach has gained prominence, particularly in the face of the evolving landscape where AI has become a potent tool for offensive cyber operations. The integration of AI introduces heightened complexity and diminished traceability to cyberattacks.

With 35 percent of cyberattacks targeting Iranian civilian critical infrastructure in 2022 leveraging AI,[89] the NPDO has strategically prioritized the infusion of AI across all indigenous systems entrusted with national cyber defense responsibil-

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83 "Iran Military Power."
84 Magid, "Iranian envoy to UN says Tehran arming, training and 'empowering' Palestinian terror groups."
85 Davies/McKernan/Sabbagh, "The 'Gospel': how Israel uses AI to select bombing targets in Gaza."
86 Modderkolk, "Sabotage in Iran."
87 "Iran Military Power."
88 Lamrani, "Iran's Conventional Military Capabilities."
89 "Cyber defense systems are being equipped with artificial intelligence
    (سامانه‌های دفاع سایری در حال تجهیز به هوش مصنوعی است)."

ities from 2023 to 2024.[90] Due to Iran's limited access to the global technology market and apprehensions regarding the security of advanced firewall technologies originating from the West, amid concerns of potential exploitation by adversaries, the NPDO has embarked on collaborative efforts with Iranian academic institutions and technology start-ups. This collaboration aims to seamlessly integrate AI into Iran's cyber defense strategy, ensuring a robust and indigenous approach to safeguarding national security.

Adopting a proactive stance towards AI, the NPDO focuses on enhancing all defense capabilities, encompassing infrastructure, through the seamless integration of AI. The Organization has ambitiously outlined mid-2024 as the timeline to realize this goal. This strategic endeavor, complemented by a fusion of D&D techniques and deliberate ambiguity regarding Iran's military advancement, positions the nation to safeguard critical infrastructure in both civilian and military sectors against non-kinetic cyber threats instigated or supported by Tehran's major state adversaries.[91] Notwithstanding these concerted efforts, the Islamic Republic's technological lag may persist, rendering critical infrastructure vulnerable to cyber-attacks as AI and other emerging technologies continue to advance.

NPDO asserts that Iran's cyber defense capabilities encompass an offensive component specifically crafted for retaliatory purposes. The focal points of Iran's cyber offensive endeavors primarily involve the infrastructure of the United States and Israel.[92] Nevertheless, states perceived as threats to the regime's S3, such as Albania, due to harboring the Islamic Republic's most formidable dissident group, are not exempt from Tehran's cyber offensive actions.[93] According to the 2024 United States Annual Threat Assessment, "Iran's growing expertise and willingness to conduct aggressive cyber operations make it a major threat to the security of United States and allied networks and data."[94] The expanding expertise of Iran may involve the incorporation of AI in its cyber offense capabilities.

3.3 Domestic Stability

Post-revolutionary Iran has been marked by persistent protests and social upheaval. Since September 2022, the Islamic Republic has grappled with one of the most extensive and prolonged series of protests since the 1979 Revolution, further

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90 "Using artificial intelligence to prevent cyber attacks in the power industry
    (استفاده از هوش مصنوعی برای پیشگیری از حملات سایبری در صنعت برق)."
91 Martini et al., Deterring Russia and Iran; Improving Effectiveness and Finding Efficiencies.
92 Maloney, "Addressing Iran's evolving threats to US interests."
93 Oghanna, "How Albania Became a Target for Cyberattacks."
94 "2024 Annual Threat Assessment of the U.S. Intelligence Community."

eroding the key components of the regime's S3. The 'Women, Life, Freedom' movement has garnered participation from diverse segments of Iranian society and has also mobilized Iranian expatriates, primarily those opposed to the Islamic regime in Iran. According to the United States assessment, "Iranian officials are concerned about the protracted protests and perceive that foreign meddling is prolonging the unrest."[95]

In response, Iran has consistently strengthened its law enforcement, military, and security apparatuses. This persistent pattern aims to suppress dissent at home and abroad[96] and impose a coercive order within Iranian society. In addition, Iranian officials have recently disclosed plans to use advanced biometric technologies, including AI and facial recognition,[97] developed by Iranian start-ups or acquired from Chinese and Russian companies.[98] This new initiative aims to pinpoint women and girls who have ceased to comply with compulsory veiling laws, particularly in the wake of Mahas Amini's death at the hands of the morality police and the emergence of the 'Women, Life, Freedom' movement.

