DEFENCE TECHNOLOGY

BY

Dr. Ravi P. Agrahari

(Faculty of KSG)

Topics of Discussion

1. Basics of Missiles
2. DRDO
2. IGMDP
3. Ballistic vs. Cruise Missiles

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Basics of Defence technology

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Study on the basis of Nature

1. Ballistic Missile

2. Cruise Missile

Study on the basis of distance

1. Short Range Missile

2. Medium Range Missile

3. Intermediate Range Missile

4. Intercontinental Missile

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Study on the basis of Speed

Mach No.: At 0 degree Celsius temperature Speed of sound in air = **332 m/s**

Subsonic: less than 1 Mach
Supersonic: more than 1 Mach – upto 5 Mach
Hypersonic: more than 5 Mach

Study on the basis of Launch

Surface to Surface Missile
Surface to Air missile
Air to Air Missile
Air to Surface Missile
Interceptor Missile
Anti-satellite weapons

DRDO (Defence Research and Development Organisation)

Defence Research and Development Organisation (DRDO) was established in 1958 by amalagamating Defence Science Organisation and some of the technical development establishments.

A separate Department of Defence Research and Development was formed in 1980 which later on administered DRDO and its 52 laboratories/ establishments.

DRDO started its first major project in **SAM (Surface to air missile)** known as **Project Indigo** in 1960s.

Indigo was discontinued in later years without achieving full success.

Project Indigo led to **Project Devil**, along with **Project Valiant**, to **develop short-range surface-to-air missile and ICBM in the 1970s**.

Project Devil itself led to the later development of the Prithvi missile Under IGMDP in the 1983.

Integrated Guided Missile Development Program (IGMDP)

The Government of India launched the Integrated Guided Missile Development Program in 1983 to ***achieve self sufficiency in the development and production of wide range of Ballistic Missiles****.*

IGMDP was an **Indian Ministry of Defence program** between the early 1980s and 2007 for the development of a comprehensive range of missiles, including the **Agni missile, Prithvi ballistic missile, Akash missile, Trishul missile** and **Nag Missile.**

Intermediate to long range missiles:

1. **Agni missile** (Surface to Surface)
2. **Prithvi missile** (Surface to Surface)
3. **Akash missile** (Surface to Air)
4. **Trishul missile** (Surface to Air)
5. **Nag Missile** (Anti Tank)

India on **07 may, 2008** announced the closing of the strategic integrated guided missile programme, and said the development and production of most of futuristic weapons systems would henceforth be taken up with **foreign partnerships**.

PRITHVI

Prithvi was the **first missile to be developed under the Program**.

DRDO earlier attempted to **reverse engineer** Surface-to-air Missile under **Project devil**.

The Prithvi missile project encompassed **developing 3 variants** for use by the **Indian Army, Indian Air Force** and the **Indian Navy**.

This class of **Prithvi missile was inducted into the Indian Army in 1994**.

Prithvi-I (SS-150)

Army Version

Range - 150 km
Payload - 1,000 kg
Single stage – Liquid
Note: Prithvi I missile will be replace by PRAHAR missile soon

Prithvi-II (SS-250)

Air Force Version

Range - 250 km
Payload - 500 kg
Two Stage – liquid and liquid

Prithvi-III (SS-350)

Naval Version

Range - 350 km ran
Payload - 1000 kg
Two stage – Solid and liquid

Pradyumna Ballistic Missile

The Prithvi Air Defense missile has been named as Pradyumna Ballistic Missile

Dhanush

Dhanush is reportedly a **naval version of Prithvi** which can be launched from Ships.

**Prithvi III** class (*codenamed* **Dhanush** *meaning* **Bow**) is a two-stage ship-to-surface missile.

The first stage is solid fuelled and the second stage is liquid fuelled

Trishul missile system

Short range
Surface-to-air missile
Range of 9 -12 km
Warhead 5.5 /15/130 kg

India had **officially shut down Trishul Missile project** on February 27, 2008.

Note :
Maitri Missile: In future it will take the place of Trishul missile due to its failure.
It is believe to be blend of French Mica and DRDO Trishul.

