Air Defence Systems

***Prelims**: Current events of national and international importance*

***Mains (GS III):** Security challenges and their management in border areas*

Why in News?

Recently, India deployed a range of air defence systems in response to Pakistan's drone and missile attacks, which were immediately tracked and destroyed.

- **Primary objective** – To ***take out threats from the skies*** like enemy fighter aircraft, unmanned drones, or missiles.
- **Technology used** – It is done with the help of a complex system of *radar, control centres, defensive fighter aircraft*, and ground-based air defence missile, artillery, and electronic warfare systems.
- **Working** – It can be sub-categorised into 3 interlinked operations
  - Detection
  - Tracking
  - Interception
- All these 3 aspects of an air defence system have to work together as a cogent whole called ***"C3" or a "command, control and communication" system***.
- **Detection** – It is *typically done by radar*, although satellites may be used in certain circumstances, such as an enemy launching an Intercontinental Ballistic Missile (ICBM).
  - Radar sends out *beams of electromagnetic radio waves* by a transmitter which are reflected by the objects that they hit.
  - A *receiver then collects the returning radio waves* and makes inferences such as the distance of the threat, its speed, and its specific nature (what kind of aircraft/ missile).
- **Tracking** – It is typically done using a combination of radar and other sensors such as *infrared cameras or laser rangefinders*.
- The accuracy of tracking is crucial for effectively neutralising the enemy without targeting false threats.
- **Interception** – Depending on the challenges they foresee; nations utilize a wide assortment of weapons to neutralise aerial threats.
  - Fighter Aircrafts
  - Surface-to-Air Missiles
  - Anti-Aircarft Artillery
  - Electronic Warfare

Fighter Aircraft	• MiG-21 • Sukhoi Su-35s • MiG-29s • HAL Tejas, • Mig-21 Bisons • Dassault Rafales
Surface-to-Air Missiles (SAMS)	• Akash missiles - Medium-range • Barak missiles - medium-to-long range • S-400 missiles - long-range

Anti-Aircraft Artillery (AAA)
• They fire shells rapidly, at rates of over *1,000 rounds per minute*. • AAA shells are designed to explode at predetermined altitudes so as to disperse shrapnel over a wide area. • This makes an AAA battery effective even if it does not achieve a direct hit. • When augmented with automated fire-control systems, they remain crucial last-ditch defences, and are also used for specialised anti-unmanned aerial vehicle (UAV) roles.
Fighter aircrafts
• These agile aircraft can be scrambled at a moment's notice, and they climb quickly to altitude and neutralise an enemy aircraft before it deploys its weapons. • Interceptors are equipped for air-to-air combat with cannon, rockets, a suite of visual-range and beyond-visual-range missiles, and electronic warfare systems.
Surface-to-Air Missiles
• They are more effective than anti-aircraft artillery (AAA), and do not put pilots in danger like interceptors. • They are radar-, infrared-, or laser-guided. In addition to being operated from the ground, SAMs can also be launched from ships. - Heavy long-range systems which are fixed or semi-mobile; - Medium-range vehicle-mounted systems that can fire on the move - Short-range man-portable air-defense systems (or MANPADS)
Electronic Warfare
• It is most often used to *jam enemy radar and targeting systems*, so as to impede its ability to accurately and effectively deploy its weapon. • It can *confuse attack drones* or prevent enemy air-to-surface missiles from homing in on targets. • These can operate from both land and air, including from specialised EW aircraft, such as the US Navy's Boeing EA-18G Growler.

- Beyond the technical capabilities superior communication and decision-making capabilities are crucial for an effective air defence.

Reference

The Indian Express| Working of Air Defence System

Related News – S-400 System | Akash Missile

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