With no imminent prospect of a change in the regime's behavior, the leadership finds itself compelled to resort to coercive measures to maintain internal order. This necessity is likely to be met using domestically produced AI tools or the acquisition of AI-based technologies and practices[99] from other authoritarian states like China and Russia. For the latter, for instance, Iran and Russia seem willing to formalize a bilateral Grand Interstate Treaty to advance military-technological cooperation,[100] which could include cooperation on AI. These tools empower the Islamic Republic to collect and analyze massive amounts of data and images on social media and protestors' smart phones particularly in situations requiring the suppression of scattered protests or the rapid deployment of forces for coercion efficiently and swiftly.

Regarding Iranian dissidents abroad, the Islamic Republic asserts that they receive substantial backing from its state adversaries, particularly the United States and Israel. This narrative is consistently propagated by Iranian mass media, often neglecting the agency of the dissidents themselves. While reports indicate that Iran primarily addresses the perceived threat posed by key dissidents through the recruitment of private detectives to spy on them,[101] it is plausible that Iran leverages its AI-empowered cyber capabilities to infiltrate the dissidents' communications and correspondences, seeking to uncover their locations and connections within and outside Iran.

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95   Ibid.
96   "US, UK Sanction Iran Over Plot to Kill Iran International Journalists."
97   "Iran: Tech-enabled 'Hijab and Chastity' law will further punish women."
98   Alimardani, "Aggressive New Digital Repression in Iran in the Era of the Woman, Life, Freedom Uprisings."
99   "Iran police ready to form joint scientific team with China: Police chief."
100 "Russian Offensive Campaign Assessment, January 15, 2024."
101 Weiser/Rashbaum, "Iran and China Use Private Detectives to Spy on Dissidents in America."

4 Organizing Defense AI

The Islamic Republic's General Staff of the Armed Forces (GSAF) serves as the highest defense and military authority in the country, responsible for coordinating and overseeing the activities of the Iranian Armed Forces including the IRGC, the Army and the Ministry of Defense (MoD). Led by the Chief of General Staff, appointed by the Supreme Leader, the GSAF is instrumental in formulating defense policies, operational planning, and ensuring the overall readiness of Iran's armed forces and defense agencies.

The Army and the IRGC have distinct roles outlined by the GSAF under the Supreme Leader's guidance. Specifically, the IRGC operates in the Persian Gulf, while the Army manages operations in the Caspian Sea and the Sea of Oman. Domestically, the Revolutionary Guard oversees internal security, while the Army exclusively handles air defense.[102] However, unlike the Army, the IRGC faces no constraints on involvement in domestic politics and financial activities. In addition, the IRGC consists of two additional forces: the Quds Force, responsible for unconventional warfare, intelligence, and special operations beyond Iran's borders, and the Basij, a paramilitary volunteer force deployed for internal security and crowd control during public protests. The Quds Force and, to a lesser extent, Basij, have played a crucial role in advancing Iran's strategic depth and revolutionary ideologies globally.[103] Thus, through its engagement in domestic affairs and external actions, the IRGC has steadily increased its influence over time, becoming a decisive force in safeguarding Tehran's S3.

The GSAF is dedicated to acquiring advanced conventional and specialized defense capabilities for both the Army and the IRGC. With a focus on achieving self-sufficiency and developing indigenous defense capabilities, three departments within the GSAF—namely, "Logistics, Support, and Industrial Research," "Research and Training," and "Science, Research, and Technology"—are directly involved in steering defense research and development (R&D). However, the IRGC, the Army and the MoD have their own R&D departments, dedicated to advancing military technologies.

