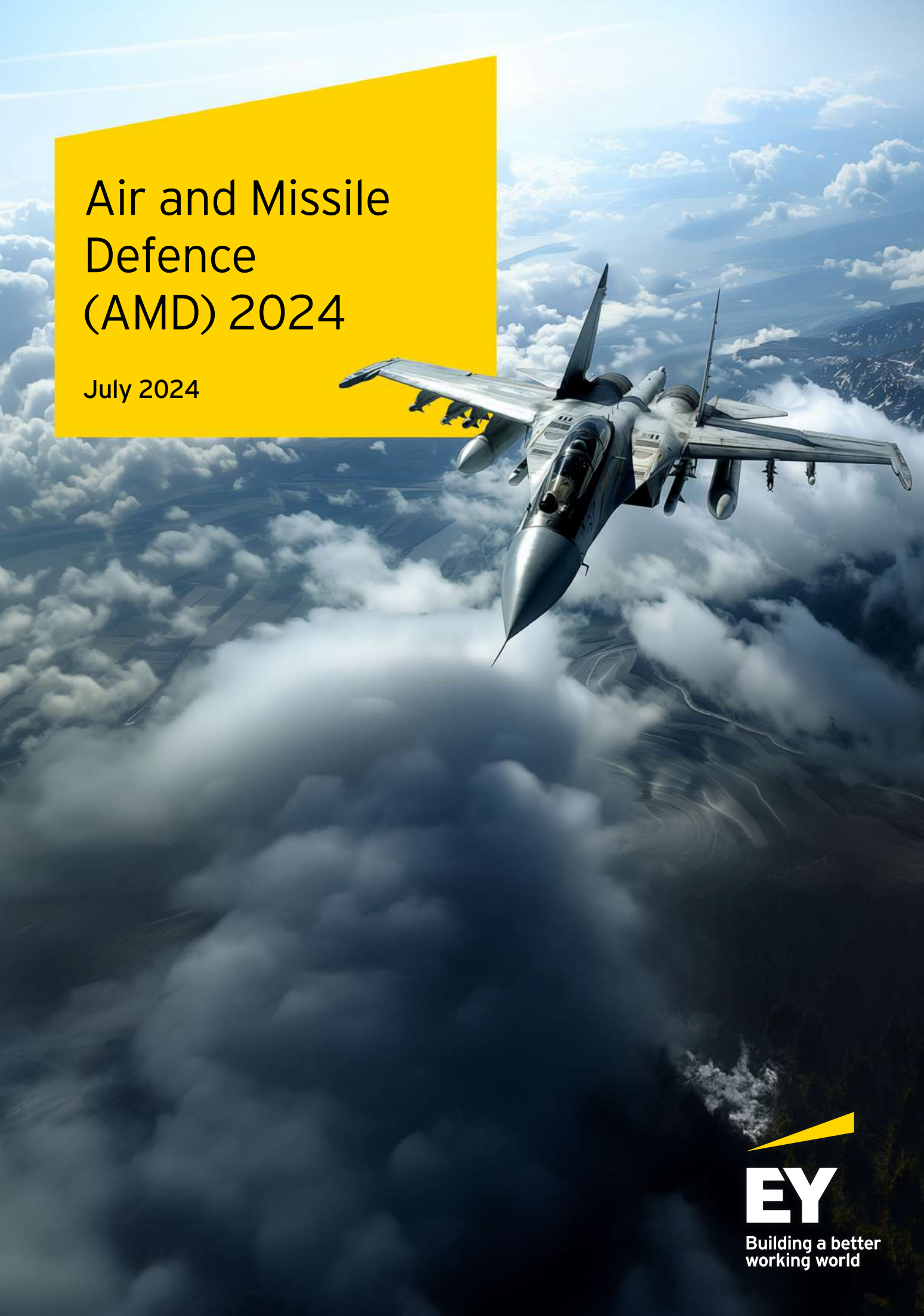
Air and Missile Defence (AMD) 2024

July 2024



Building a better working world

Overview

Air defence (AD) systems are indispensable for maintaining national security and ensuring the integrity of a country's airspace. The increasing sophistication and accessibility of aerial and missile technology underscore the need for robust air and missile defence(AMD) systems to protect a nation's sovereignty, infrastructure, and populace.

Air and missile defence is essential for several reasons:

Protection of sovereignty and territory: Effective AMD systems deter adversaries from launching attacks and provide a means to neutralize threats before they can inflict damage.

Safeguarding civilian populations: Robust AMD systems protect cities and civilian infrastructure; helps reduce casualties and maintain public morale during conflicts.

Defence of critical infrastructure: Key infrastructure, such as power plants, military bases, and communication hubs, are prime targets for enemy strikes. AMD systems safeguard these assets, ensuring continuity of operations, and reducing the strategic advantage of adversaries.

Deterrence and diplomatic leverage: A credible AMD capability acts as a deterrent against potential aggressors, enhancing a nation's diplomatic leverage. It signals a country's readiness and capability to defend itself, thus contributing to regional and global stability.

Control of the air: Air defence systems are critical to achieving control of the air, a key factor that directly influences the execution of overall military strategy. This control enables efficient operations of both air and surface forces within the battlespace while denying the enemy similar advantages.

