General Science

Short Answers

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Defence Technology

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CHAPTER 5: DEFENCE SECTOR TECHNOLOGY

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5.1 INTRODUCTION TO DEFENCE SECTOR TECHNOLOGY

In the last century, Science has transformed the world in almost all areas of society. The importance of technology in the field of defence is well realised. In the era of atomic bombs, ballistic missiles, and space warfare no country's defence forces can be deprived of the latest technology for defence purposes. Defence Research and Development organization (DRDO) has provided India with some of the promising missile technologies and state of art defence capacities which has improved the defence preparedness of India.

However, India has still not achieved the goal of becoming self-reliant in Defence manufacturing and technology. It is still one of the largest importers of defence technology and is heavily dependent upon its strategic partners to fulfil its defence sector needs. This requires an urgent and sustained action and a long term blueprint for achieving self-reliance and self-capability in the defence sector.

DEFENCE RESEARCH AND DEVELOPMENT ORGANIZATION (DRDO)

It was established in 1958 by the Government of India, under the Ministry of Defence.

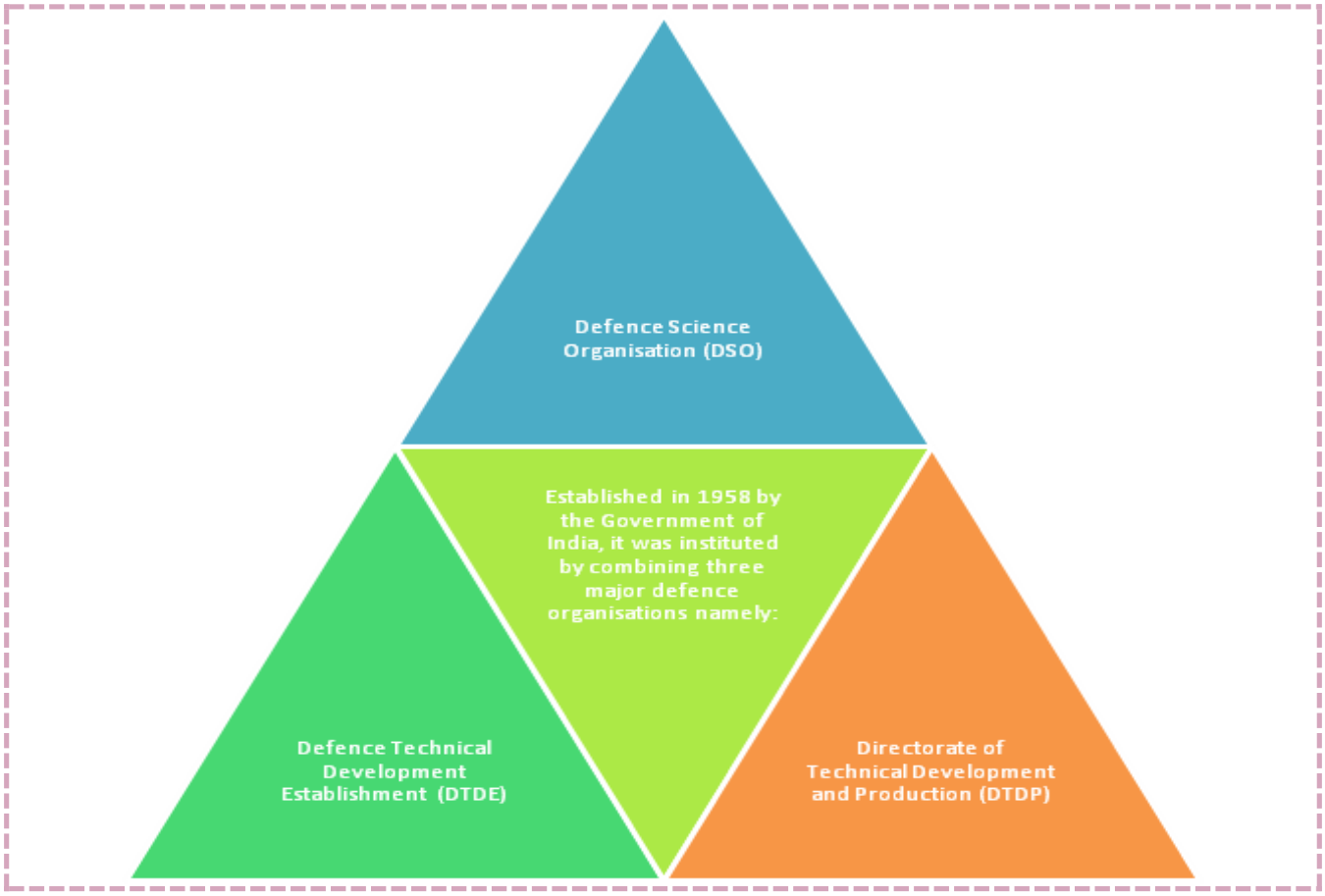


Fig 5.1: Defence Organisation

- With a project in 1960 on Surface to Air Missiles (SAM), the **Project Indigo** was the DRDO's first major defence project. This project was discontinued without any success.

Vision	Empowering the nation with state-of-the-art indigenous Defence technologies and systems.
Mission	Design, develop and lead to production state-of-the-art sensors, weapon systems, platforms and allied equipment for our Defence Services. Provide technological solutions to the Services to optimise combat effectiveness and to promote well-being of the troops. Develop infrastructure and committed quality manpower and build strong indigenous technology base.

DRDO is the Research and Development wing of the Ministry of Defence, Government of India. DRDO's pursuit of self-reliance and successful indigenous development and production of strategic systems and platforms such as Agni and Prithvi series of missiles; light combat aircraft, Tejas; multi-barrel rocket launcher, Pinaka; air defense system, Akash; a wide range of radars and electronic warfare systems; etc., have given quantum jump to India's military might, generating effective deterrence and providing crucial leverage.

Today, DRDO is a network of more than 50 laboratories which are deeply engaged in developing defense technologies covering various disciplines, like aeronautics, armaments, electronics, combat vehicles, engineering systems, instrumentation, missiles, advanced computing and simulation, special materials, naval systems, life sciences, training, information systems and agriculture.

To ensure private participation in defense technology development, DRDO engages with several private industrial units at regular intervals. Moreover, it takes up regular interactions with Confederation of Indian Industries (CII), FICCI, ASSOCHAM, etc.

5.2 MAJOR TECHNOLOGIES (DRDO)

Airborne Telemetry Receiving System:

Evaluation of medium and long-range missiles requires physical parameters of subsystems as well as navigational data acquired and recorded through telemetry. The instruments to be deployed for adequate coverage of the flight are ensured during launch, mid-course and terminal phases of the flight path. The tracking and telemetry systems deployed at the launch site ensure data reception requirements of launch and mid-course phases of the flight path. The maximum distance of signal reception is limited by the line-of-sight (LOS) conditions; the instruments located near the launch site will not be able to receive telemetry signals during the terminal phase of the flight path. To receive telemetry information in the final phase of trajectory, ship-borne measurement stations are deployed near the expected impact point.

However, the ship-borne instruments can receive telemetry data only up to a limited height above sea level because of the limitation of LOS. Also, for validation of anti-ship cruise missiles cruising at very low altitudes of approximately 5 to 10 m the conventional approach of ship-borne down range instrumentation will be less effective. To overcome the problems of reception of telemetry signals at low heights, DRDO has developed a comprehensive helicopter-borne measurement station to ensure the required range of straight visibility. Such systems available elsewhere are cost-prohibitive.

All Electric Type Weapons Control System For-ICV:

An all-electric type weapon control system with independent stabilization has been developed indigenously by DRDO in association with private sector industry for the turret of **Infantry Combat Vehicle (ICV), Abhay**. The purpose of an all-electric drive (AED) is to position the 40 mm main gun of Abhay on to the target in azimuth and elevation and to provide twin-axis stabilization to the weapon platform against external disturbances.

It is an electromechanical system, which uses brush-less drives with specially designed backlash-free elevation and traverse gearboxes. It employs vector control technology. It uses state-of-the-art fiber optic gyros as feedback elements for stabilization and has real-time connectivity with Fire Control System and Battlefield Management System.

The system has been tested onboard vehicles on cross-country and has been successfully test-fired on static targets. Being an indigenous development, AED can be suitably configured to drive and stabilize similar weapons/allied platforms.

Fig 5.2: ABHAY

(Image source: DRDO)

Salient Features	Provides fire on move capability	Operates in various mode	Inbuilt provision for equipment testing	Interlocks for safe operation	Dual control through gunner and commander joysticks with override facility to commander

Explosive Reactive Armours

These armors disrupt and defeat the shaped charge jet of anti-tank missile warheads effectively and also provide protection to tanks against KE threats as well as heat. Have Provision for fitment of reactive elements in panels without removing the panels, thus fast up arming of the tank.

Explosive Reactive Armour (ERA) Mk-I

ERA Mk-I for Tank T-72 M1(CI Ajeya) has been developed by HEMRL for protecting modern anti-tank guided missiles like MILAN. This technology has been transferred to Ordnance Factories for production.

Salient Features

- Modular type of configuration on hull glacis
- Reduces the penetration of Shaped Charge warheads by ~ 70%
- No sympathetic detonation between adjacent panels and minimum collateral damage
- Easy fitment and replacement
- Least sensitivity and safe to handle
- Effective even after deep fording.

Explosive Reactive Armour (ERA) Mk-II

- Integral type configuration on hull glacis, in which the panels have been welded on the tank surface and a window for positioning of reactive elements.
- Adaptable to all the three tanks i.e. T-72, T-90 and Arjun Mk-II of Indian Army
- No sympathetic detonation between adjacent elements inside the panel and immune to detonation against small arms
- Additional weight on one tank: 1.5T
- Effective even after deep fording
- The product has been accepted by the Users and likely to be inducted for fitment on MBT Arjun Mk-I A and import substitute for T-90 Tanks.