The Research and Self-Sufficiency Jihad Organization (RSSJO) is an entity closely associated with the air, navy, and ground forces of both the IRGC and the Army in Iran. The primary roles of these six organizations revolve around overseeing and conducting specialized R&D activities tailored to the unique needs of each respective military force. These entities also collaborate with civilian universities and military research institutes. Notable examples include Imam Hossein University (IHU), Malek Ashtar University of Technology (MUT), and Imam Khamenei University of Marine University and Technology (IKUMUT), which are three IRGC-affiliated

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102 "Why were Army and IRGC not merged? (چرا «ارتش» و «سپاه» ادغام نشدند؟)."
103 Bahgat/Ehteshami, Defending Iran; From Revolutionary Guards to Ballistic Missiles.

research universities. Additionally, the Army operates the War University and the Imam Khomeini Naval University of Noshahr. These academic institutions engage in direct collaboration with various RSSJOs for R&D in defense. With a specific focus on defense AI, the RSSJOs are believed to be involved in independent R&D efforts and joint initiatives with academic institutions.

The MoD is also involved in defense R&D, overseeing multiple entities dedicated to advancing military technology and providing military capabilities to both the IRGC and the Army. The MoD comprises 13 companies and two organizations, with each entity being allocated a specific budget from the country's annual public budget. The Aerospace Industries Organization (AIO) stands out as a pivotal entity within the MoD, overseeing the development and production of aerospace technologies for both civilian and military applications. Established in the early 1980s, the AIO plays a central role in advancing Iran's capabilities across various domains, including reconnaissance planes, UAVs, cruise and ballistic missiles, satellite launch programs, avionics, propulsion systems, and aerospace manufacturing.[104] Subsidiaries, subordinates, and front companies affiliated with the AIO have been implicated in procuring equipment worth millions of euros for the development of Iran's missile program.[105] AIO developed and unveiled the first AI-enhanced cruise missile, Abu Mahdi, in July 2023.[106]

As the MoD and its affiliated entities are engaged in the development of advanced military technology, a senior authority within the MoD announced in December 2022 that the Ministry has signed partnership agreements with 80 universities and the majority of the 800 industrial towns nationwide.[107] The connectivity between universities, industrial towns, and MoD entities is facilitated primarily through two research institutions:

- **Defensive Innovation and Research Organization (DIRO)**
  Formerly led by Mohsen Fakhrizadeh until 2020, DIRO functions as Iran's equivalent to the United States' Defense Advanced Research Projects Agency (DARPA), focusing on the development of cutting-edge technologies for defense and military applications.

- **Defense Industries Training and Research Institute (DITRI)**
  DITRI serves as a crucial component of the MoD's support structure, providing high-level scientific and technological assistance for educational and research processes. It plays a principal role in fostering technology and innovation

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104 "Aerospace Industries Organization (AIO)."
105 "Treasury Adds Two Entities to the List of Iranian Weapons Proliferators."
106 "Iran Boosts Navy With Acquisition Of New Long-Range Cruise Missiles."
107 "Deputy Minister of Defense: Developing the relationship between the defense industry and the university is one of the strategic principles of the Ministry of Defense (توسعه ارتباط صنعت دفاعی و دانشگاه از اصول راهبردی وزارت دفاع است)."

within the defense industries. DITRI functions as a hub for missile design and the manufacturing of crucial components essential to produce solid rocket fuel.[108]

No publicly available data or evidence exists regarding the involvement of these institutions in defense AI. However, considering the MoD's tangible strides in developing AI-driven capabilities, as demonstrated by the Abu Mhadi missile, the prospect of the MoD's departments and agencies playing a role in defense AI is not merely speculative.

This assumption is reinforced by the actions of the Supreme Council of the Cultural Revolution (SCCR), which established a dedicated Commission for Defense AI within its Secretariat in September 2022.[109] The Commission comprises representatives from all branches of the armed forces, the SGAF, the Office of the Supreme Leader, the Ministry of Intelligence, and the Ministry of Higher Education. This composition underscores the paramount importance placed on cultivating synergy and collaboration among diverse stakeholders in the realm of defense AI.