Nag missile

Nag is a third generation "Fire-and-forget" (Heat seek missile)
anti-tank missile developed in India
weight of 42 kg
Ranges 4–5 km.

The Nag is claimed to be first anti-tank missile which has a complete fiberglass structure.

The land version has been tested from a tracked vehicle known as **NAMICA (Nag Missile Carrier).**

Nag will be configured to be used on the Advanced Light Helicopter(ALH) and the HAL Light Combat Helicopter(LCH). This version will be known as
HELINA (HeliCopter Nag).

AGNI MISSILE

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Missile	Payload (Kg)	Range	Fuel stages
Agni - I	1000	700 - 1250	Single - solid
Agni - II	750 - 1000	2000 - 3500	Two - solid
Agni - III	2000 - 2500	3500 - 5000	Two - solid
Agni - IV	800 - 1000	3000 - 4000	Two - solid
Agni - V	1500	5500 - 8000	Three - solid
Agni - VI	1000	6000 - 8000	Three - solid

Akash missile system

Medium range
Surface-to-air missile
Intercept range of 30 km.
launch weight of 720 kg,
Diameter of 35 cm and a length of 5.8 metres.
Supersonic speed, reaching around **Mach 2.5**.
It can reach an altitude of 18 km.
Akash allows for **attacking multiple targets.**
The Akash missile's use of **ramjet propulsion system** allows it to maintain its speed without deceleration, unlike the Patriot missiles.
The missile is supported by a multi-target and multi-function phased array fire control radar called the '**Rajendra**' with a range of about 80 km in search.

Anti-ballistic missile system

A significant initiative to develop and deploy a multi-layered ballistic missile defence system to enable protection from ballistic missile attacks.

As a double-tiered system, it consists of two interceptor missiles, and includes:

1. **Prithvi Air Defence (PAD)** missile for **high altitude interception**
2. **Advanced Air Defence (AAD)** Missile for **lower altitude interception**

In November 2006, the PAD was tested which was followed by the AAD in December 2007.

India, emerged as the fourth country to have successfully developed anti-ballistic missile system, following United States, Russia, and Israel, after the test of PAD**.**

Advanced Air Defence (AAD)/ Ashwin Ballistic Missile Interceptor

Advanced Air Defence (AAD), an anti-ballistic missile, is designed for **intercepting incoming ballistic missiles** in the atmosphere at an altitude of 30 km.
AAD is a **single-stage, solid-fuelled missile.**

Sudarshan (laser-guided bomb)

In order to occupy the niche of a precision delivery mechanism, **India's first laser-guided bomb**, Sudarshan was developed.
It is the latest weapon system and can fit to a 1000-pound gravity bomb.

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Astra Missile

It is **a Air to Air Missile**, first indigenously developed and tested from a Sukhui – 30 MKL combat jet on 24 May 2014.

It **has a range of around 40 km. which will be extended to 100 km in the next phase.**

Aiming to arm the complete fleet of Air Craft with this Missile, including Sukhui, Tejas and Light Combat Aircraft.

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Shaurya Missile System

Short-range
Surface-to-surface
Ballistic missile developed by DRDO for use by the Indian Army.
Capable of **hypersonic speeds**
Range of **600 km**
Payload of one-tonne **conventional** or **nuclear warhead**
Many successful test happened.
The Shaurya missile provides India with a significant **second strike capability**.
The missile was tested in November 2008.
Shaurya missile is a land version of the under-water launched K-15 missile, Sagarika (missile).
Climbed to an altitude of 40 km and distance of this missile is 800 km with a speed of 7.5 times of sound speed.

Topics of Discussion

1. Cruise Missile
2. Nuclear Test
3. Nuclear Submarine
4. Frigates, Destroyer, Aircraft carrier
5. Different generation of Aircraft
6. Nuclear capable aircraft
7. Tejas
8. BWC and CWC
9. Tank

Cruise missiles

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Nirbhay

Subsonic cruise missile being developed in India.
All three platform - Army, Navy and Air Force**.**
India is said to be in the intermediate stages of developing a new cruise missile, Nirbhay.
The subsonic Nirbhay is said to be 6 m in length with a 520 mm diameter,
Warhead 1,000 kg and have a
Range 1,000 km range with a
Speed of 0.7 mach.