Light Combat Aircraft:

The maiden flight of Light Combat Aircraft Technology Demonstrator 1 took place in 2001 which was a significant development that led to the entry of Light Combat Aircraft into the flight test program of DRDO.

It is a light multi-role jet military aircraft most coming from advanced trainers that have been modified or designed for engaging in light combat missions, either in a light strike or attack missions, surveillance or interdiction roles while some are keeping its trainer role. They are also slower than their bigger aircraft and most capable of running at subsonic speeds though some are capable of reaching Mach 1+. It is generally used for self-defense purposes or anti-hostile aircraft/helicopter missions not for air defense as lightweight fighters do. These aircraft are usually smaller and more lightly armed than the bigger multi-role or strike aircraft.

The light combat aircraft program was started in 1983, and the Project definition phase was started in 1989 while the full-scale engineering development phase started in 1993. The development of light combat aircraft is taken up by Aeronautical Development Agency (ADA) which is responsible for the design, project monitoring and promoting the development of advanced technology related to light combat aircraft. The Principal Partner of LCA is Hindustan Aeronautical Limited (HAL).

Light Combat Aircraft -Tejas:

The Light Combat Aircraft (LCA) program was started by the Government of India in 1984 when they established the Aeronautical Development Agency (ADA) to manage the LCA program.

- LCA Tejas was designed and developed by India's HAL (Hindustan Aeronautics Limited).
- It replaced the aging Mig 21 fighter planes.
- It was in 2003 that the Light Combat Aircraft program was named 'Tejas' (meaning radiance in Sanskrit) by the then PM Atal Bihari Vajpayee.
- It is the second supersonic fighter jet that was developed by HAL (the first one being HAL HF-24 Marut).
- LCA Tejas is a single-engine multi-role light combat aircraft.
- It is the lightest and smallest multi-role supersonic fighter aircraft in its class.
- It is designed to carry a range of air-to-air, air-to-surface, precision-guided and standoff weaponry.
- Tejas has a single-engine, compound Delta wing and has a tailless design.
- The idea behind the LCA program was to expand and develop India's indigenous aerospace capabilities.
- Since the 1970s, the MiG 21 planes have been the mainstay of the Indian Air Force. The primary goal of the LCA program was to replace the ageing MiGs.
- The secondary goal was the advancement of indigenous domestic aviation capabilities.
- HAL plans to deliver 123 Tejas aircraft to the Indian Air Force by 2024-25.

Specifications:

Tejas has a maximum payload capacity of 4000 kg. It is a single pilot single-engine aircraft that has a maximum take-off weight of 13,300 kg. It can attend the maximum speed of Mach 1.8. It has a general range of 850 km and a combat range of 500 km.

Tejas is a low-cost aircraft with a simple design. Hence, it is very attractive to cost-conscious nations in Asia.

Although currently, Tejas is not sold to other countries, Singapore, Egypt, Sri Lanka, the UAE, Turkmenistan and Malaysia have expressed interest in acquiring this aircraft.

Variants of Tejas:

- **Tejas Trainer:** 2-seater operational conversion trainer for training air force pilots.
- **LCA Navy**: Twin- and single-seat carrier-capable for the Indian Navy. However, the Navy has declared that the Tejas is too heavy for it to be operational from aircraft carriers (like INS Vikrant, INS Vikramaditya, etc.)
- **LCA Tejas AF MK2**: This is an improvement over the LCA Tejas Mk1 with a higher thrust engine.
- **LCA Tejas Navy MK2**: This is phase 2 of the LCA Navy variant.

Main Battle Tank-ARJUN:

Main Battle Tank (MBT) Arjun is a multi-laboratory program of DRDO with CVRDE as the lead Laboratory. It is a state-of-the-art tank with superior firepower, high mobility, and excellent protection. Twelve Mk 1 prototypes of MBT Arjun have been manufactured and their performance tests have provided satisfactory results. Some of the breakthroughs achieved by CVRDE during the development of MBT Arjun are in Engine, Transmission, Hydropneumatic Suspension, Hull and Turret, and Gun Control System.

Salient Features

The superior armor defeating capability of the indigenously developed Fin Stabilized Armour Piercing Discarding Sabot (FSAPDS) ammunition and 120 mm caliber rifled gun give MBT ARJUN an edge over contemporary world tanks. A computer-controlled integrated fire control system incorporating a day-cum-night stabilized sighting system guarantees a very high first-round hit probability and reduced reaction time to bring effective fire on targets.

The stabilization system for the main armament, slaved to the sighting equipment in elevation and azimuth, with a high and accurate laying speed, allows fire on the move.

The superior firepower of MBT is based on:

- The rifled 120 mm ARJUN gun together with the newly developed super velocity ammunition, can defeat any contemporary armor used in tanks. The electro-slag refined gun steel tube is autofrettaged to withstand higher gas pressures. A thermal jacket prevents irregular temperature distribution on to the tube due to the weather influences.
- A coaxial 7.62 mm machine gun for anti-personnel and a 12.7 mm machine gun for anti-aircraft and ground targets are provided as secondary weapons.
- Gunner's Main Sight consists of a day-sight, thermal sight, a laser range finder, and a stabilized head common to all the three channels. The common sighting head mirror is stabilized in elevation and azimuth. The day- sight provides dual magnification.
- The thermal imager provides night vision facility to the gunner and the commander to observe and engage targets in total darkness and the presence of smoke, dust, haze and light camouflage. Integral with the main sight is the laser range finder by which targets can be ranged accurately.
- Commander's panoramic sight enables the commander to effect all-round surveillance on the battlefield without removing his eyes from the sight and without being disturbed by the turret motion. The field of view is stabilized with the help of a two-axis rate gyro-mounted on the platform of the head mirror. The sight offers dual magnification.
- Two types of ammunition, viz, FSAPDS and HESH have been developed for this armament. The highly lethal FSAPDS ammunition which is the main battle ammunition of the tank has accounted itself admirably during the trials. Besides, the anti-helicopter round to combat the air threat to armour is also under development.

- Low ground pressure, high power-to-weight ratio and new design concepts in transmission suspension and running gear result in a highly mobile and agile weapon platform.

The remarkable mobility of MBT which also adds to its protection is the result of:

- Due to the high power-to-weight ratio and low specific ground pressure, MBT is fast, highly maneuverable and extremely mobile to cross the most difficult terrain with ease. High acceleration rapid braking capabilities with excellent steering characteristics make MBT agile on the battlefield. Adequate fuel storage capacity and relatively low fuel consumption allow for an optimal operational range.
- An important criterion for the mobility of any AFV is the effective performance of the driver. Excellent vision systems both for day and night provide the most effective means of observation in all battlefield conditions. The need to keep the crew's fatigue including that of the driver at the minimum level over long periods of continuous operation has been taken care of.
- All-round protection from anti-tank ammunition is achieved by t~e newly developed KANCHAN armor to a degree much higher than available in present generation tanks. A high degree of immunity is achieved.
- Fire Power:-Accurate and fast target acquisition capability during day and night and in all types of weather
- Shortest possible reaction time during combat engagements.
- Ability to accurately engage targets on move.
- Capability to destroy all possible enemy armor at maximum battle ranges
- Excellent first hit probability.

5.3 INTEGRATED GUIDED MISSILES DEVELOPMENT PROGRAMME (IGMDP)

It was an Indian Ministry of Defence programme for the research and development of the comprehensive range of missiles. The programme was managed by the Defence Research and Development Organisation (DRDO) and Ordnance Factories Board in partnership with other Indian government organizations. The IGMDP project started in the year 1982–83 under the leadership of Abdul Kalam and completed in 2008 under his able leadership after these strategic missiles were successfully developed.

During the phase of 1980s, the Defence Research and Development Laboratory (DRDL) had developed competence and expertise in the fields of propulsion, navigation and manufacture of aerospace materials based on the Soviet rocketry technologies. Thus, India's political leadership, which included Prime Minister Indira Gandhi, Defence Minister R. Venkataraman, V.S. Arunachalam (Political Advisor to the Defence Minister), decided that all these technologies should be consolidated which led to the initiation of the Integrated Guided Missile Development Programme with Dr. APJ Abdul Kalam, to conceive and lead it. While the scientists proposed the development of each missile consecutively, the Defence Minister R. Venkataraman asked them to reconsider and develop all the missiles simultaneously. Thus, four projects, to be pursued concurrently, were part of IGMDP.

- PRITHVI- Short range surface-to-surface missile

- TRISHUL-Short range low-level surface-to-air missile
- AKASH- Medium range surface-to-air missile
- NAG- Third-generation anti-tank missile
- Agni Series of missile
- AGNI V-Long range intercontinental ballistic missile

Brief description of the missiles under the Integrated Guided Missile Development Development Programme:

1.PRITHVI

- Prithvi is a tactical surface-to-surface short-range ballistic missile (SRBM) developed by DRDO of India under the Integrated Guided Missile Development Program (IGMDP).
- It is deployed by India's Strategic Forces Command.
- It is the first in the series of missiles to be developed under the programme.
- The missile is capable of running on solid or liquid or both the fuels and carries nuclear warheads.

The Prithvi project encompassed developing three variants for Army, air force and Indian Navy.

Fig 5.3: Prithvi Projects

Dhanush

Dhanush is a variant of the surface-to-surface or ship-to-ship Prithvi III missile, which has been developed for the Indian Navy. It is capable of carrying both conventional as well as nuclear warheads with pay-load capacity of 500 kg-1000 kg and can strike targets in the range of 350 km

2. AKASH MISSILE:

Two rounds of medium range nuclear capable surface-to-air missile Akash was test fired successfully from a defence test facility off the Odisha coast against two unmanned aerial vehicles.

- The Akash missile is capable of engaging aerial threats upto a distance of approximately 25 kms.
- The Akash missile having a multi target, multi directional, all weather air-defence system consisting of surveillance and tracking radars, could take off at a speed of around 2.5 Mach and reach a high altitude of 18 kms and as low as 30 meters.
- The missiles were test fired against a Pilot less target aircraft (PTA) , Unmanned Aerial Vehicle (UAV) and Para-barrel, twice.
- More than 250 industries are involved in the production and supply of various subsystems/components with military/aerospace grade quality and ground systems developed by the DRDO for Akash missile.