The development and deployment of AMD systems involve a multi-layered strategy, incorporating both kinetic and non-kinetic means of interception. Kinetic defence includes the use of missiles and interceptor aircraft to physically destroy incoming threats, while non-kinetic methods leverage electronic warfare, cyber capabilities, and advanced radar and sensor technologies to disrupt or disable them. This layered approach ensures redundancy and enhances the effectiveness of the defence system, providing multiple opportunities to intercept threats before they can reach their targets. Key components of these systems include early warning radars, command-and-control centers, and various interceptor platforms, all of which work in concert to provide comprehensive coverage and protection.

This paper delves into these key components of AMD systems, exploring their market dynamics, supply chain intricacies, and the challenges faced in their development and deployment. Additionally, it examines various development programs and the opportunities available within the country to advance AMD capabilities.

Challenges faced by AMD systems

01

Air defence systems face challenges from a varied range of threats. The table below describes important properties of these threats and the challenges they pose.[1]

Weapon system	Level(s) of impact	Advantage	Disadvantage	Defence	Cost	Trend
Ballistic missile	Strategic; theatre	Speed, trajectory, (possible) range	Predictable trajectory, difficult to transport and hide	Highly difficult	High	Focus on multiple independently targetable reentry vehicle (MIRV) technology
Cruise missile	Theatre	Maneuverability, varying altitudes, limited logistical tail	Less suited for certain targets, lower speeds	Difficult	Medium	India in talks to export Brahmos to more nations
Hypersonic missiles	Strategic; theatre	Range, speed, maneuverability	Trade-offs between them, logistical tails	Highly difficult	Very high	China tested Hypersonic Glide Vehicle
Manned aircraft	Strategic; theatre; tactical	Fixed wing: versatility, range, speed, maneuverability; rotary wing: maneuverability	Logistical tail, expensive, not expendable	Difficult for 5th gen; less for previous generations and rotary wings	Very high for newer generations	Focus on stealth
Unmanned aircraft	Theatre; tactical	Loitering, persistent sensing, versatile but expendable	Limited ranges, logistical tail depending on class	Difficulty depends on class, but especially on saturation	Moderate to cheap, depending on class	Highest CAGR
G-RAM	Tactical	Highly difficult to intercept	Limited range, limited guidance	Highly difficult	Cheap	Presence of conventional equipment

Source: The Hague Centre for Strategic Studies

[1] https://hcss.nl/wp-content/uploads/2021/12/Integrated-Air-and-Missile-Defence-HCSS-Dec-2021.pdf

01 Combined attacks to overwhelm defence systems

The threat posed by combining diverse weapons—both new and old, complex and simple, expensive and cheap—alongside advanced sensors into a single, powerful salvo attack is significant. This strategy can overwhelm adversaries' defences through simultaneous strikes using various weapons, such as ballistic and cruise missiles, hypersonic glide vehicles, loitering munitions, and unmanned aerial vehicles (UAVs). Despite improvements in air and missile defence integration, these systems are less effective against modern, complex threats compared to previous conventional challenges.

02 Compressing space and time, shrinking windows of decision-making

The integration of various technologies and advancements in missile speed and range have significantly reduced the response time for defenders. Ballistic and hypersonic missiles can travel great distances rapidly, with hypersonic missiles potentially avoiding detection. Due to their high cost, these missiles are typically reserved for high-value targets, such as critical infrastructure and command centers. At the same time, more cost-effective and agile platforms, like loitering munitions and UAVs, enable attackers to overwhelm defences. As advancements in sensing, computing, artificial intelligence (AI), and systems integration continue, decision-makers face increasing pressure to quickly identify and arespond to threats.

03 Precision and transparency

Armed forces now face a more transparent and deadly battlefield environment due to improvements in sensor quality, diverse signal detection, continuous monitoring, and AI-enhanced communication and computing. The proliferation of Intelligence, Surveillance, and Reconnaissance (ISR) UAVs and low earth orbit (LEO) satellites facilitates accurate targeting of high-value assets, undermining the stability of deterrence. Recent disputes highlight the risks posed by increased battlefield visibility. The ability to maintain persistent surveillance and strike capabilities is blurring the distinction between high-end and low-end technologies, enabling even smaller powers to carry out precise and lethal attacks. This change is fueled by the integration of various systems and technologies.

04 Declining costs driving vertical and horizontal proliferation

The lower costs of missile technologies and UAVs compared to advanced aircraft have made these weapons more accessible to a broader range of actors. The ease and affordability of producing cruise missiles, UAVs, and loitering munitions has led to their widespread proliferation. Both sophisticated and simpler UAVs play crucial roles in persistent ISR tasks, frequently evading ground-based radar defences. Horizontal proliferation gives more state and non-state actors access to these weapons, while vertical proliferation provides major powers with diverse platforms, enabling new offensive strategies. Defending against these threats, particularly salvos, remains complex and expensive.

