

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-Aircraft Artillery
 - Electronic Warfare

Fighter Aircraft	<ul style="list-style-type: none"> • MiG-21 • Sukhoi Su-35s • MiG-29s • HAL Tejas, • Mig-21 Bisons • Dassault Rafales
Surface-to-Air Missiles (SAMS)	<ul style="list-style-type: none"> • 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](#)