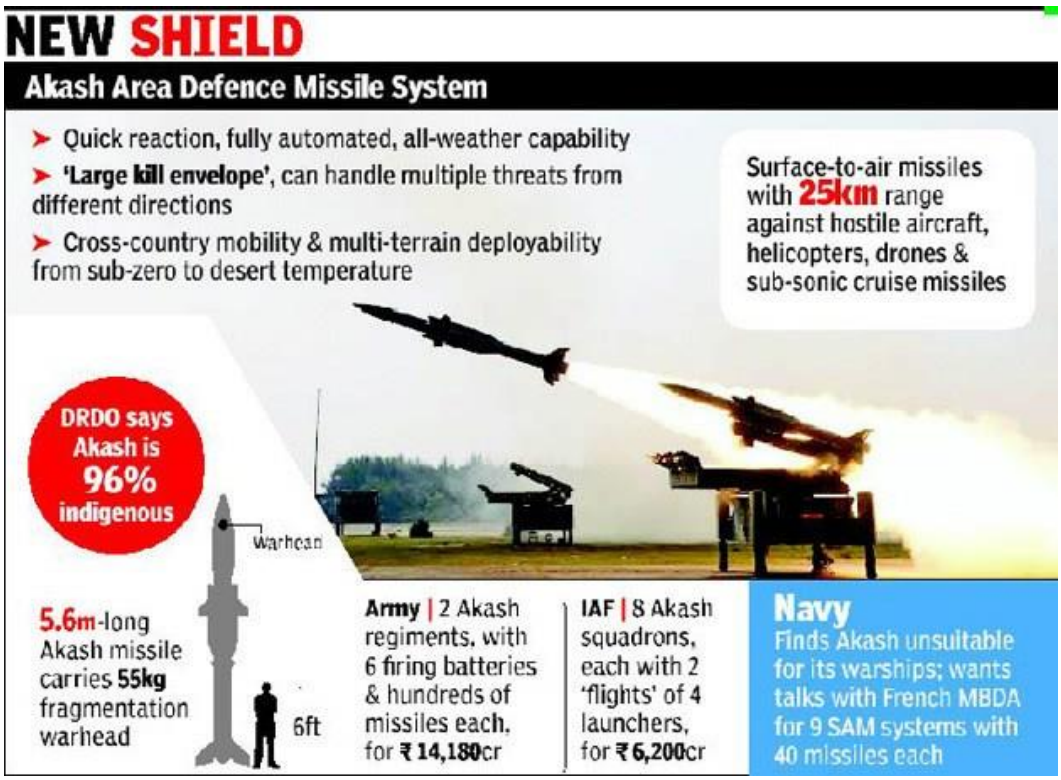


Fig 5.4 Akash Missile

(image source :The Hindu)

3. NAG (ANTI TANK GUIDED MISSILE):

NAG is an anti-tank guided missile that can destroy enemy tanks miles away. It is the world's finest all-weather missile with day and night capabilities that comes in four variants that are capable of being launched from land and air.The fire-and-forget missile is developed by DRDO under the integrated guided missile development programme (IGMDP).

NAG has a minimum range of 500 metres and a maximum of 20 km, depending on the launch type. Its top speed is 230 meter/second

- it is a fire-and-forget, lock-on-before-launch missile.

- The missile locks the target before its release.
- NAG missiles can locate the enemy tanks with the help of thermal imaging and After identifying the target, a thermal reference image of the target is captured and locked into the Nag's seeker system.
- The missile is launched towards the locked target with this reference image.As the missile moves towards the target at a high speed, it keeps capturing target images and cross-check it simultaneously with the reference image.
- Any deviations from the set path is corrected through Nag's four control fins. It all happens at a very high speed of 230 meter/second and within a range of 4-20 km, depending on the launch type.

Fig 5.5: NAG anti-tank guided missile

(*Image source: DRDO)*

NAG VARIANTS:

Prospina	**HELINA**	**Man Portable Anti-tank Guided Missile (MPATGM)**
Prospina with range 500m-4km, is the land version meant for infantry, and can be launched from a tracking-cum-launch vehicle known as NAMICA	It is a helicopter-launched version of NAG with an extended range of 7 to 10 km. The launch system is mounted on HAL "Rudra" helicopter	This version is lighter (14.5 kg) in comparison to other variants and can be launched from the shoulder. It has a strike range of

(Nag Missile Carrier). The launch system is mounted on light infantry vehicle BMP-2 and can carry up to six missiles. Each launcher can fire four missiles in one minute..	using "Rudrastra" twin-launcher system and HAL Light Combat Helicopters. The launch system is used by both the Indian Army and Air Force. **Helina (SANT) (15-20 km):** This is an upgraded version of the third-generation Helina with an extended range. The higher range and a new nose-mounted radar seeker help the missile launch platform stay at a safe distance, to evade enemy fire	2.5 km.

4. TRISHUL:

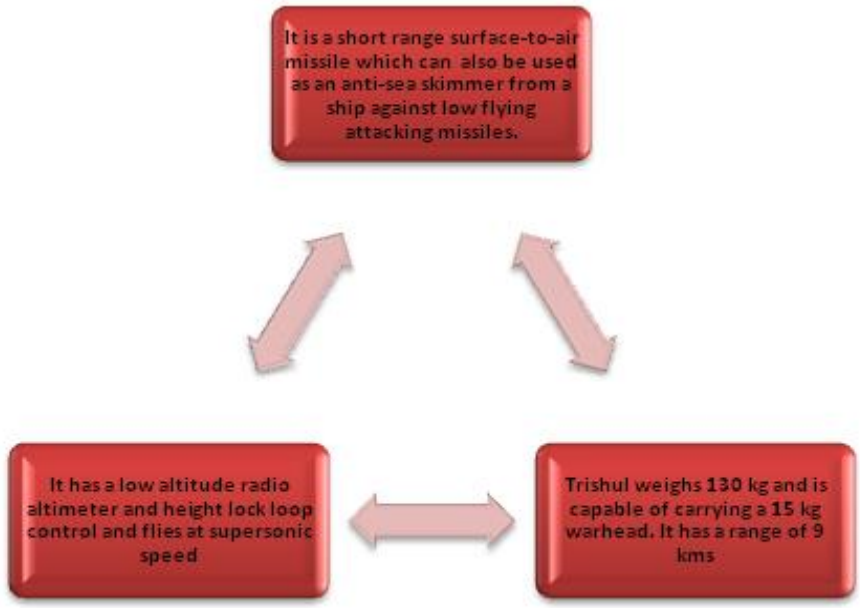


Fig 5.6: Trishul

5. AGNI :

The Agni missile series comprises medium and Intercontinental range ballistic missiles developed by the Defence Research and Development Organisation (DRDO), India. Agni missile systems are long-range ballistic missiles capable of carrying nuclear warheads.

The technology demonstrator version of Agni was the first missile of the series which was developed under the integrated guided missile development programme and was tested in 1989. The Agni series of missiles comprises 6 variants namely Agni-I, Agni-II, Agni-III, Agni-IV, Agni-V, and Agni-VI.

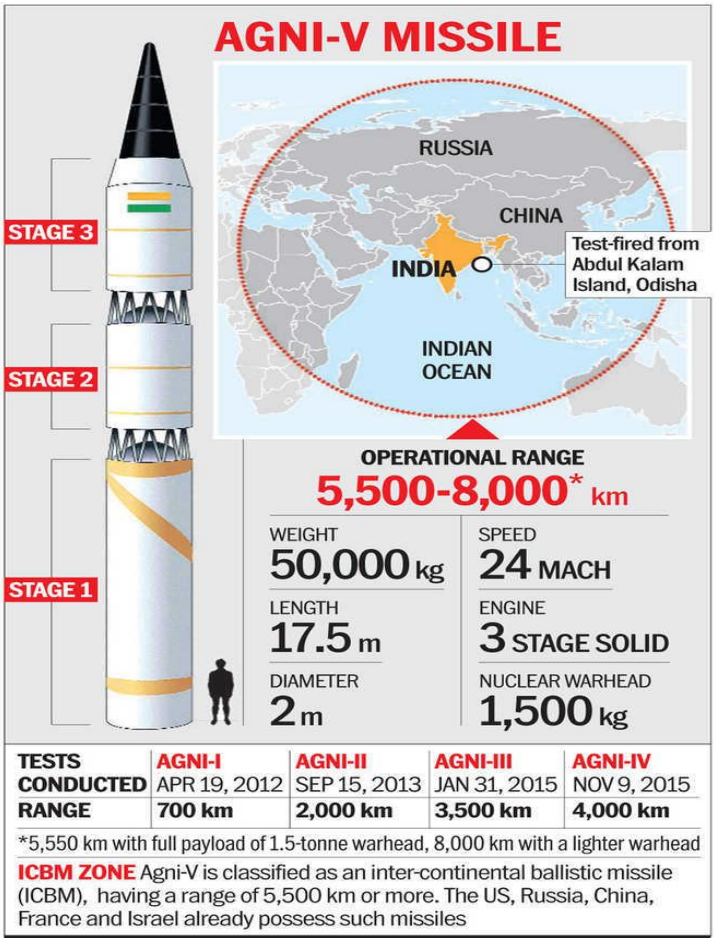


Fig 5.7 Agni V and other Agni Series

(*Image source*: tribuneIndia.com)

AGNI SERIES MISSILES:

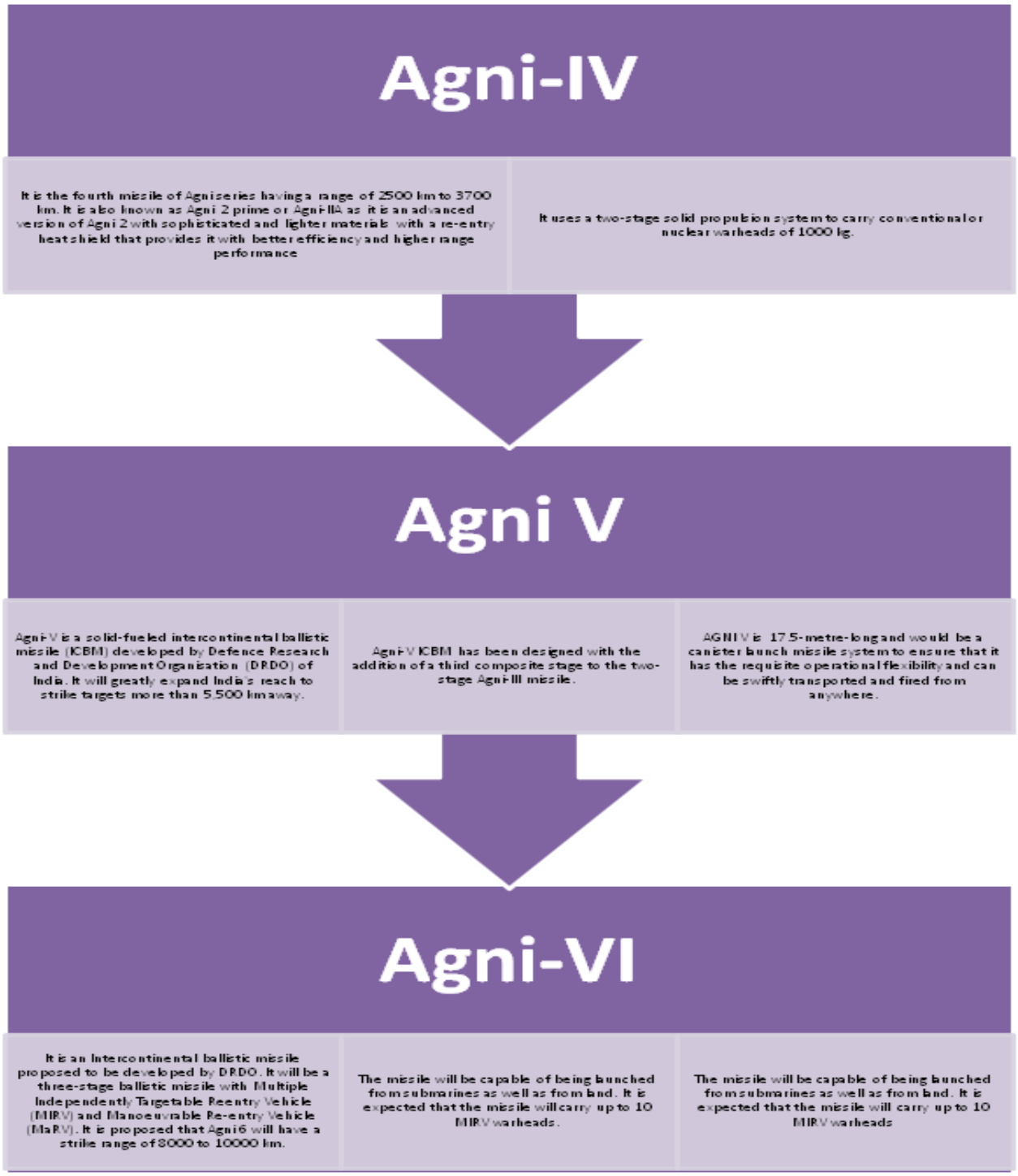


Fig 5.8 Agni series Missiles

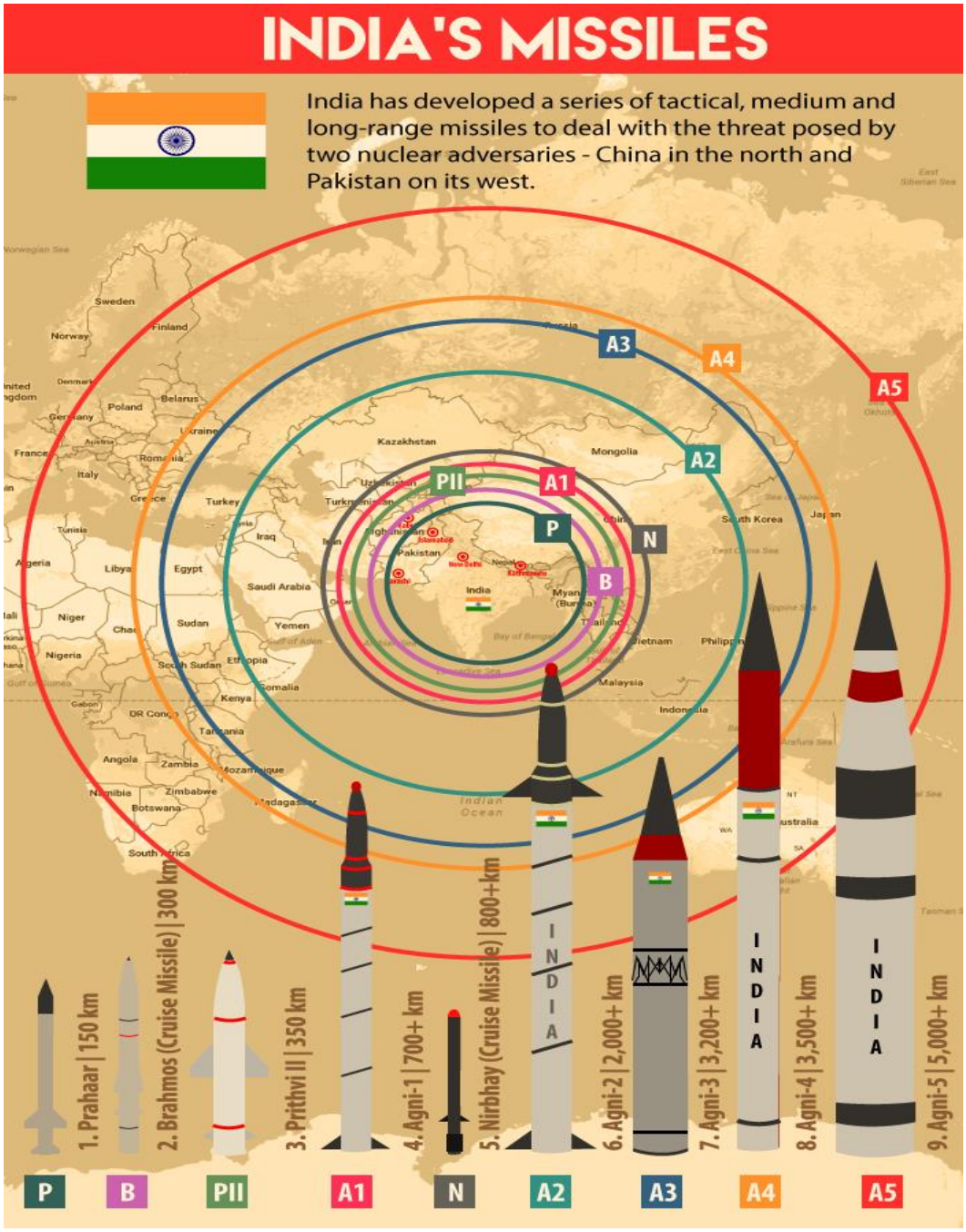


Fig 5.9 Missiles of India

(Image source:India.com)

5.4 OTHER MISSILES BY DRDO

1. NIRBHAY MISSILE

- Nirbhay is an all-weather low-cost, long-range subsonic cruise missile with stealth and high accuracy designed and developed in India by the DRDO.

- The missile has a range of more than 1000 km. It weighs about one tonne and has a length of 6 meters.
- Its relatively slow flight speed allows it to navigate its way precisely to the target.
- The Nirbhay cruise missile is an Indian version of the American Tomahawk.
- The missile is capable of being launched from multiple platforms on land, sea and air.
- 'Nirbhay' missile can travel with a turbofan or turbojet engine and is guided by a highly advanced inertial navigation system indigenously developed by the Research Centre Imarat (RCI),
- The cruise missile is expected to supplement the Indo-Russian joint venture supersonic cruise missile BrahMos, which can carry warheads up to 290 kilometers.
- In particular, Nirbhay is being adapted for the Indo/Russian Su-30MKI. The missile is capable of carrying nuclear warheads.
- With two side wings, the missile is capable of flying at different altitudes ranging from 500 m to 4 km above the ground and can also fly at low altitudes (like low tree level) to avoid detection by enemy radar.

2. K-MISSILE FAMILY

The K family of missiles named after Indian scientist and former president A. P. J. Abdul Kalam is a series of submarine-launched ballistic missiles (SLBM) developed by India to boost its second-strike capabilities and thus augment its nuclear deterrence. Information about this family of missiles has mostly been kept classified. The "K" missiles are believed to be faster, lighter and stealthier than their Agni missile family

The K missiles are being developed by DRDO in cooperation with Bharat Dynamics Limited, these missions are generally used by Indian Navy Services (INS).