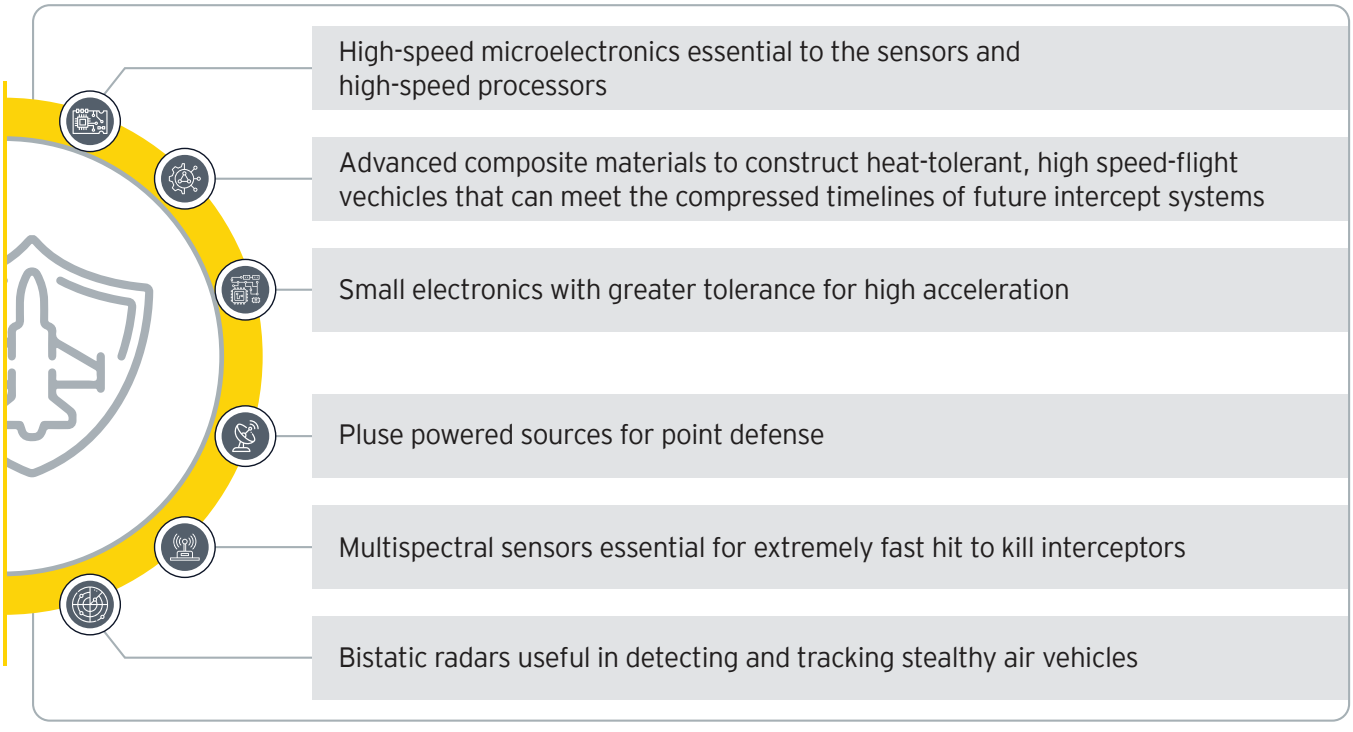
05 Failure in deploying mass and cost-effective AD systems

Most air defence systems are prohibitively expensive. For example, India spent approximately INR40,000 crore on procuring five regiments of the S-400 missile defence systems from Russia. These procurements are consistently costly, straining the limited defence budget allocated for capital expenditures.

Technology focus

02

The landscape of air defence has evolved significantly due to technological advancements, particularly with the advent of critical and emerging technologies (CETs). CETs are revolutionizing air defence systems, significantly enhancing their capabilities to detect, track, and neutralize aerial threats. The advancements in the development cycle and manufacturing technologies are also leading to the emergence of highly capable components, systems, and sub-systems.



Source – Researchgate, secondary sources

For instance, advanced radar systems are employing sophisticated algorithms and AI to provide real-time threat analysis and improve target acquisition accuracy. Innovations like quantum radar and photonic radar offer unprecedented sensitivity and resolution, capable of detecting stealth aircraft and hypersonic vehicles that traditional radar systems might miss. Additionally, integrated sensor networks combining land, sea, and space-based platforms are creating a comprehensive surveillance grid that can track multiple threats simultaneously, improving situational awareness and response times. Directed energy weapons, such as high-energy lasers and microwave weapons, are emerging as viable options for intercepting and neutralizing incoming threats at the speed of light. These systems offer a cost-effective alternative to traditional kinetic interceptors, with the potential for virtually unlimited ammunition and lower operational costs. Furthermore, developments in hypersonic missile defence are underway to counter the increasing threat posed by hypersonic glide vehicles and cruise missiles. The integration of these new technologies with existing defence frameworks through sophisticated command-and-control systems ensures that emerging technologies can be effectively employed to protect against both current and future aerial threats.

