

TODAY'S IMPORTANT CURRENT AFFAIRS

UPSC MAINS

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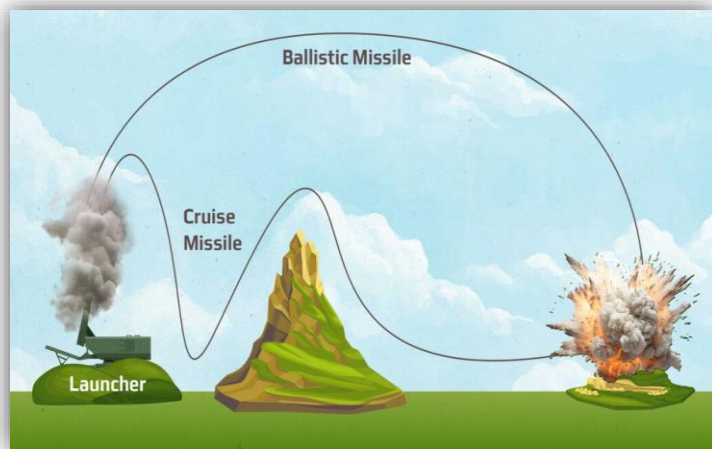
CRUISE AND BALLISTIC MISSILES

Source: The post is based on the article published in “The Hindu” on 12.05.2025.

In News: Indian missiles in **operation sindoor**

Syllabus: Mains – GS III (SCIENCE AND TECHNOLOGY)

Cruise and ballistic Missiles



Ballistic Missiles

- ❖ Powered by rockets only during the initial boost phase, after which they follow a high, **arched (ballistic) trajectory**, often **exiting the atmosphere** before descending onto the target.
- ❖ Used for long-range, high-speed attacks, including **intercontinental strikes**, and can carry nuclear or conventional warheads.

Cruise Missiles

- ❖ Powered and **guided throughout their flight**, flying at **low altitudes within the atmosphere** along a relatively straight, pre-programmed path.
- ❖ Designed for precision strikes against specific targets, with high accuracy and maneuverability.

Key Features

Feature	Ballistic Missiles	Cruise missiles
Propulsion	Rocket (boost phase only)	Jet engine (air-breathing, self-propelled throughout)
Trajectory	High-arc, often exits atmosphere	Low, straight, within atmosphere
Speed	Supersonic to hypersonic	Subsonic or supersonic
Guidance	Guided during boost; unguided after	Guided throughout flight
Accuracy	Less precise	Highly accurate
Platforms	Land, submarine	Land, sea, air, submarine
Detectability	Easier (especially during boost)	Easier (especially during boost)
Warhead Types	Nuclear/conventional	Nuclear/conventional
Indian Examples	Agni, Prithvi, Dhanush	BrahMos, Nirbhay

Development in India

- ❖ **Integrated Guided Missile Development Program (IGMDP):** Launched in the 1980s, this program led to the development of both ballistic (**Prithvi, Agni series**) and cruise missiles (BrahMos, Nirbhay).
- ❖ **Ballistic Missiles:** India's Agni series (including Agni-V, an intercontinental ballistic missile) and Prithvi series are key strategic assets, capable of carrying nuclear or conventional warheads.
- ❖ **Cruise Missiles:** BrahMos (supersonic, developed with Russia) is one of the world's fastest cruise missiles, deployable from land, sea, and air. Nirbhay is India's indigenous long-range subsonic cruise missile.

Features of Indian Missiles:

- ❖ **Indigenous technology**, quick reaction, high accuracy, and heavy payloads. Many use solid fuel for rapid deployment, and advanced guidance for precision.
- ❖ India continues to enhance its missile capabilities for both deterrence and precision strike roles, aiming for strategic balance and regional security.