In the domain of critical infrastructure protection, the primary duty of securing military critical infrastructure rests with the armed forces and the MoD. Furthermore, the NPDO is assigned the responsibility of ensuring the safety and resilience of civilian critical infrastructure. As per the NPDO's director, this undertaking is accomplished with the collaboration of Iranian start-ups. The NPDO has also entered into partnership agreements with several civilian technology universities to garner assistance and intellectual support for its missions.[110] A noteworthy aspect of these agreements is the commitment of the universities to establish academic programs dedicated to the NPDO's focal areas. The NPDO has pledged to incorporate AI into safeguarding critical infrastructure. In pursuit of this goal, collaboration with start-ups and universities is anticipated to encompass elements of defense AI.

Regarding the preservation of internal order and stability, the primary responsibility lies within various security and intelligence agencies in Iran. The country's intelligence community comprises 15 entities drawn from different branches of power and armed forces. While each agency is assigned distinct tasks, occasionally overlapping with others, they are thoroughly empowered to uphold coercive order within the nation and suppress dissenting voices abroad, among other responsibilities.[111] The former Minister of Intelligence acknowledged in a Janu-

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108 "Organization of Defensive Innovation and Research."
109 "Bylaws of the Strategic Council for Defense and Security Science, Technology and Innovation
(آیین نامه شورای راهبردی علم، فناوری و نوآوری دفاعی و امنیتی)."
110 "Signing of a joint cooperation agreement between Tabriz University and the country's non-operational defense organization
(امضای تفاهم‌نامه همکاری مشترک دانشگاه تبریز با سازمان پدافند غیرعامل کشور)."
111 "Islamic Republic Creating Yet Another Parallel Intel Agency."

ary 2024 interview that elements within the Ministry are tasked with "employing sophisticated intelligence tactics to bring anti-security elements living abroad into the country alive as much as possible."[112]

Concurrently with the implementation of physical tactics, Iranian intelligence agencies have progressively embraced cutting-edge technologies, including AI, to tackle cases both within Iran and abroad. Nevertheless, outsourcing is viewed unfavorably, given the distinctive traits of these agencies. As a result, it is highly likely that all AI-driven ISR activities focused on individuals are centralized within each respective agency, with minimal interagency coordination.

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112 "The previous government did not pay attention to the warning of the Ministry of Intelligence/ Breaking from the ballot box does not benefit the people (دولت سابق به تذکر بنزینی وزارت اطلاعات توجه نکرد/ قهر با صندوق رأی برای مردم عایدی ندارد)."

5 Funding Defense AI

In 2022 and 2023, Iran allocated €6.2bn and €6.3bn, respectively, to its defense budget.[113] Aligned with Iran's 7th Five-Year Development Plan, which shapes the country's annual budgets and development strategies until 2028, a provision exists mandating the dedication of at least five percent of the public budget to enhance defense capabilities.[114] However, obtaining precise figures for defense AI R&D proves challenging due to the complex network of stakeholders in this domain, characterized by opaque budgets and the partial allocation of efforts, if any, to defense AI within each entity.[115]

In accordance with the latest annual budget for the fiscal year 2023, commencing on 21 March 2023, the AIO has been allocated the highest research budget among all entities under the MoD. The designated budget for AIO's research is €59,000; however, it does not provide a clear breakdown indicating the specific amount earmarked for investment in defense AI. The total research budget for the 15 entities within the MoD is approximately €265,000.[116]

In relation to passive defense, the annual budget for the fiscal year 2023 designates €6.6M exclusively for the NPDO.[117] Furthermore, each agency and ministry is mandated to allocate a one-percent budget commitment to support passive defense initiatives facilitated by the NPDO, resulting in a combined contribution of €1.6bn throughout the fiscal year 2022.[118] Although the specific allocation of these funds for defense AI remains unclear, the NPDO's emphasis on the comprehensive integration of AI into the critical infrastructure protection implies that a substantial portion of the budgets is likely directed towards advancing defense AI capabilities.