The Defence Research and Development Organisation (DRDO) has released a list of 75 technology-priority areas to boost indigenous defence manufacturing. Few of these are focused on air defence ecosystem, for example:

Missile systems	Aerodynamics	Aeromechanical systems	Surveillance and tracking
C4ISR	Sensors/detectors	Control systems	Counter Swarm Technology
Electro optics	Electronic warfare	Embedded systems	Guidance and navigation
High performance Computing	Hypersonic technologies	AI/ML technology	Aero structures
Passive countermeasures	Propulsion technologies	Radar	Aero structures
Warhead/explosive and ballistic protection	Space situational awareness	Space technologies	Communication

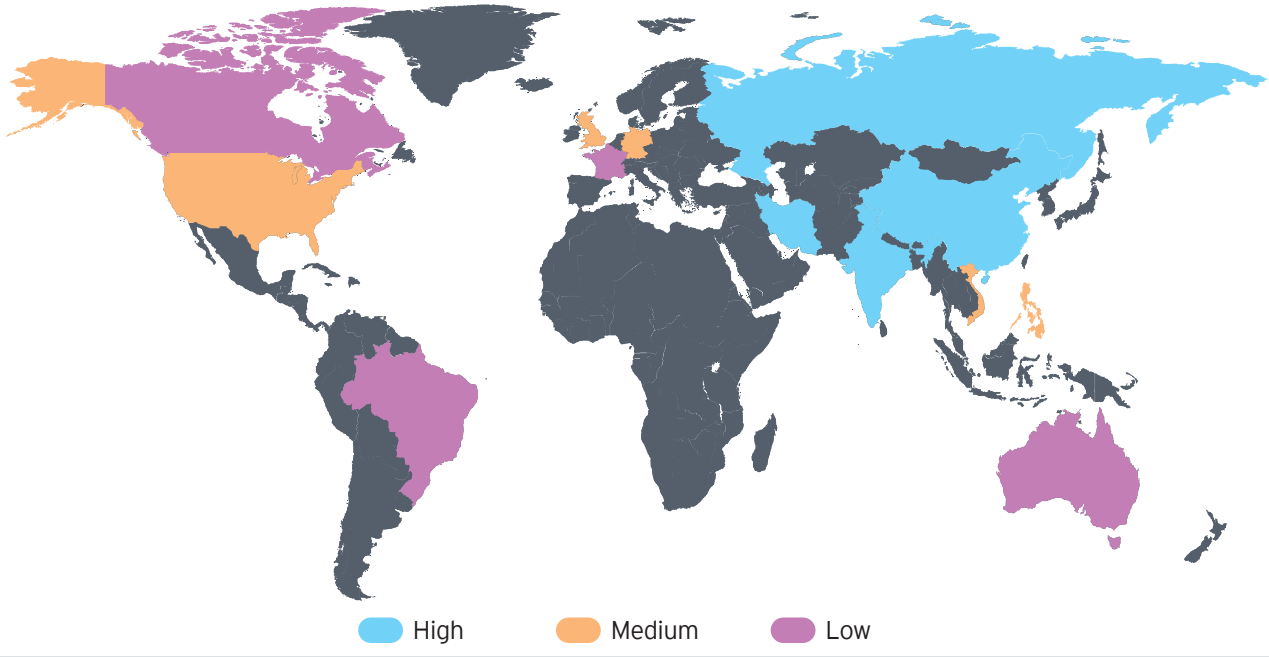
Source: DRDO

Air defense market

03

The air defence systems' market size is estimated at USD 46.42 billion in 2024, and is expected to reach USD 58.51 billion by 2029, growing at a CAGR of 4.74% during the forecast period .[2]

High CAGR countries for air defence market



Source: Secondary research, EY analysis

Rising global military expenditure is expected to drive significant growth in the acquisition of next-generation air defence systems in the coming years, boosting the market considerably during the forecast period. Increasing border unrest and disputes worldwide have prompted defence forces to invest heavily in advanced air defence systems to enhance their capabilities and counter aerial attacks by enemy forces, thereby gaining a competitive edge in modern warfare.

Other factors impacting the air defence market:

- Technological advancements in weapon systems: Advances in technology have led to the development of more sophisticated air defence systems. These systems incorporate cutting-edge radar, missile interception, and communication technologies, making them more effective in detecting and neutralizing threats.
- Usage of new-age weapons: The emergence of new-age weapons, such as first-person view (FPV) drones and several other types of low-cost remotely piloted aircraft system (RPAS), has necessitated the deployment of robust air defence systems.
- Development of integrated defence systems: The trend towards integrated air defence systems that provide comprehensive coverage against various aerial threats is also propelling market growth.

[2] https://www.mordorintelligence.com/industry-reports/air-defence-systems-market

Major air and missile defence contracts across the world:

- In April 2024, Elbit Systems was awarded a contract worth USD 50 million for two batteries of Red Sky air defence system. The Red Sky is a Tactical Very Short-range Air Defence (VSHORAD) System designed to provide protection against low-altitude aerial threats.[3]
- In March 2024, the Polish Ministry of National Defence signed a USD 2.5 billion deal with the US to acquire the Integrated Battle Command System (IBCS), to synchronize its air- and missile-defence weapons under development.[4]
- In March 2024, the US Missile Defence Agency has selected Lockheed Martin to deliver the new homeland missile defence capability. The overall program, worth USD 17 billion, is for the development of the Next Generation Interceptor to modernize the Ground-Based Midcourse Defence (GMD) program.[5]
- In March 2024, Germany awarded Raytheon a contract worth USD 1.2 billion for Phased Array Tracking Radar for Intercept on Target, or Patriot air defence systems, including radars, launchers, C2 stations, associated spares, and support.[6]
- In March 2024, the Australian Department of Defence signed a contract worth USD 500 million with Lockheed Martin Australia to build Australia's future Joint Air Battle Management System under project AIR 6500 Phase 1.[7]
- In February 2024, Canada has approved plans to invest USD 225 million in an air defence capability enhancement program for Canadian Armed Forces members in Latvia. The country has finalized contracts with Saab Canada Inc. to procure the RBS 70 NG short-range air defence system.[8]
- In January 2024, Sweden has awarded Saab for Mobile Short Range Air Defence (MSHORAD) solution from the Swedish Defence Materiel Administration (FMV). The order carries an order value for SEK300 million.[9]
- Poland and the UK signed an industry deal worth Euro 4 billion for next generation air defence system.
- Polish Armaments Group (PGZ) for more than 1,000 Common Anti-Air Modular Missiles – Extended Range (CAMM-ER) and over 100 iLaunchers.[10]
- Rheinmetall was awarded a contract worth EUR 182 million to supply two Skynex VSHORAD system batteries.[11]
- NATO Support and Procurement Agency (NSPA) awarded a contract worth USD 5.5 billion contract to COMLOG, a joint venture between Raytheon and MBDA for up to 1,000 Patriot missiles.[12]

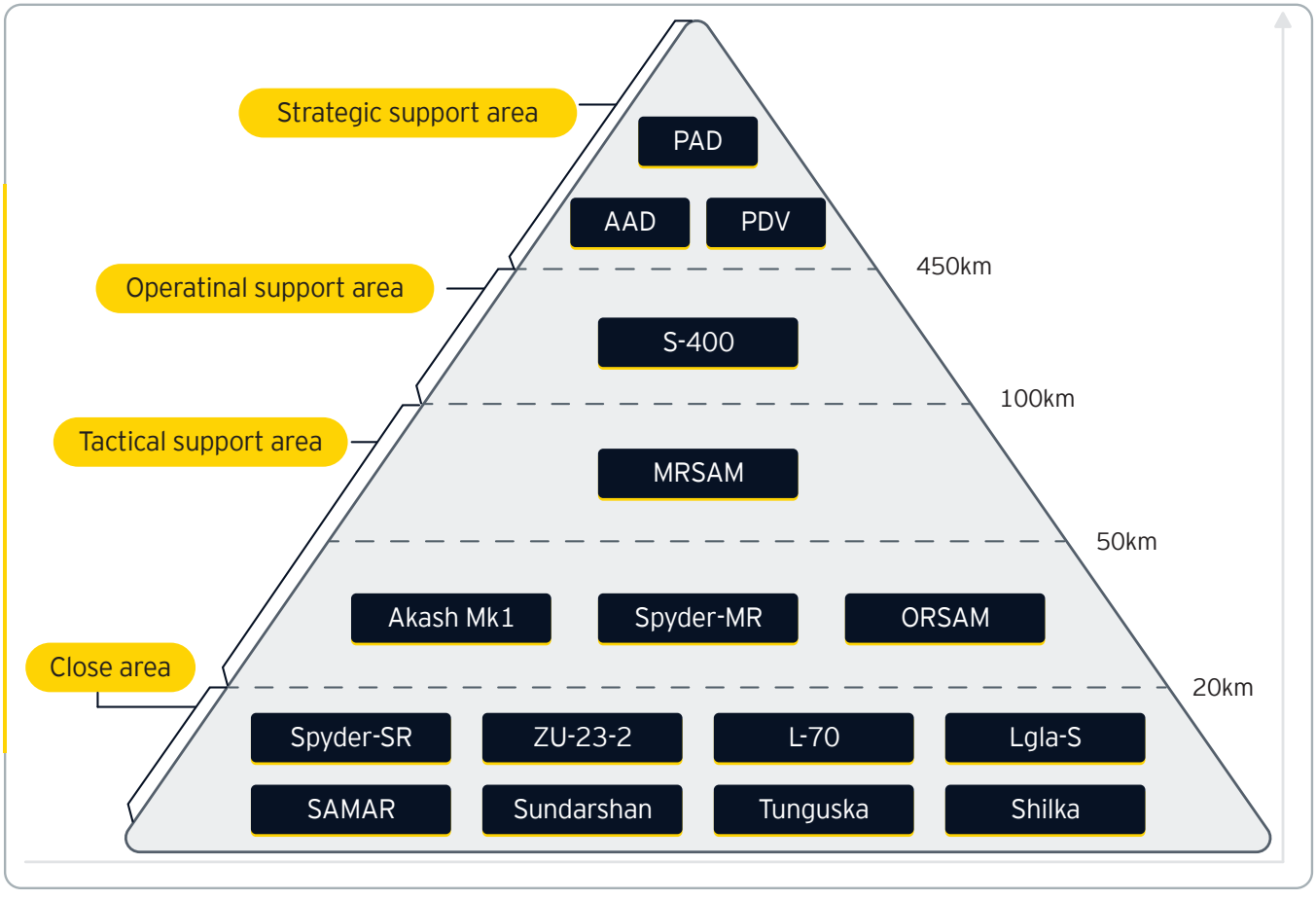
[3] https://elbitsystems.com/pr-new/elbit-systems-awarded-approximately-50-million-contract-for-a-new-air-defence-system-by-an-international-customer/
[4] https://www.defencenews.com/global/europe/2024/02/29/poland-signs-25-billion-deal-for-us-air-defence-software-hub/
[5] https://www.defencenews.com/pentagon/2024/04/16/lockheed-chosen-to-build-new-homeland-missile-defence-interceptor/
[6] https://www.defenceconnect.com.au/joint-capabilities/13826-raytheon-secures-1-2-billion-contract-to-provide-patriot-defence-system-to-germany
[7] https://australianaviation.com.au/2024/04/government-signs-500m-contract-for-next-generation-air-defence/
[8] https://www.canada.ca/en/department-national-defence/news/2024/02/canada-acquiring-air-defence-and-anti-drone-capabilities-for-canadian-armed-forces-members-deployed-with-nato-in-latvia.html
[9] https://www.saab.com/newsroom/press-releases/2024/saab-receives-order-from-sweden-for-mobile-short-range-air-defence
[10] https://www.gov.uk/government/news/4-billion-uk-poland-air-defence-deal-strengthens-european-security
[11] https://euro-sd.com/2022/12/news/28674/rheinmetall-awarded-contract-for-skynex-air-defence-system/
[12] https://www.nato.int/cps/en/natohq/news_221626.htm