K-15 /Sagarika	**K-4**	**K-5**	**K-6**
The Sagarika/K-15 missile is the SLBM version of the land-based Shaurya Missile. With a shorter range than K-4 missiles, it is to be integrated with Arihant class submarines concurrently developed for the use of Indian	K-4 is an intermediate-range submarine-launched ballistic missile under development by DRDO. It is a 10 m long missile weighing 20 tonnes, capable of carrying a 2-tonne payload up to a range of 3,500 km. INS Arihant,	K-5 missile is reportedly being developed by Defence Research and Development Organisation (DRDO) for the Indian strategic forces' underwater platforms. It will arm the future variants of Arihant class	K-6 missile is SLBM which is reportedly under development by Defence Research and Development Organisation (DRDO)'s Advanced Naval Systems Laboratory in Hyderabad. It is a three-stage solid-fuel MIRV capable missile with a

Navy. Sagarika/K-15 was developed at the DRDO's missile complex in Hyderabad. The complex consists of the Defence Research and Development Laboratory (DRDL), the Advanced Systems Laboratory (ASL) and the Research Centre, Imarat (RCI). DRDL designed and developed the missile, while the ASL provided the motors and propulsion systems. The RCI's contribution was in avionics, including control and guidance systems and inertial navigation systems. Medium range K-15 ballistic missile has a range between 700 km to 1,500 km with a varying payload. This will also get help from the Indian Regional Navigation Satellite System (IRNSS) to ensure guaranteed national access to precision navigation. These will enable high accuracy required for precision strike. The last developmental test of the missile was conducted on 28 January 2013 from an underwater launch	first of the Arihant Class Submarines, will be able to carry 4 K-4 missiles. The K-4 missile was successfully tested on 24 March 2014 from an underwater pontoon submerged 30 m deep. India successfully test-fired the 3,500 km strike range nuclear-capable K-4 submarine-launched ballistic missile off the coast of Andhra Pradesh on 19 January 2020	submarines of the Indian Navy. Reportedly, DRDO is in the process of developing a submarine-launched solid-fuel missile with a maximum range of 5,000 kilometres.	length of 12m, a width of 2m, a payload of 2-3 tonne warhead and a maximum range of 6,000 km. It will arm the S5 class of ballistic missile submarines of the Indian Navy.

platform off the coast of Visakhapatnam.			

These 'K' missiles are important for India's nuclear deterrence arsenal because they provide India with a much needed ideal and invulnerable second-strike capability stated in India's Nuclear Doctrine and thus shift the balance of power in India's favour in Asian region.

3. SHAURYA MISSILE

The Shaurya is a hypersonic surface-to-surface ballistic missile, developed by Defence Research & Development Organization (DRDO) of India.	The Shaurya is a 6.2 ft canister launched missile, with a 10 m length, and 0.74 m diameter with a range of 700 to 1 900 km and a payload weight of 180 to 1 000 kg. It can carry conventional or nuclear warheads.	It is a land variant of Indian K-15 submarine-launched missile. A number of tests were conducted before the missile was officially inducted into service in 2013. It Fulfils the tactical need of the country in offensive/defensive scenarios. The canister launch capability improves the mobility of the system even in rough terrains and bad weather.
The Shaurya uses a two stage propulsion system solid propellants to attain a speed of Mach 7.5 and altitude of 40 km. It has been incorporated with an advanced ring laser gyroscope, resulting in a good accuracy of 20-30 m CEP Circular Error Probable (CEP).	The two stage propulsion starts with the first stage solid fuel booster pushing the missile to a 5 km low atmospheric pressure altitude. At this point the second stage starts and an inter-stage coupling mechanism (softstage) separates the missile parts. The second stage payload rises to its flight altitude and conducts in-flight maneuvers to increase the accuracy before plummeting towards it during the atmospheric re-entry.	The SHAURYA missile has a hypersonic speed which offers minimal chance of getting destroyed by any interceptor missile. Also , the missile is highly maneuverable like a cruise missile and has reduced signature, rendering it invisible to the satellites to a very high extent.Further improvements to the missile system include better operational range, accuracy and increased payload capability.

4. BRAHMOS MISSILE

BRAHMOS is a two-stage missile with a solid propellant booster engine. The second stage or the liquid ramjet then takes the missile closer to 3 Mach speed in cruise phase. BRAHMOS has Stealth technology and guidance system with advanced embedded software

It has a flight range of up to 290-km with supersonic speed all through the flight, leading to shorter flight time, consequently ensuring lower dispersion of targets, quicker engagement time and non-interception by any known weapon system in the world.

It operates on 'Fire and Forget Principle', adopting varieties of flights on its way to the target. Due to large kinetic energy on impact, Its destructive power is enhanced. Its cruising altitude could be up to 15 km, and terminal altitude is as low as 10 meters. It carries a conventional warhead weighing 200 to 300 kgs.

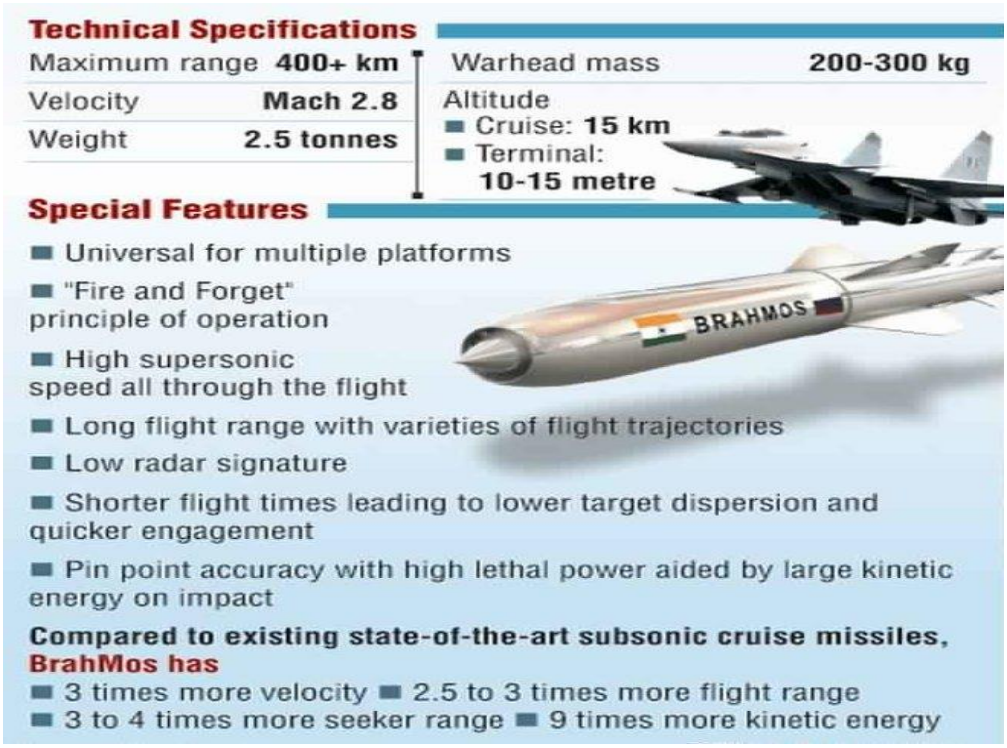


Fig 5.10 BrahMos Missile

(IMAGE SOURCE: THE HINDU)

Status:

BRAHMOS is the first supersonic cruise missile known to be in service. Induction of the first version of the BRAHMOS Weapon Complex in the Indian Navy commenced from 2005 with INS Rajput as the first ship. All future ships being built and ships coming for mid-life up-gradation will be fitted with the missile. The Indian Army has also inducted three regiments of BRAHMOS supersonic cruise missile.

In-Service:

Ship-based Weapon Complex (Inclined & Vertical Configuration)

Land-based Weapon Complex (Vertical Launch Configuration from Mobile Autonomous Launcher).

In Progress

Air launch version (successfully test-fired in 2017, creating history)

The canisterised missile is capable of being launched vertically from underwater and had been successfully flight tested from a submerged platform. Deployment depends on the requirement of the Indian Navy or navies of friendly countries.

The air-launched version has been developed and has lesser weight and additional rear fins for aerodynamic stability during separation from the aircraft during launch. The missile has gone through a complete cycle of ground trials. The required modifications in SU-30 MKI for interface with the missile launcher and integration with the weapon control of the aircraft are being carried out together with Indian Air Force and Sukhoi Design Bureau. The BRAHMOS missile created history on 22 November 2017 after it was successfully flight-tested for the first time from the Indian Air Force's (IAF) frontline fighter aircraft Sukhoi-30MKI against a sea-based target in the Bay of Bengal.

Difference Between Cruise And Ballistic Missile:

Cruise missiles are **unmanned self-propelled guided missiles** that can carry large payloads with high precision. The missile is guided entirely to the target under its power. These are known for their **low-level flight,** closer and horizontal to the surface which helps them to avoid detection from anti-missile systems. They can be launched from air, land, ship or submarine.

Based on the speed they can be categorized as Subsonic cruise missile (Speed around **0.8 Mach)**, Supersonic Cruise missile: Speed around **2-3 Mach**, Hypersonic Cruise Missile: Speed is more than **5 Mach.**

On the other hand, a ballistic missile follows **a ballistic trajectory (projectile trajectory)** over most of its flight path. Unlike cruise missiles that remain in the same atmosphere, a ballistic missile changes their atmosphere. It can **travel well outside the atmosphere** and then warhead detaches and falls back to the earth.

It depends upon gravity to reach its target.

With a high terminal speed of around **5000m/sec**, ballistic missiles have shorter time available making them **harder to intercept than cruise missiles. Ballistic** missiles flying over the atmosphere have **a much longer range than possible for cruise missiles of the same size.**

5. BRAHMOS II MISSILE

- BrahMos-II or BrahMos-2 or BrahMos Mark II is a hypersonic cruise missile currently under joint development by Russia's NPO Mashinostroyenia and India's Defence Research and Development Organisation, which have together formed BrahMos Aerospace Private Limited.
- It is the second of the BrahMos series of cruise missiles.
- The BrahMos-II is expected to have a range of 450 km and a speed of Mach 7.
- The missile will be propelled by a scramjet airbreathing jet engine During the cruise stage of flight the
- It is expected to be ready for testing by 2020.

6. ASTRA MISSILE

- Astra is the Beyond Visual Range Air to Air Missile (BVRAAM) developed by DRDO (Defence Research and Development Organisation).

- It can engage aerial targets at a range of 80 km – 110 km. It has been integrated with Sukhoi 30 Mki, Mirage 2000, LCA, MiG-29 fighter aircraft.
- Astra is equipped with electronic counter-countermeasures to allow operation even during enemy attempts to jam the seeker using electronic countermeasures.
- It carries a 15 kg high explosive warhead activated by a proximity fuse.
- The maximum range of Astra is 160 km under the head-on chase mode and 40 km in tail chase mode.
- The maximum range is achieved when the missile launches from an altitude of 3 km . while from an altitude of 2 km, the range drops to 144 km and when it is launched from sea level, the range drops further to 121 km.