Klub

India acquired from Russia.
Range of 250 km-300 km
Average speed of .8 Mach
Maximum of 2.9 Mach

Popeye

India imported a large number of **Israel's Rafael made Popeye Missile in late 1999.**
Popeye II, an air launched cruise missile
Capable of carrying nuclear warheads with a
Range of 80 km can be launched from planes was given to India

Ametist

India has Soviet Ametist submarine - launched cruise missiles.
The missiles can carry nuclear warheads
Range of 50–65 km.

Moskit

Moskit is a Russian supersonic ramjet powered cruise missile
Capable of being launched from land and ships
India has most probably bought both land and ship variants
Range of 120 km

Brahmos

In **1998, the Government of India, signed an agreement with Russia** to design, develop, manufacture and market a Supersonic Cruise Missile System which has been **successfully accomplished by 2006**.

BrahMos is a **supersonic cruise missile** that can be **launched from submarines, ships, aircraft or land.**

At **speeds of Mach 2.5 to 2.8**, it is the world's fastest cruise missile and is about three and a half times faster than the American subsonic Harpoon cruise missile.

BAPL is contemplating a hypersonic **Mach 8 version of the missile, named as the BrahMos II.**

BrahMos II will be the first hypersonic cruise missile and is expected to be ready by 2020-21.

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Two rivers, the **Brahmaputra of India** and the **Moskva of Russia**.

The **ship-launched and land-based missiles can carry a 200 kg warhead**, whereas the **aircraft-launched variant (BrahMos) can carry a 300 kg warhead**.

It has a **two-stage propulsion system**, with a **solid-propellant rocket for initial acceleration** and a **liquid-fueled ramjet responsible for sustained supersonic cruise**.

The BrahMos is currently being configured for aerial deployment with the Su-30MKI as its carrier.

Nuclear Test

As early as 26 June 1946, Pandit Jawaharlal Nehru, soon to be India's first Prime Minister, announced.

India's first nuclear test occurred on 18 May 1974.

Since then India has conducted another series of tests at the Pokhran test range in the state of Rajasthan in 1998 – "**Operation Shakti**".

In 1998, as a response to the continuing tests, the United States and Japan imposed temporary economic sanctions on India.

India

Nuclear program start date	1967
First nuclear weapon test	18 May 1974 (Smiling Buddha)
First fusion weapon test	11 May 1998
Last nuclear test	13 May 1998
Total tests	6
Maximum missile range	3,500 km (Agni-III)

Nuclear submarines

India currently maintains six submarines of the Sindhughosh Class that can launch the nuclear-capable 3M-54 Klub cruise missiles.

Arihant class submarine

The **Arihant** class submarines are a class of nuclear-powered Ballistic Missile submarines being **constructed for the Indian Navy at Visakhapatnam**, **The first of these, INS Arihant was launched on 26 July 2009**

INS Cruise Missile Submarines

The **INS Sindhuraj, INS Sindhuvir, INS Sindhuratna, INS Sindhushastra , INS Sindhukesari** and **INS Sindhuvijay** are capable of launching 3M-54 Klub and BrahMos nuclear-capable cruise missiles.

Frigates, destroyers and aircraft carriers

Other than submarines, India also maintains ships such as destroyers, modified patrol crafts and frigates which can launch nuclear capable ballistic and cruise missiles.

Frigates: (small sized warshp)

A frigate is a medium – sized surface combat
between 2000 and 5000 tons
A frigate is generally the smallest surface combatant that can conduct extended blue-water missions in high-threat environment.

Destroyer: (large sized warship)

largest type of surface combatant.
5,000 to 10,000 tons
It is considered to be a ship that has all of the sensors, combat systems and weapons needed to operate in a high-threat environment.

AIRCRAFT CARRIER

Admiral Gorshkov

*K*iev class aircraft carrier of the **Russian Navy**,
Originally named ***Baku***.
Its Indian name is **INS *Vikramaditya***.
Sergey Gorshkov was responsible for the expansion of the Soviet Navy during the Cold War.