Indian air defence ecosystem

04

Overview

India, recognizing the strategic importance of advanced air defence capabilities, has been actively enhancing its infrastructure and technology in this domain over the past few years. In order to effectively monitor, detect, and defend its airspace from diverse threats, the country has embarked on a robust plan to develop a multi-layered air defence system.



To manage air defence in Indian airspace, the country is divided into areas controlled by Air Defence Control Centres (ADCC). These areas are further split into smaller sectors managed by Air Defence Direction Centres (ADDC), which oversee all air defence battles. Each ADDC commands several Integrated Air Command and Control System (IACCS) nodes, central to air defence command and control. Ground and air-based defence weapons are deployed around key assets, with the India Air Force (IAF) and Army resources managed by their respective services, except for centrally distributed strategic resources.[13]

Indian armed forces have recently awarded major contracts for AD systems to be placed in the multi-tier AD systems.

- The Armed Forces have already received three squadrons of S-400 and the deliveries of remaining squadrons would resume in 2026.
- In November 2023, the Army signed a deal with Russia for 120 launchers of Igla-S with 400 missiles.
- In March 2024, Ministry of Defence (MoD) signed a contract with Larsen & Toubro (L&T) worth INR13,300 crore to buy Close-In Weapon Systems (CIWS) for the IAF for deployment across India to protect vital assets from all types of low flying, low signature aerial threats.
- In March 2024, MoD signed a contract with L&T worth INR5,700 crore to buy high power radar, a static sensor for long range aerial surveillance with higher uptime.[14]

India is also working on several other AD programs, both on strategic and tactical level.

[13] https://cenjows.in/wp-content/uploads/2022/06/IADC-Final-by-Brig-Rajat-Upreti-on-24-May-2020.pdf
[14] https://mod.gov.in/press-releases-ministry-defence-0/press-release-mar-2024

India's ongoing air defence development programs

- **Quick reaction SAM -** The quick reaction Surface-to-Air Missile (QRSAM) system, developed by the DRDO, is a canister-based system designed to shield moving Army armored columns from enemy aerial attacks. Being canister-based, it offers controlled internal environment, facilitating easy transport, storage, and improved shelf life of weapons. The system, which can detect, track, and engage targets during short halts, is mounted on a mobile and maneuverable platform, enabling air defence on the move. It has a range of 25 to 30 km and incorporates a fully automated command-and-control system. The QRSAM system includes two 360-degree coverage radars with search and track capabilities even when in motion. The compact design uses a single stage solid propelled missile with a mid-course inertial navigation system, a two-way data link, and a terminal active seeker developed indigenously.
- **Akash New Generation (NG) -** The Akash-NG is a new variant of the Akash missile, a surface-to-air missile system developed indigenously in India. Capable of striking targets at distances up to 60 km and reaching speeds up to Mach 2.5, this weapon system promises to significantly enhance the IAF's air defence capabilities. The missile was developed by the Defence Research & Development Laboratory (DRDL) in Hyderabad, in collaboration with other DRDO labs, and is manufactured by Bharat Electronics Limited (BEL) and Bharat Dynamics Limited (BDL). The DRDO conducted a successful test for the missile system in July 2021 and more recently in January 2024.
- **Vertical Launch Short Range Surface to Air Missile (VL-SRSAM) -** The Vertical Launch Short Range Surface to Air Missile (VL-SRSAM) is a defensive missile system jointly developed by the DRDO for the purpose of equipping Indian naval warships. It is designed to neutralize various aerial threats at close ranges, including sea-skimming targets, which are tactics used by certain missiles and aircraft to avoid radar detection. The VL-SRSAM has a range of 40-50 km and can reach altitudes of around 15 km. It is based on the design of the Astra missile, India's first beyond-visual-range air-to-air missile, also developed by DRDO. The missile has unique features such as cruciform wings for aerodynamic stability, thrust vectoring for controlling angular velocity and attitude, and a canisterized system for a controlled storage environment, ensuring ease of transport and longer shelf life. The Indian Navy and DRDO conducted a successful test of the missile in June 2022.
- **XRSAM -** The eXtra-long Range Surface to Air Missile (XR-SAM) is a mobile long-range air defence system currently being developed by the DRDO. Once deployed, the XR-SAM may complement the existing Indo-Israeli Barak 8 and Russian S-400 missile systems in the Indian armed forces. It is anticipated to fill the range gap between the Medium Range-SAM, which has a range of 70 km, and the S-400 with a range of 400 km. The XR-SAM is expected to have a range of 250 km against fighter jets and 350 km against targets such as cruise missiles, sea-skimming anti-ship missiles, Airborne Warning and Control System (AWACS) aircraft, and mid-air re-fuelers. It may also be equipped to intercept ballistic missiles and stealth fighters during their terminal phase. A naval variant may also be developed to supplement the Long Range Surface-to-Air Missile (LR-SAM) in the Indian Navy.
- **Very Short Range Air Defence System (VSHORAD) -** VSHORADS is a Man Portable Air Defence System (MANPAD) designed and developed indigenously by Research Centre Imarat (RCI) in collaboration with other DRDO laboratories and Indian industry partners. The missile, powered by a dual thrust solid motor, integrates various state-of-the-art technologies, including a miniaturized Reaction Control System (RCS) and integrated avionics. DRDO crafted the missile and its launcher with a specific focus on its portability. On 11 January 2023, Ministry of Defence (MoD) accorded Acceptance of Necessity (AoN) to VSHORAD (IR Homing) missile variant. Recently, DRDO conducted two successful flight tests of Very Short-Range Air Defence System (VSHORADS) missile on 28 and 29 February 2024 from a ground based portable launcher.