113 "Iran's New Year Military Budget and Shifting Priorities."
114 "Allocation of at least 5% of public budget resources in the 7th plan to strengthen the country's defense infrastructure (اختصاص حداقل ۵ درصد از منابع بودجه عمومی در برنامه هفتم به تقویت بنیه دفاعی کشور)."
115 McInnis, "Understanding the Iranian Military Budget."
116 "The budget law of 1402 (قانون بودجه سال 1402 کل کشور)."
117 Ibid.
118 "Zero credit in 1402 for passive defense is not good for the country (اعتبار صفر در سال ۱۴۰۲ برای پدافند غیرعامل به صلاح کشور نیست)."

6 Fielding and Operating Defense AI

Despite a growing recognition of the pivotal role played by AI in Iran's defense doctrine, the current state of deployment, as per publicly available data, does not definitively illustrate complete integration into the Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR). Financial constraints emerge as a crucial impediment to Iran's progress, given that the R&D and implementation of advanced AI technologies demand substantial resources. Moreover, the challenges are exacerbated by the clear technological advantage maintained by adversaries compared to Tehran's utilization of less sophisticated, if not outdated, gear.

The strategic choices made by Iran in this context indicate a nuanced approach aimed at navigating financial limitations, addressing technological disparities, and progressively constructing a more resilient defense infrastructure capable of tackling contemporary challenges.[119] Within this framework, the deployment of AI remains selective, primarily confined to a few niche defense capabilities, representing a pragmatic response to the existing hurdles. The following four areas of application are particularly noteworthy:

- **Missiles**
  As of March 2024, the Abu Mahdi precision-guided cruise missile, formally disclosed in July 2023, signifies Iran's first foray into modern defense capabilities, wherein AI integration has been engineered into its core architecture since inception. Positioned as the premier long-range anti-ship cruise missile, it boasts a range exceeding 1,000 kilometers, advanced AI-enabled C2 systems, radar evasion, and real-time course adjustments. Designed for engaging warships, frigates, and destroyers, it features dual-band radar seekers for enhanced precision. The launch system enables swift preparation and deployment, with a multi-missile launch capability for synchronized convergence onto a target. Developed by the Ministry of Defense, it's a cutting-edge addition to Iran's military capabilities, deployed to both the IRGC and the Army. The missile's inauguration was characterized by the Iranian Minister of Defense as "strategic" and "unprecedented" in sophistication and impact.[120]

  Two additional missiles have been unveiled by Iranian military officials, featuring AI capabilities. In contrast to the Abu Mahdi missile, both the ballistic missile Fath-360 and the Ghadir cruise missile represent military capabilities that have been augmented through the integration of AI. The Fath-360 missile is a short-range tactical ballistic missile guided by satellites. It has a range of 30 to 120 km and can carry a warhead weighing up to 150 kg. Developed by

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119 Martini et al., Deterring Russia and Iran; Improving Effectiveness and Finding Efficiencies.
120 "The use of artificial intelligence in the Abu Mahdi long-range missile system
(استفاده از هوش مصنوعی در سامانه موشک برد بلند ابومهدی)."

the MoD, it was initially deployed to the IRGC in 2020 and later to the Army in 2021. The Ghadir cruise missile, introduced in 2014, is an anti-ship cruise missile featuring a range of 330 km. This missile can be deployed from both coastal installations and naval vessels.[121] These AI-augmented missiles made their debut during the IRGC war game in August 2023, reportedly as a response to Russia's move against Iran's territorial integrity. This followed Moscow's support for the United Arab Emirates' stance on disputed islands with Iran, expressed in the July 2023 joint statement of the 6th Russia-Gulf Cooperation Council Joint Ministerial Meeting for Strategic Dialogue.[122]