7. SOLID FUELLED DUCTED RAMJET (SFDR):

Defense Research and Development Organisation (DRDO) successfully flight tested the second indigenously developed 'Solid Fuel Ducted Ramjet (SFDR)' propulsion based missile system on 8th February 2019 from ITR, Chandipur, Odisha.

Details :

- It will facilitate the development of long-range air-to-air missiles in the country.
- The ramjet propulsion system used in it acts as an oxidizer, and the solid propellant reacts with the air flowing through a solid propellant duct.
- Ramjet uses the air as an oxidizer just like a jet engine, unlike conventional rockets that carry propellant and oxidizer. Therefore the weight of the fuel required is eliminated.
- The SFDR propulsion is designed in such a way that it allows for an up and down throttling.
- This further lets the missile to amplify its speed until it reaches the terminal phase of the flight.
- The speed increases until the point when sharp turns are required to search for highly maneuvering targets.

Background

- The first flight of SFDR, developed under a joint Indo-Russian R&D project, was tested in 2018. It had achieved the speed of Mach 3.
- The Indian SFDR will be used as variants of missiles such as the advanced version of ASTRA.

8. PRALAY MISSILE:

- It is a surface to surface solid fuelled guided short-range ballistic missile.
- The missile is based on the Prithvi Defence Vehicle, which is a part of the Indian Ballistic Missile Defence Programme.

- It carries a payload of 1 tonne and can strike targets ranging up to 350 km away.
- It can travel up to 500 km if the payload is halved.
- It can evade ballistic missile defense systems and can fly faster than the conventional missiles in its class.
- It can be launched from its own canister-based transport erector launcher.

9. ASHWIN/ADVANCED AIR DEFENCE (AAD):

- It is a single-stage solid rocket propelled guided missile consisting of Akash missiles.
- It is capable of endo-atmospheric interception that is; to intercept incoming ballistic missiles at altitudes of up to 30km ().
- The AAD is equipped with an inertial navigation system, advanced computer and an electromechanical activator.

10. PRITHVI AIR DEFENCE (PAD) SYSTEM:

- The PRITHVI AIR DEFENCE will be able to tackle incoming missiles at ranges of 80-120 km (exo-atmospheric interception).
- It is also known as Pradyumna and comprises a two-stage missile based on the Prithvi missile.
- The first stage is liquid-fuelled, and the second stage is solid-fuelled.
- The missile is equipped with manoeuvre thrusters for lateral acceleration.
- It can engage the targets of the ballistic missiles up to a range of 300km-2,000km at a speed of Mach 5.
- It has a long-range tracking radar for target acquisition and fire control.

Note:- Both Advanced Air Defence and Prithvi Air Defence systems form part of India's Ballistic Missile Defence Programme.

5.5 MISSION SHAKTI

An Anti-Satellite (A-SAT) missile test named ‘Mission Shakti’ from Dr APJ Abdul Kalam Island in Odisha was conducted by Defence Research and Development Organisation (DRDO). DRDO-developed Ballistic Missile Defence (BMD) Interceptor Missile successfully engaged an Indian orbiting target satellite in Low Earth Orbit (LEO) in a ‘Hit to Kill’ mode. The interceptor missile was a three-stage missile with two solid rocket boosters.

It is a vindication of the strength and robust nature of DRDO’s programs and has also demonstrated the nation's capability to defend its assets in outer space.

India joins a select group of nations, which have such capability, with the launch of ANTI SATELLITE MISSILE. The test has once again proven the capability of indigenous weapon systems.

Anti-satellite (ASAT) System

- It is a missile-based system to attack moving satellites.
- It is of 2 kinds— based on launching from the ground or planes.

- Defense Research and Development Organisation (DRDO) has -developed an Anti-satellite (ASAT)completely indigenously.

Anti-satellite (ASAT) attacks can take a variety of forms and serve a range of goals. For example, they may cause temporary, reversible interference, or they may be intended to cause permanent damage. They may target the satellite, the ground station, or the links between them. They may be overt, or they may be intended to be covert and thus not attributable to the attacker. The ASAT system may be based on the ground or in space. It may be relatively simple or require sophisticated technology appropriate to a space-faring nation. It may be able to interfere only with satellites in low earth orbit, or it may reach all the way to geostationary altitude.

Details:

They are generally of two types: kinetic and non-kinetic.

Kinetic:- The kinetic ASAT systems must physically strike an object to destroy it. Examples of kinetic ASATs include ballistic missiles, drones that drag an object out of orbit or detonate explosives in proximity to the object, or any item launched to coincide with the passage of a target satellite.

This means any space asset, even a communications satellite, could become an ASAT if it is used to physically destroy another space object.

Non - Kinetic ASAT systems: A variety of nonphysical means can be used to disable or destroy a space object.

These include frequency jamming, blinding lasers or cyberattacks. These methods can also render an object useless without causing the target to break up and fragment absent additional forces intervening.

ASATs can be used to intercept and jam communication or military satellites of enemy countries in the time of war and stop them from communicating with their soldiers. It can also be used to access critical information about troop movements or incoming missiles.

The anti-satellite weapons can even undertake pellet cloud attacks on the enemy's low orbit satellites. Other ASAT capabilities include cyber-attacks on space systems, Electro-Magnetic Pulse (EMP) explosion devices, directed energy (laser-based) weapons and targeted missiles for the destruction of satellites to sabotage the enemy's military operations. Although no ASAT system has yet been put to use in the actual war, several nations have shot down their own (defunct) satellites to exhibit their ASAT prowess in a show of power.

The range of an ASAT is limited and depends on where it is launched from. Satellites above the range of 20,000 kilometers are out of range. The US and Russia have the capabilities of launching an ASAT from the ship, land and space, while India, presently, has used a land installation.

5.6 AIRBORNE EARLY WARNING AND CONTROL SYSTEM (AEWC)

The Airborne Early Warning and Control System (AEW&C) in IOC configuration was developed by DRDO and handed over to the Indian Air Force (IAF), on 14 February during Aero India 2017 at Yelahanka Airbase in Bengaluru, and it was named **NETRA.**

Significance of the system

- The Airborne Surveillance System will transform the trajectory of air warfare.

- The AEW&C system has a state-of-the-art Active Electronically Scanned Radar, Secondary Surveillance Radar, Electronic and Communication Countermeasures, LOS (Line of Sight) data link, voice communication system and self-protection suite.
- A Complex tactical software has been developed for the fusion of information from the sensors, to provide the air situation picture along with intelligence to handle identification/classification threat assessment.
- Battle management functions are built in house to work as a network-centric system of Integrated Air Command & Control System (IACCS) node.
- This system has been developed and evaluated through collaborative efforts between DRDO and the IAF, with coordination for certification clearance and quality assurance by CEMILAC and DGAQA.
- The AEW&C system has undergone all weather and environmental trials and has been accepted by the IAF for induction.

5.7 ADVANCED LIGHT HELICOPTERS (ALH)

This program is an indigenously designed and developed 5.5-ton class multirole helicopter by RWRDC, HAL, Bengaluru. The Initial Operational Clearance (IOC) for helicopters was issued in 2001. The variants of the helicopter-like ALH Mk-I, ALH Mk-II, ALH Mk-III and ALH Mk-IV Rudra have been certified and cleared for operational use in various configurations like wheeled and skid versions.

The indigenously designed and developed Advanced Light Helicopter (ALH-DHRUV) is a twin-engine, multi-role(an aircraft that can perform multiple roles; such as -air to air combat, reconnaissance, electronic warfare etc) and multi-mission new generation helicopter in the 5.5-ton weight class.

The basic Helicopter is produced in a skid version and wheeled version. Dhruv is “type –Certified” for Military operations by the Centre for Military Airworthiness Certification (CEMILAC) and civil operations by the Directorate General of Civil Aviation (DGCA).

Certification of the utility military variant was completed in 2002 and that of the civil variant was completed in 2004. The deliveries of production series helicopters commenced from 2001-02 onwards. A total of 228 Helicopters have been produced by March 2017 including 216 for the Indian Armed Forces.

The major variants of Dhruv are classified as Dhruv Mk-I, Mk-II, Mk-III & Mk-IV.

5.8 SUBMARINES IN INDIA

A submarine is a watercraft that can travel and operate underwater. These are fully autonomous craft, capable of renewing its power and breathing air. Submarines are usually large crew vessels that can remain submerged for several weeks and even months.

Program for indigenous development of submarines was envisaged in India right in the 1990s which ultimately led to the culmination of several projects and acquisition of submarines from strategic partners. Indian Navy currently has 15 submarines in total and 2 more to join in this year. Indian Navy has 2 nuclear submarines- **INS Chakra** and **INS Arihant**

NUCLEAR POWERED SUBMARINES:

AKULA CLASS:

The construction of Akula II began in 1991, but it was suspended for ten years due to a lack of funds. A new Akula II submarine, the SSN Nerpa, for ten years was leased by the Indian Navy after signing an agreement with Russia. The vessel was commissioned to the Russian Navy in December 2009. The submarine, renamed INS Chakra, was recommissioned by the Indian Navy in April 2012.

The submarine has a double-hulled configuration. The very low acoustic signature has been achieved by incremental design improvements to minimize noise generation and transmission – for example, the installation of active noise cancellation techniques.

The Akula Class carries up to 12 Granit submarine-launched cruise missiles. The missiles are fired from the 533mm torpedo launch tubes. Granit (Nato designation: SS-N-21 Sampson) has a range of about 3,000km and delivers a 200kt warhead. The land-attack Granit missile uses inertial and terrain-following guidance.

The submarine's anti-ship missiles are the Novator SS-N-15 Starfish and the Novator SS-N-16 Stallion. The Starfish, fired from the 533mm tubes, has a target range of 45km. The Stallion, fired from the 650mm tubes, has a longer range of up to 100km. The submarine has eight torpedo launch tubes, four 650mm and four 533mm tubes.