[14] https://mod.gov.in/press-releases-ministry-defence-0/press-release-mar-2024

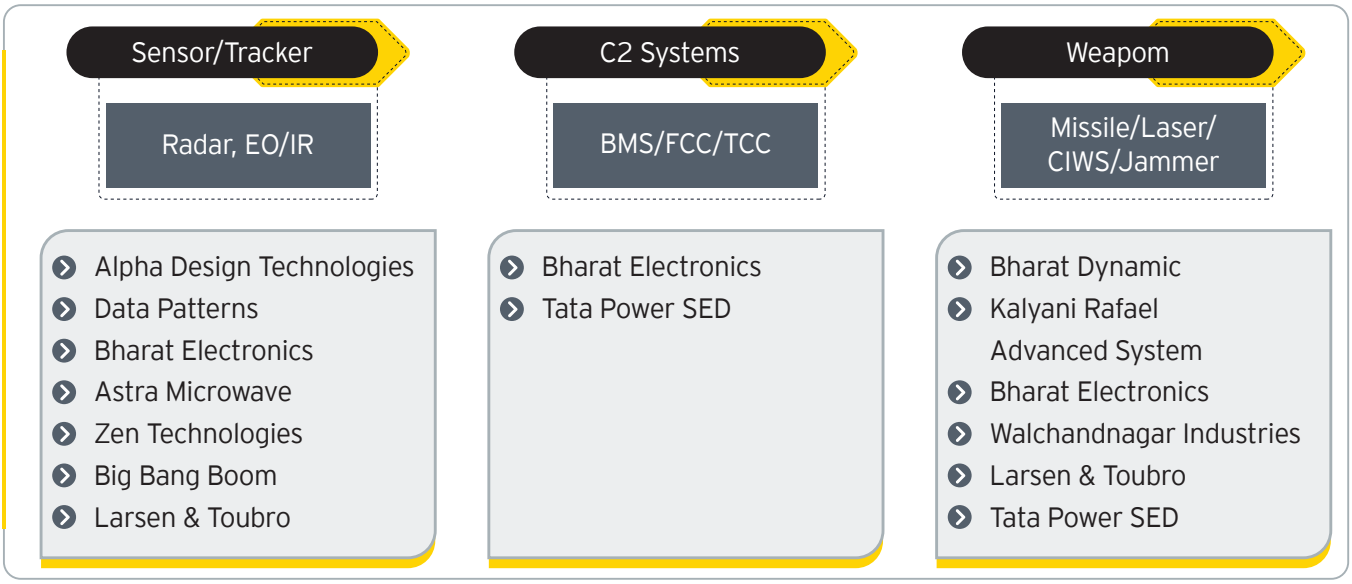
- **Laser DEW:** DRDO through its Center for High Energy Systems & Sciences (CHESS) is developing Directed Energy Weapons (DEW) of various categories such as 5KW, 9KW, 25KW and 30KW. The 30KW laser is capable of neutralizing helicopter and drones up to 5 km away. The system has an integrated EO/IR sensor providing the weapon with 360 degree coverage for detection, recognition and identification, and precision targeting. The DRDO is also working on 100KW laser for various air defence applications.
- **SAMAR 2:** The IAF has made a notable advancement in enhancing the nation's air defence capabilities with the creation of the Surface-to-Air Missile for Assured Retaliation (SAMAR-2) system. The innovative efforts of the 7 Base Repair Depot (BRD) in Tughlakabad have repurposed Russian R-27 air-to-air missiles, converting them into a formidable surface-to-air defence solution. SAMAR-2 represents a strategic approach to maximizing the utility of aging missile systems. The IAF has successfully tested the SAMAR system, conducting firing trials during the Astra Shakti 2023 exercise at Suryalanka Air Force Station in Andhra Pradesh.