Different Generation of Aircraft

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1st generation (mid-1940s to mid-1950s)

Messerschmit Me 262, Mig -15, Mig - 17
Subsonic speeds, **straight wings**, **lack of radar**,
Machine guns as primary weapon and **unguided bombs**.

2nd generation (mid-1950s to early 1960s)

Mig-21, Su-9 and F-106, F-104 star fighter, F-5, MiG-19 and Sukhoi-7 etc.
Turbojet engines
Planes were **equipped with radars**, which gave the opportunity to **use the air-to-air missiles as a primary weapon**.
Aerodynamics engine, which allowed them to reach and sustain **supersonic speeds in level flight.**

Jet fighters into two categories:

Interceptors **(MiG-21, SU-9, F-106)** specialized in preventive missions against enemy bombers and aerial reconnaissance flights.

Second were **fighter-bombers** **(F-105, SU-7)** providing air superiority and ground attack.

Third generation aircrafts

Mirage F1, Mig-23, Mig-25, F-4 and f-5
Advance avionics, aerodynamics performance and
Air guide missiles, **air-to-air missiles and radar systems**.
However, **poor accuracy of weapons and**
Electronic countermeasure (device designed to track detection system) did not make it easy to win an air fight.

4th generation aircraft

Mig-29, Mig-27, Mirage-2000, Su-27, F-16, F-18
Fourth-generation jet fighter is a **general classification of jet fighters in service from approximately 1980 to present day**
Long-range air-to-air missiles

4.5th Generation Fighter Planes (late 1990s and into the 2005)

Eurofighter Typhoon, Saab JAS 39 Gripen and Dassault Rafale (Medium Multi-Role Combat Aircraft , MMRCA).

Active Electronically Scanned Array (AESA) radar was a significant enough game-changing combat capability.

Radar absorbent materials, thrust vector controlled engines, greater weapons carriage capacity (Supercruise).

Addition of Stealth technology

fifth-generation

Most advanced jet fighter generation as of 2015.
Stealth even when armed
Low probability of intercept radar (LPIR),
High-performance airframes,
Advanced avionics features, and
Highly integrated computer systems capable of networking with other elements within the battle space for situation awareness.
F-22 Raptor, F-35 Lightning II, Sukhoi PAK FA, Chengdu J-20 and **Shenyang J-31**

Nuclear-capable aircraft

India currently has Fourth generation jet fighters capable of launching nuclear weapons:

 # Sukhoi Su-30 MKI,
 # Dassault Mirage 2000 (French)
 # MiG-29
 # MiG-27
 # Hawk (Europe)
 # Tejas

Due to similar features and components, the MKI variant is often considered to be a customized Indian variant of the Sukhoi Su-35.

The **Mirage** 2000Hs were heavily customised during the Kargil War and is the only other version, other than the French 2000N, to be able to be armed with nuclear weapons.

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Both the **HAL Tejas** and **Su-30MKI can travel excess of 3,000 km without refueling;** this allows India to attack targets far away in an effective manner only using planes rather than delivery systems such as the Agni.

The **HAL Tejas** is **India's only indigenous plane to be armed with nuclear weapons**, thus making India less dependent on Russia.

India has leased four Russian **Tupolev Tu-22M3** bombers, **which could carry air-launched cruise missiles**. India has reportedly upgraded its Russian-built Tu-142 maritime patrol aircraft to carry air-launched cruise missiles.

TEJAS

The **HAL Tejas** is a **4.5 generation**
Lightweight, multirole jet fighter being developed by India. It is a tailless, compound delta wing design **powered by a single engine**.
Originally known as the **Light Combat Aircraft (LCA** named "*Tejas*" by then Prime Minister Atal Bihari Vajpayee.
Tejas notched a speed of over 1,350 km per hour, thus becoming the second supersonic fighter manufactured indigenously by Hindustan Aeronautics Limited after the HAL Marut.

1983: In a bid to replace the ageing Russian-designed MiG-21 aircrafts, the government launched the Light Combat Aircraft (LCA) programme.