- **UAV**

    Iran's UAVs have garnered significant attention, particularly for their use by Russian forces in Ukraine. According to the United States official assessment, Iran supply Russia with UAVs to bolster Moscow's capacity to target Ukraine, given the depletion of Russia's own precision-guided munitions.[123] Subsequently, Iran has delivered numerous one-way attack UAVs, the Shahed-131 and Shahed-136, to support Russia's military operations in Ukraine. The Shahed-181, which can be used for ISR and combat missions and can be equipped with two precision-guided missiles,[124] is the sole UAV reportedly equipped with AI technologies within its class. Reports covering the IRGC Aerospace Force's annual military exercise in 2021 speculated that AI might have been used to coordinate navigation and flight paths to enable a group of several UAVs to fly in synchronized formation.[125]

    Tangsiri's remarks on the defense AI development, discussed in Section 3, recognize Iran's multiple endeavors in this field. Nevertheless, upon closer examination of instances and use cases, it becomes evident that the envisioned advancement of defense AI in the Islamic Republic is not materializing to the extent initially articulated.

- **Infrastructure Protection**

    In the realm of securing critical infrastructure, each Iranian province has unique passive defense strategies sanctioned by the NPDO. These strategies are specifically designed to align with the varied networks and capabilities inherent to each province.[126] This decentralized approach ensures a targeted and flexible

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121 "Unveiling of missiles equipped with artificial intelligence in the IRGC Navy
   (رونمایی از موشک‌های مجهز به هوش مصنوعی در نیروی دریایی سپاه پاسداران)."
122 "Iran summons Russian ambassador over statement on Gulf islands."
123 "2023 Iranian UAVs in Ukraine."
124 D'Urso, "Iran showcases Shahed 181 and 191 drones during "Great Prophet 14" Exercise."
125 "The army reached the edge of the global technology of AI suicide drones
   (ارتش به لبه تکنولوژی جهانی «پهپادهای انتحاری دارای هوش مصنوعی» رسید)."
126 "The comprehensive passive defense plan for 31 provinces is on the agenda
   (طرح جامع پدافند غیرعامل برای ۳۱ استان در دستور کار است)."

nationwide passive defense strategy. Moreover, the NPDO has established offices within public agencies and national industries, providing guidance and regulations to fortify the resilience of the infrastructure.[127] Additionally, it conducts real-time monitoring to guarantee the continual safety and security of vital assets, safeguarding against cyberattacks and external intrusions. With the NPDO's renewed focus and commitment to AI, it becomes evident that a significant portion of these passive defense efforts is updated through the application of AI technologies.

▪ **Domestic Stability**

In addition to the protection of critical infrastructure, Iranian authorities consistently claim that local start-ups are engaged to support maintenance of coercive order domestically and the intimidation of Iranian dissidents abroad. The veracity of the pivotal role played by Iranian start-ups remains unverifiable, given Iran's disconnection from the global technology market. However, there are occasional reports suggesting support from authoritarian regimes such as China and Russia in helping Iran achieve these goals. For instance, amid accusations from Washington against China's Huawei for assisting the Iranian regime in monitoring protesters following the killing of Mahsa Amini, an investigative report further discloses that Chinese-based Tiandy Technologies provides Tehran and Moscow with advanced technologies, including facial recognition software and emotion-detecting AI technologies.[128] The recent shift in the regime's approach, moving away from reliance on informants and physical patrols toward automated digital surveillance to target critics, necessitates the acquisition of advanced technologies from repressive states like China – a trend likely to persist and evolve in the future.

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127 "For the first time, we used artificial intelligence technology in the exercise
(برای نخستین مرتبه از فناوری هوش مصنوعی در رزمایش استفاده کردیم)."
128 Singleton, "Targeting Tiandy."