Indian air defence system's supply chain

05

Overview

India's air defence supply chain is becoming increasingly robust, marked by a growing number of players providing radar solutions, developing software packages and command-and-control systems. This diversification is strengthening the indigenous air defence manufacturing ecosystem, promoting innovation and self-reliance. The involvement of these domestic players not only enhances India's defence capabilities, but also helps win contracts in foreign countries. For instance, Zen Technologies won a contract worth INR340 crore for the export of its Counter-Unmanned Aircraft System (CUAS).



Foreign joint ventures such as Kalyani Rafael Advanced Systems, are also significantly contributing to building a local ecosystem of sub-system suppliers. These collaborations are crucial for transferring technology and expertise, helping India develop a self-sufficient defence industry. Additionally, recent major contracts for CUAS have attracted more companies to enter this space, further expanding the domestic market. This influx of both foreign and local investments is creating a vibrant and competitive environment and robust supply chains.

Opportunity with the Indian armed forces

06

The Indian AMD market will see significant growth during the next few years owing to demand from the armed forces, upgrade and replacement of obsolete inventory, volatile geopolitical situation, increased funding, and growing technological prowess.

The opportunities in air and missile defence domain can be tapped by mapping the Technology Perspective and Capability Roadmap (TPCR), RFIs/RFPs/AoNs, and the positive indigenization list.

TPCR provides to the industry an overview of equipment that is envisaged to be inducted into armed forces up to the late 2020s.

Program/Project	Expected life cycle of the equipment (Years)	Approximate quantity	Procurement service
Anti RPA Defence System (RF inhibition)	10	More than 70	Joint (Army and Air Force)
Tactical High Energy Laser System	12	▶ For Phase-1 Less than 5 ▶ For Phase-2 More than 15	Joint (Army and Air Force)
Close in Weapon System to replace AK 630	25	30	Navy

List of active Request for Information (RFI)/Request for Procurement (RFP)/Acceptance of Necessity (AoN)

Date	Type	Category	Description
January 2023	AoN	Buy (Indian-IDDM)	VSHORAD (IR Homing)
March 2022	AoN	Buy (Indian-IDDM)	Air defence fire control radar (light)
October 2022	RFP	Buy and Make (Indian)	220 air defence guns and 1,41,576 rounds of ammunition
October 2022	RFI	Buy (Indian-IDDM)	CUAS

Positive indigenization list

The items listed in the positive indigenization list will provide ample visibility and opportunity to the domestic defence industry for understanding the trend and futuristic needs of armed forces and create requisite R&D and manufacturing capacity within the country.

Name of platform/ weapon/ system/ equipment	Indicative year import embargo
Successor of Flycatcher and Upgraded Super Fledermaus (USFM)/Air Defence Fire Control Radar (ADFCR)	December 2020
Simulators for towed and self-propelled guns of air defence	December 2020
Land-based MRSAM Weapon System	December 2021
Land-based MRSAM Weapon System	December 2021
Ship-based Medium Range Surface to Air Missile (MRSAM)	December 2022
Counter Drone System (Hard Kill)	December 2022
Counter Drone System (Soft Kill)	December 2022
L-70 Integrated Air Defence Combat Simulator (IADCS)	December 2023
L-70 Integrated Air Defence Combat Simulator (IADCS)	December 2023
Augmented Reality (AR) based head mounted display system for weather information to Army air defence systems	December 2025
Operational Control System for Air Defence Weapon for Army (Project AKASHTEER)	December 2026
Automatic missile detection radar for ships	December 2027

Conclusion

Air and missile defense systems are pivotal in ensuring national security and maintaining global stability in an era marked by increasingly sophisticated threats. The integration of advanced technologies and multi-layered strategies has significantly enhanced the effectiveness and reliability of these defense systems. By employing both kinetic and non-kinetic methods, nations can create robust defensive frameworks capable of addressing a wide range of threats. However, the complexity of these systems necessitates continuous investment in research and development, as well as collaboration with international partners, to keep pace with evolving threats and technological advancements. The Indian armed forces, for instance, operate a wide network of AMD systems, and future requirements across the three services may be consolidated into a single requirement to achieve greater economies of scale during production and reduced maintenance costs over the lifecycle of these systems.

Moreover, the development and deployment of AMD systems present both challenges and opportunities. The intricate supply chains and market dynamics require careful management to ensure the timely and cost-effective delivery of essential components. Addressing these challenges through innovative development programs and strategic initiatives, such as joint tri-service procurements for indigenously developed AD systems, may significantly reduce development timelines. These joint procurements ensure that the weapon systems' design considers the needs of all three services in mind, allowing customizations for individual requirements to progress concurrently. By focusing on enhancing these capabilities, nations can strengthen their defence postures, contribute to regional stability, and uphold international non-proliferation efforts. As the landscape of modern warfare continues to evolve, the role of air and missile defence systems will remain crucial in safeguarding national and global security.

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