Significance of Cruise and Ballistic Missiles in India

- ❖ **Strategic Deterrence:** Long-range ballistic missiles like Agni provide credible minimum nuclear deterrence, ensuring India can respond to nuclear threats and maintain strategic stability in the region.
- ❖ **Tactical Superiority:** Short-range ballistic and cruise missiles (e.g., Prithvi, BrahMos) enable deep strikes on enemy infrastructure, logistics hubs, and airbases, giving India a battlefield edge.
- ❖ **Coastal and Air Defense:** Anti-ship and surface-to-air missiles strengthen India's coastal security and air defense, protecting against hostile warships, aircraft, and missiles.
- ❖ **Technological Advancement and Self-Reliance:** Indigenous missile programs foster innovation, reduce dependency on foreign suppliers, and align with the goal of “Atmanirbhar Bharat” (self-reliant India).
- ❖ **International Standing:** Success in missile development enhances India’s global defense stature and strategic partnerships.

Challenges Facing India’s Missile Programs

- ❖ **Dependence on Imports:** India still relies on foreign suppliers for critical missile components like seekers, propulsion systems, and advanced electronics, impacting self-sufficiency.
- ❖ **Development Delays:** Several missile projects have faced delays due to technological hurdles and project management issues, affecting timely deployment.
- ❖ **Technology Transfer Barriers:** Restrictions on international technology transfer hinder domestic development of advanced missile subsystems.
- ❖ **Operational Integration:** Ensuring seamless integration of new missile systems with existing defense infrastructure and platforms remains a complex challenge

Missiles used in Operation Sindoor

1. SCALP (Storm Shadow) Cruise Missile

Type: Air-launched, long-range cruise missile

Origin: France/UK (MBDA)

Range: 250–500 km (export variant for India: ~250 km)

Technology & Features:

- ❖ Stealthy, terrain-hugging flight profile for evading radar

- ❖ Precision guidance using INS, GPS, and terrain referencing
- ❖ Designed for deep strikes against fortified, high-value targets (bunkers, command centers)
- ❖ Warhead: Penetration and blast/fragmentation

Role in Operation Sindoor: Used by Rafale jets for deep, surgical strikes on terror infrastructure in Pakistan and PoK

2. HAMMER (Highly Agile Modular Munition Extended Range)

Type: Precision-guided air-to-ground bom

Origin: France (Safran)

Range: 50–70 km (depending on launch altitude)

Technology & Features:

- ❖ **Modular guidance:** GPS, infrared, or laser
- ❖ All-weather, jam-resistant, capable of hitting moving or stationary targets
- ❖ Effective against hardened structures and mobile assets

Role in Operation Sindoor: Enabled precision attacks on bunkers and logistical centers, complementing SCALP's long-range reach

3. BrahMos Supersonic Cruise Missile

Type: Supersonic cruise missile (land, sea, air-launched)

Origin: India-Russia (DRDO & NPOM)

Range: 290–500 km (post-MTCR: up to 450–500 km)

Technology & Features:

- ❖ Speed: Mach 2.8–3.0 (supersonic)
- ❖ Fire-and-forget, high accuracy, adaptable for multiple platforms
- ❖ Warhead: 200–300 kg, capable of low-altitude terminal attack

Role in Operation Sindoor: Used to destroy at least 11 Pakistani airbases and military installations, targeting radar sites, command centers, and ammunition depots

4. Loitering Munitions (Kamikaze Drones)

Type: Loitering munition/drone

Origin: Various (indigenous and imported)

Range: Varies by model

Technology & Features:

- ❖ Can hover over target areas for surveillance and strike roles
- ❖ Autonomous or remote-controlled, high precision, ideal for mobile/time-sensitive targets

Role in Operation Sindoor: Provided real-time surveillance and precision strikes, enhancing the effectiveness of missile attacks

5. Meteor (BVRAAM)

Type: Beyond Visual Range Air-to-Air Missile

Origin: Europe (MBDA)

Range: 100+ km

Technology & Features:

- ❖ Solid-fuel ramjet for sustained high speed
- ❖ Advanced active radar seeker, large no-escape zone, effective in electronic warfare

Role in Operation Sindoor: Provided air superiority and interception capability, protecting strike aircraft from enemy fighters