7 Training for Defense AI

The IHU and MUT are public post-graduate universities specifically designed to cater to the research and operational needs of the Armed Forces and/or the MoD. For the academic year 2023-2024, both universities had a capacity to admit 29 students for the Master of Science in AI. Additionally, these institutions admitted 26 students for the Master of Science in EW and 56 students for the Master of Science in passive defense. Upon graduation, admitted students are obligated to work either at the Armed Forces or the MoD.[129] Regarding the PhD programs, the MUT has accepted four researchers for AI, while the IHU has admitted four researchers for EW for the 2023-2024 academic year. Upon completion of their studies, the researchers are required to contribute their expertise to the Armed Forces.[130]

The War University welcomes post-graduate officers from "friendly and allied" foreign countries. As of 2021, the institution has provided training to officers from North Korea, India, Oman, Pakistan, and Iraq. The training encompasses both theoretical and operational courses.[131] While specific details about the incorporation of defense AI into the curriculum are not publicly available, given the program's emphasis on information and intelligence planning, it is plausible that the utilization of military technology, including AI for ISR, forms an integral component of the program.

Considering the ever-evolving landscape of AI, continuous in-service education and training programs are imperative for research and military personnel engaged in defense AI within the Armed Forces and the MoD. As the Army, the IRGC, and the MoD each maintain their dedicated research institutes, these institutes serve the crucial function of collecting best practices and state-of-the-art capabilities from both leading nations and potential adversaries,[132] with the goal of bolstering local efforts in the field of defense AI. In this regard, Iran has also benefited from training with countries like North Korea. Furthermore, unverified reports have occasionally surfaced indicating Tehran's collaboration with authoritarian states such as Russia, China, and Belarus for technology transfer and military personnel training.[133] Despite the Supreme Leader's ban on acquiring foreign goods and services for defense, with certain exceptions, including technology transfer, it is difficult to gauge to what extent these training and technology transfer initiatives also cover defense AI. However, the Army has recently launched a virtual reality project focused on training fighter pilots to operate in various climatic conditions and hybrid warfare scenarios. Although there is currently no evidence of AI inte-

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129 "Master's Degree Entrance Exam Guidebook (راهنمای انتخاب رشته آزمون ورودی مقطع کارشناسی ارشد ناپیوسته)."
130 "PhD Entrance Exam Guidebook (راهنمای انتخاب رشته آزمون ورودی مقطع دکتری)."
131 "Foreign students of the Army University graduated (دانشجویان خارجی دافوس ارتش فارغ التحصیل شدند)."
132 "Defense Industries Educational and Research Institute, an arm to monitor and communicate with the world's military industries (مؤسسه آموزشی و تحقیقاتی صنایع دفاعی؛ بازوی «ودجا» برای رصد و ارتباط با صنایع نظامی جهان)."
133 Ben Taleblu, Arsenal; Assessing the Islamic Republic of Iran's Ballistic Missile Program.

gration in this new training series, one of the project's aims is to acquaint pilots with adversaries' AI-enhanced capabilities.[134]

Iran's approach to support proxies encompasses the transfer of technology. This requires equipping proxies with knowledge and technology on the assembly and use of the military capabilities.[135] There is currently no evidence suggesting that Iran's proxies employ defensive AI capabilities. Nevertheless, it is reasonable to conjecture that Iranian military scientists and commanders may have shared advanced aspects of EW with Tehran's proxies. As defense AI advances, there is a potential for these proxies to exploit the positive externalities of defense AI capabilities provided by the Islamic Republic. This is particularly significant given that Iran's adversaries, such as Israel, have been using defense AI to counter Hamas in the Gaza Strip since October 2023.

In the realm of passive defense, the NPDO adopts a strategic approach that prioritizes public awareness. Harnessing the power of mass media and platforms such as Friday Prayers, the Organization is committed to educating and enlightening the public on passive defense measures.[136] Moreover, with a dedicated presence in industries and public agencies the NPDO strives to provide training and information to employees and workers, emphasizing best practices crucial for civilian infrastructure protection and staff safety in digital spheres. On an annual basis, a dedicated week is devoted to showcasing the accomplishments in passive defense and highlighting the NPDO's initiatives, drawing nationwide attention and admiration.[137] This weeklong event serves as a catalyst for amplifying the Organization's outreach through mass media channels, thereby fostering heightened public awareness.