The Akula can launch a range of anti-submarine and anti-surface vessel torpedoes. The Akula's surface search radar is the Snoop Pair or the Snoop Half.

The submarine is fitted with the MGK 540 sonar system which provides automatic target detection in broad and narrow-band modes by active sonar. It gives the range, relative bearing and range rate. The sonar system can also be used in a passive, listening mode for the detection of hostile sonars. The sonar signal processor can detect and automatically classify targets as well as reject spurious acoustic noise sources and compensate for variable acoustic conditions.

ARIHANT CLASS:

INS Arihant class is the lead ship of India's Arihant class of nuclear-powered ballistic missile submarines.The 6,000-tonne vessel was built under the Advanced Technology Vessel (ATV) project at the Ship Building Centre in the port city of Visakhapatnam. It has the code name S2. The vessel is classified as a Strategic Strike Nuclear Submarine by India.

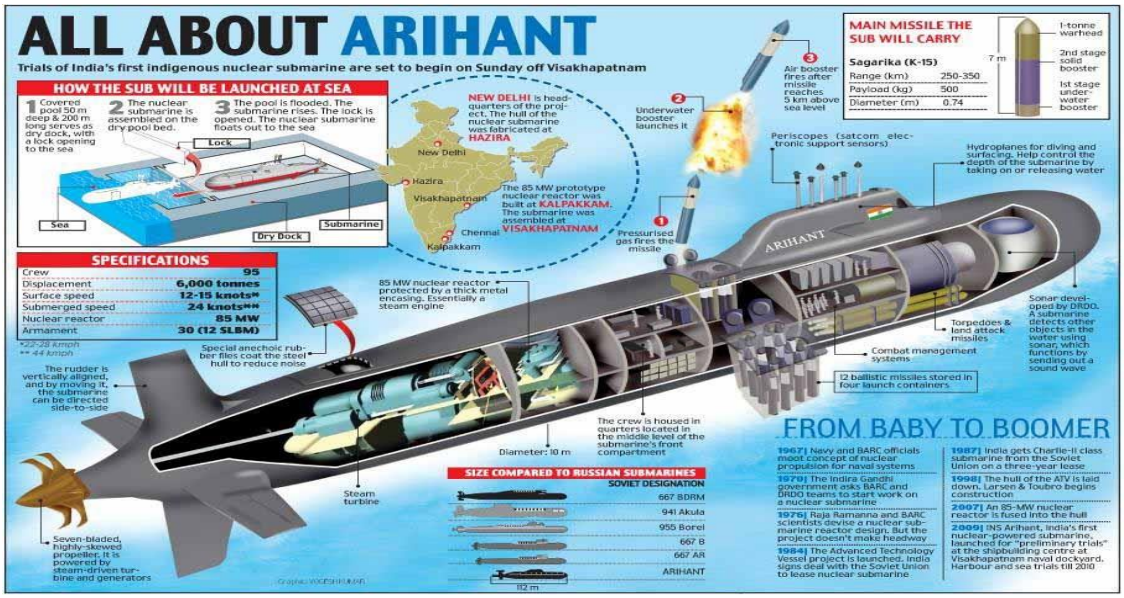


Fig 5.11 Arihant

(Image source:defense 24.pi)

ARIGHAT:

INS Arighat which was previously called Aridhmaan is the second Arihant-class submarine. It is the second nuclear-powered ballistic missile submarine being built by India. It is being built under the Advanced Technology Vessel project to build nuclear submarines at the Ship Building Centre in Visakhapatnam.

CONVENTIONALLY POWERED SUBMARINES

This class of submarines run on diesel and electricity. They have a huge network of batteries which depend on the diesel generator for charging. These subs have to surface to charge their batteries. They can also **snorkel**, which means to travel just below the surface of the water with the periscope and the exhaust pipe above the water surface. Since they become vulnerable when they surface, these subs usually snorkel while charging their batteries. Once they charge the batteries, they dive into the ocean and run silently on battery power with the diesel generators shut down.

INS SHALKI:

- It is a shishumar class diesel electric submarine of Indian Navy
- It was the first ever submarine built in India and was launched in the year 1987.

SHISHUMAR CLASS:

In December 1981 the Indian government reached an agreement with Howaldtswerke-Deutsche Werft, a German organization based in Kiel, for a four-section contract covering four conventional submarines of the Type 1500 variant of the very successful boats of the U-206 class.

The four Shishumar boats are the Shishumar, Shankush, Shalki and Shankul. Built in Germany the first two boats were laid down in May and September 1982 for launching in December and May 1984 and completion in September and November 1986, while the last two boats, built in India, were laid down in June 1984 and September 1989 for launching in September 1989 and March 1992 and completion in February 1992 and May 1994.

The submarines are basically conventional with a single central bulkhead, their most notable operational features being the provision of an IKL-designed escape system.

The eight torpedo tubes are all grouped in the bows, and provision is made for the embarkation of six reload torpedoes. The Shishumar started a mid-life refit in 1999, with the other boats following in order of completion, and improvements that may be retrofitted are French Eledone sonar and an Indian action data system.

SINDHUGHOSH CLASS SUBMARINE:

- These are the kilo class diesel-electric submarines in active service with the Indian Navy
- These were designed as part of Project 877, and built under a contract between the Rosvooruzhenie and the MINISTRY OF DEFENCE, INDIA .

- SINDHUGHOSH submarines have a displacement of 3,000 tonnes,top speed of 18 Knots, a maximum diving depth of 300 meters, and are able to operate solo for 45 days with a crew of 53. The final unit was the first to be equipped with the 3M-54 anti-ship cruise missiles with a range of 220 km.

DELHI CLASS DESTROYER

The Delhi class are the third largest Naval warships built by the Mazagon Dock Limited, Mumbai. These destroyers have the facilities which can help them to act as a command unit and the Delhi class are equipped with facilities to operate in a nuclear, biological and chemical Warfare environment. Rafael Barak 1 air defence missile system will be deployed on these destroyers.

TIMELINE OF INDUCTION INTO SERVICE:

RAJPUT CLASS DESTROYERS:

Rajput class guided missile A frigate is a type of warship, having various sizes and roles over time destroyers are the modified versions of Soviet Kashin class destroyers built for the Indian Navy. The Other destroyers of 10 class include INS Rana, INS Ranjit, INS Ranvijay, and INS Ranvir.

Rajput class destroyers have anti-aircraft and anti-submarine warfare abilities for aircraft carrier task force for defending against submarines, cruise missiles, and low flying aircrafts.Rajput class destroyers were the first Naval warships to deploy Brahmos Supersonic Cruise missiles.

FRIGATES OF NAVY

SHIVALIK CLASS FRIGATES:

The Shivalik class or Project 17class FRIGATES largest currently in service with the Indian Navy. INS Shivalik is the first ship of this class and it is also the first naval warship built with stealth features in India. It was commissioned in the Indian Navy in April 2010

The three ships of this class are ;

- INS Satpura,
- INS Sahyadri and
- INS shivalik

built by Mazagon Dock Limited in Mumbai.

The armaments and defence systems of this class of frigate include surface to air missiles, medium range missiles, Brahmos anti-ship cruise missiles, torpedo launchers etc The successor of this class of frigates known as the project 17A has been started with the construction of its first ship in 2017.

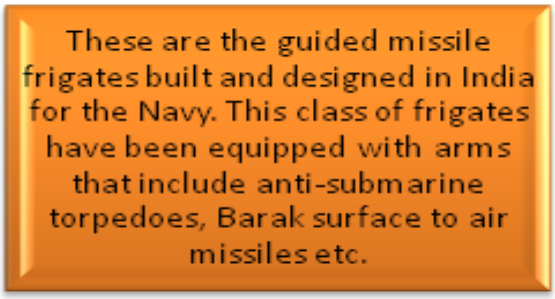
TALWAR CLASS FRIGATES

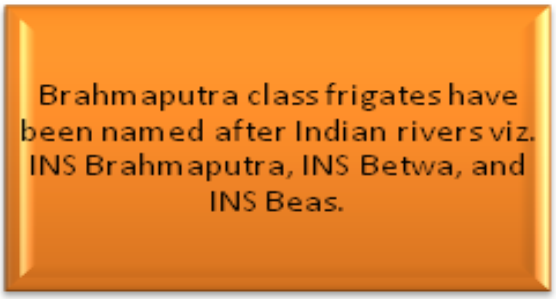
Talwar class are guided missile frigates ,that are designed and built by Russia for the Navy and consist of a number of systems of Indian design in manufacture such as communication equipment, anti-submarine sensors etc.Talwar class has a displacement of 4000 tons with a speed of 30 knots. The talwar class frigates can be used for a variety of missions. INS Talwar, INS Trishul, INS Tarkash, INS Trikand, and INS Tabar are frigates of this class.

GODAVARI CLASS FRIGATES

Godavari class are guided missile frigate that are built under project 16 for the Indian Navy
The only ship of this class currently in service are- INS Ganga and Gomati

BRAHMAPUTRA CLASS FRIGATES





CORVETTE

- It is the smallest class of vessels which is considered as a proper naval warship.
- A Corvette vessel is larger than a Coastal Patrol vessel and smaller than a traditional Frigate combat vessel.
- Five different classes of Corvette vessels are operated by INDIAN NAVY viz. Kamorta class, Kora class, Khurki class, Abhay class, and Veer class.

PATROL VESSELS

- It is a relatively small naval vessel designed for coastal defense duties.
- Patrol vessels consist of many designs
- They are generally used by the nation's navy, coast guard, police force, or customs and may be intended for marine or estuarine or river environments.
- They are commonly found engaged in various border protection roles, including anti-smuggling, anti-piracy, fisheries patrols, and immigration law enforcement.
- Patrol vessels often participate in rescue operations.

AIRCRAFT CARRIER

An aircraft carrier is a naval warship from which the fighter jets and airplanes may take off and land on them. It serves as a seagoing airbase and allows the naval force to project air power worldwide without the requirement for local bases for aircraft operations.