134 "Unveiling of the 'Qadr 29' missile and new drones of the Army Airforce
(رونمایی از موشک «قدر ۲۹» و پهپادهای جدید هوانیروز ارتش)."
135 "From General Soleimani's secret trip to Gaza to the transfer of modern weapons manufacturing technology to the Resistance,
(از سفر محرمانه سردار سلیمانی به غزه تا انتقال فناوری ساخت تسلیحات مدرن به مقاومت)."
136 "Iran Military Power."
137 "The passive defense week of 1402 and the importance of cyber defense
(هفته پدافند غیر عامل ۱۴۰۲ و اهمیت پدافند سایبری)."

8 Conclusion

Defense technological innovations play a role in conferring a strategic advantage upon the Islamic Republic—a belief deeply embedded in the leadership's convictions in Tehran. Iran perceives defense AI as the latest innovation that can be leveraged to safeguard the core tenets of its overarching strategy: the preservation of regime survival, security, and stability against significant state adversaries.

Strongly opposed to the existing world order and its centers of power, the Islamic Republic is unreserved in thinking about and developing defense AI as a means to rekindle its founding vision: a resilient model for the Muslim world and an inspiration for all oppressed communities and nations globally. The genuine architects of the Islamic Republic view Iran not merely as a state but as a movement, and they believe that AI in defense and other domains holds the potential to actualize the visionary aspiration.

If this is indeed Iran's perception of defense AI as a once-in-a-lifetime opportunity to challenge its major adversaries and transform into an unassailable and inspired power, then the leadership is likely to leave no room for hesitation in capitalizing on defense AI. Iran's emergence as a global arms supplier,[138] boasting a reported revenue of USD1bn (around €920M) from March 2022 to February 2023,[139] stands as a significant achievement for Tehran, especially considering decades of embargoes and restrictions on its military-industrial complex. The positive ramifications of arms sales, such as providing one-way attack drones to Russia, extend beyond mere financial gains. For instance, Iran anticipates receiving technology from Russia for extracting oil and gas from challenging terrains,[140] thereby boosting its energy production and subsequent revenue. Given the dim prospects of extensive relations with Western advanced economies, Iran considers bolstering ties with Russia as a strategic imperative, making collaborations in defense technology mutually beneficial.

This preference needs to be seen in the context of ongoing small-scale military conflicts engulfing the Middle East in early 2024, that increase concerns of escalation into larger-scale warfare. Consequently, the region has become a focal point for the testing of defense and military AI capabilities by the United States and Israel in their engagements with Iran's proxies and partners in the Palestinian territories, Yemen and elsewhere. This marks the dawn of a new era in state (shadow) combat, one in which Iran is very unlikely to remain passive.

Although these developments shape Iran's policy perspectives and the role defense AI plays therein, there is – as of today – no indication that Iran's arms exports

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138 Faucon, "Iran's Rise as Global Arms Supplier Vexes U.S. and Its Allies."
139 "Iran's Annual Arms Exports Total $1 Billion."
140 "Russia exports technologies for oil, gas production to Iran – business council chairman."

contain elements of AI as its military industries do not yet integrate AI fully. In so doing, Iran will walk on a thin line as past attempts at expanding its defense capabilities had backfired. This happened in the past when Iran stepped up its industrial nuclear programs and worked with Moscow and Beijing behind the scenes.[141] Thus any transformation of Tehran's defense capabilities with AI could pose a direct threat to Russia, indirectly endanger China's interests in the Middle East, and further sour relations with regional powers. While the Iranian leadership acknowledges these risks, the entrenched isolation within the country's strategic culture, coupled with the multifaceted threats from its adversaries, may drive Tehran to further accelerate the integration of AI technologies into its 360-degree defense doctrine. This leaves scant space for alternative strategies, especially as Tehran's principal state opponents continue to rapidly invest in AI technologies with substantial budgets.

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141 Katz, "Russia secretly feared the Iran nuclear deal. Here's why."

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