INS VIKRANT

- INS Vikrant was the first aircraft carrier to ever grace the arsenal of the Indian Navy.
- Initially starting life as the HMS Hercules of the British Royal Navy, the ship was re-christened as ‘Vikrant’ after purchase by the Indian Navy.

- The construction aircraft carrier began when World War II was in full swing, but would not be completed even after the end of the conflict.
- The incomplete ship was sold to the Indian Navy in 1957, who would finish its construction by the year 1961.
- INS Vikrant measured a length of 700ft, with a beam of 128 ft wide, considerably shorter than her sister ship, the INS Viraat, at 748 ft in length and 160 ft in width. The INS Vikrant was a bridge between full-sized fleet carriers and smaller, more economical escort carriers. In other words, INS Vikrant can be categorized as a "light fleet carrier". Formally, INS Vikrant falls under the Majestic-class of aircraft carriers.
- The indicated horsepower of the ship totaled up to 40,000 (30,000 kW). It gave a speed of 25 knots which is about 46 km/hr. INS Vikrant could house about 1100 officers, men and aircrew.

INS VIKRAMADITYA

- INS Vikramaditya is the Indian Navy's largest short take-off, but assisted recovery (STOBAR) aircraft carrier and warship converted from the Russian Navy's decommissioned Admiral Gorshkov vertical take-off and landing (VTOL) missile cruiser carrier. INS Vikramaditya was commissioned into service in November 2013.
- The warship has been extensively refurbished with new propulsion systems, hull sections, sensors and flight deck. It was operationally deployed with a full complement of MiG-29 aircraft in May 2014.
- The vessel can carry more than 30 long-range multi-role fighters with anti-ship missiles, air-to-air missiles, guided bombs and rockets. The aircraft aboard the carrier include MiG 29K / Sea Harrier combat aircraft, Kamov 31 radar picket Airborne Early Warning (AEW) helicopter, Kamov 28 naval helicopter, Sea King helicopter, ALH-Dhruv, and Chetak helicopter.

5.9 UNMANNED AERIAL VEHICLE OF INDIA

The unmanned aerial vehicle (UAV) also known as a drone is an aircraft that works without a human pilot on board. The Unmanned Aerial Vehicles are a component of an unmanned aircraft system and generally comprise UAV, a ground-based controller, and a system of communications between the two. The flight of UAVs may operate with various degrees of autonomous modes: either under remote control by a human operator or autonomously by onboard computers.

The Unmanned Aerial Vehicle generally fall in one of the six functional categories:

- Target and decoys
- Reconnaissance
- Combat
- Logistics

- Research and Development
- Civil and commercial services

NISHANT:

- Nishant is a multi-mission Unmanned Aerial Vehicle launched using a Mobile Hydro pneumatic Launcher with Day/Night capability used for battlefield surveillance and reconnaissance, target tracking & localization, and artillery fire correction.
- A sophisticated image processing system is used for analyzing the images transmitted from the UAV.
- The air vehicle has autonomous flight capabilities and is controlled from a user-friendly Ground Control Station.
- Nishant is a highly mobile, compact and easily deployable system.
- It is recovered with the Aero Conical Parachute and impacts the attenuation system.
- Onboard flight control and navigation system enable the aircraft to fly in autonomous WayPoint Navigation mode.
- Nishant has been inducted in the Indian Army.

RUSTOM-1 and 2

- RUSTOM-1 is an all-composite, 800 kg class Short Range Remotely Piloted Aircraft System (SR-RPAS) having capabilities of Intelligence, Surveillance, Reconnaissance, Target Acquisition/ Tracking and Image Exploitation.
- Rustom-1 is the first Indian RPAS to have conventional take-off and landing capability.
- It has autonomous flight mode and Get-To-Home features.
- Rustom-1 RPAS has completed 65 flights and demonstrated flight endurance of 10 hrs, a range of 200 km and an altitude of 20,000 ft.
- Up-gradation of SR-RPAS with Automatic Take-off & Landing (ATOL), Synthetic Aperture Radar (SAR) and Store carrying capability is achievable.
- **Rustom 2** is being developed on the lines of predator drones of the US to carry out Intelligent, surveillance and reconnaissance (ISR) roles for the armed forces with an endurance of 24 hours.
- **Rustom 2** is capable of carrying different combinations of payloads like synthetic aperture radar, electronic intelligence systems, and situational awareness payloads.

PANCHI

- Panchi is a variant of Nishant (launcher based tactical UAV) with the capability of conventional take-off and landing.
- Panchi is integrated with all composite landing gear and has improved flight envelope and endurance.
- Panchi carries a stabilized payload platform.

- It carries payloads like daylight camera, infrared camera and laser designator.
- It is powered with an indigenously developed rotary Wankel engine.
- It has state of art systems, capable of surveillance, reconnaissance, target location detection and artillery fire correction.
- Five flights of Panchi have been completed proving the concept of conventional takeoff and landing.
- Data for aerodynamic, structure integrity and Flight control studies have been generated and analyzed.

AURA

- It is an autonomous unmanned combat air vehicle, being developed by the DRDO for the Indian Air Force.
- The design work on the UCAV is to be carried out by the Aeronautical Development Agency (ADA).
- The details of this project are not open to the public.
- AURA is a self-defending high-speed reconnaissance UAV with weapon firing capability.

HERON

- The Heron (Machatz-1) is a medium-altitude long-endurance unmanned aerial vehicle (UAV) developed by Israel Aerospace Industries.
- India has imported Heron from Israel and it has been inducted in all the three services.

5.10 RECENT DEVELOPMENTS IN THE DEFENCE SECTOR

PRAHAAR MISSILE

- It is a surface-to-surface short-range tactical ballistic missile which was test-fired by DRDO from Chandipur, Odisha.
- It was reported that the missile traveled a range of 200 km before hitting its simulated target, thereby successfully achieving all mission objectives.
- It was developed by the Defence Research and Development Organisation (DRDO) the prahaar weapon system is capable of carrying several different warheads like nuclear, high-explosives (HE) and submunitions among others.
- Also, the Indian Army weapon is capable of engaging and successfully neutralising a wide range of targets in different directions.
- The Prahaar weapon system is 7. Kms long and has a body diameter of 0.42m, with a launch weight of 1,280kg

PRANASH MISSILE

India is working on a new tactical ballistic missile capable of striking targets at a range of 200km. The surface-to-surface missile, being developed by the Defence Research and Development Organisation (DRDO), has been named Pranash.

The new weapon traces its origin to the Prahaar missile developed by the DRDO. The Prahaar has a range of 150km but the army wanted a weapon with a better range, which is why Pranash is being developed.

P-8I MARITIME SURVEILLANCE AIRCRAFT:

- It is a long-range maritime surveillance aircraft used for reconnaissance and anti-submarine warfare.
- Indian Navy inducted this maritime surveillance aircraft which took off from the Seattle facility of Boeing.
- P-8I would be armed with torpedoes, rockets, and missiles to fight against warships and for anti-submarine warfare.

AIRCRAFT CARRIER - (VISHAL)

- INS Vishal, also known as Indigenous Aircraft Carrier 2(IAC-2), is a planned aircraft carrier to be built by Cochin Shipyard Limited for the Indian Navy.
- It is intended to be the second aircraft carrier to be built in India after INS Vikrant(IAC-1), and the first supercarrier to be built in India.
- The proposed design of the second carrier class will be new, featuring significant changes from Vikrant, including an increase in displacement.
- An Electromagnetic Aircraft Launch System (EMALS) CATOBAR system is also under consideration.

5.11 SCORPENE SUBMARINES (PROJECT-75)

- The Scorpene-class submarines are a class of diesel-electric attack submarine jointly being developed by the French DCN and the Spanish company Navantia and now by DCNS.
- It features diesel propulsion and an additional air-independent propulsion (AIP) system.
- The state-of-art features of the Scorpene include superior stealth and the ability to launch an attack on the enemy using precision-guided weapons.
- The attack can be launched with torpedoes, as well as tube-launched anti-ship missiles, underwater or on the surface.
- Designed to operate in all theatres including the tropics, the submarines can undertake multifarious missions including anti-surface warfare, anti-submarine warfare, intelligence gathering, operations by special forces and mine laying, etc.
- The Scorpene is believed to be stealthier than the average submarine because of its advanced combat management system and low acoustic signature.
- It also uses a noise-canceling technique, whereby its equipment is mounted on elastic to prevent noisy vibrations from traveling outside the vessel.
- Its body is also designed to be more difficult for sonar to detect.
- **Kalvari is the first of Indian Navy's Scorpene-class stealth submarines being built under the Project 75**.

The following submarine is proposed to be developed under Project 75

- INS KALVARI
- INS KHANDERI
- INS KARANJ
- INS VELA
- INS VAGEER
- INS VAGSHEER

5.12 GHATAK

It is a new engine that will power India's first unmanned combat aircraft, or drones capable of delivering bombs as well as tackling aerial threats, as part of a project that envisages major participation of the private sector.

Ghatak will be a derivative of the abandoned Kaveri project that had been in the works for over two decades. The key difference in the current plan is the proposed participation of the private sector in a significant way.

The Indian UCAV (Unmanned Combat Aerial Vehicle) project is tentatively called Autonomous Unmanned Research Aircraft (AURA). The target is to get the system operational within eight years once the funds are cleared by the government. The original Kaveri project was meant to power the light combat aircraft but it got shelved as the engine could not deliver sufficient thrust for the fighter aircraft. In its revived avatar, the engine will be modified and its afterburners will be removed to power the first Indian UCAV.

DEFENSE SPACE RESEARCH ORGANISATION (DSRO)

- Recently Cabinet Committee on Security Clear The Proposal To Setup DEFENCE SPACE RESEARCH ORGANISATION To Promote India's Space Warfare Capacity
- It Will Be A Technical and Research Report organization to its parent agency The Defence Space Agency
- It will be headed by a senior different scientist who will lead a team of other scientists
- The Organisation Will Be Charged With finding and implementing defense applications for the entire spectrum of space technology.