1984: The government set up the Aeronautical Development Agency as the nodal agency to develop the LCA.

1986: An allocation of Rs 575 crores was made for the programme.

2009: LCA aircraft Tejas completed 1000 flights.

January 2015- Defence minister Manohar Parrikar handed over Tejas aircraft to Indian Air Force.

Chemical weapons

In **1992 India signed the Chemical Weapons Convention** (CWC), stating that it did not have chemical weapons and the capacity or capability to manufacture chemical weapons.

By doing this India became one of the original signatories of the Chemical Weapons Convention [CWC] in 1993, and ratified it on 2 September 1996.

Biological Weapons

The **Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction** (usually referred to as the **Biological Weapons Convention**, abbreviation: **BWC**, or **Biological and Toxin Weapons Convention**, abbreviation: **BTWC**) was the **first multilateral disarmament treaty banning the production of an entire category of weapons**.

The Convention was the result of prolonged efforts by the international community to establish a new instrument that would supplement the 1925 **Geneva Protocol**.

The Geneva Protocol prohibits use but not possession or development of chemical and biological weapons.

A draft of the BWC, submitted by the British-was **opened for signature on 10 April 1972 and entered into force 26 March 1975** when twenty-two governments had deposited their instruments of ratification.

It commits the 173 states, which are party to it as of December 2014 to prohibit the development, production, and stockpiling of biological and toxin weapons.

Indian Tanks

Tanks which Indian Army has used/using are following:

AMX – 13

Is a **French Light tank** produced from **1953 to 1985**.
It was used by 25 Nations including India.
India Army has used, this tank in 1965 WAR between India and Pakistan.
At that time Pakistan troops was using M-48 Patton's, which were for superior then AMX-13.

Vijayanta

It was the **main battle tank built in India**.
Vijayanta was the first indigenous tank of the Indian Army.
It was in service from **1965-2008**, **now it has been supplanted by the T-72 MI in Indian service**.

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T-72

Is a **soviet designed main battle tank.**
It has **two variants T-72 N and T-72 MI**.
It is **indigenous name is Ajeya Tank**.
It has been using by the Indian Army from late nineteen and early 2000's.

T-90

It's **indigenous name is Bhishma**.
In 2001 around 310 T-90S tank were **imported from Russia**.
It had almost similar feature to the T-72, with improved and some new feature now. Indian scientist is currently locally producing a customized and improved version of T-90, the T-90 M Bhishma, as of now, a grand total of 500 T-90 and T-90 M tanks are operated by the Indian Army.

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Tank Ex or NBT Ex

It is **India's Ambitious Defence Project to build a battle tank after the MBT Arjun**.

DRDO is working on this from 2002, **it will be improved of T-90 MI and name would be "Karna", it can with stand a nuclear, biological and chemical (NBC) attack, it would be more superior and being much lighter than the Arjun MBT**.

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Arjun Tank NK.2

The Arjun is a **third generation main battle tank** developed by DRDO for the Indian Army.

It is powered by a single **Multi-Fuel diesel engine** and can achieve a maximum **speed of 67 km/h** and a cross country speed of 40 km/h.

‘**Arjun MK-I’ entered in service inIndian Army from 2004**, but failed to impress Army and improvements were required in order to make it combat – world.

The new ‘Arjun MK-2’ has improved version, it was in 2012 and now would be replacing T-55 and T-72 M.

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Topics of Discussion

1. UAV and Drone
2. Helicopters of India
3. MBRL: Pinaka
4. Su-30
5. Admiral Goshkov
6. AWACS
7. Stealth Technology
8. SONARS
9. TORPEDOS
10. NAVAL EXERCISES

Unmanned aerial vehicles

The DRDO has also developed two unmanned aerial vehicles- the **Nishant (Restless) tactical UAV** and the **Lakshya (Target) Pilotless Target Aircraft (PTA)**.

Lakshya

Efforts are on to develop the PTA further, with an improved **all digital flight control system, and a better turbojet engine.**

Nishant

is a hydraulically launched **short-ranged UAV** for the tactical battle area. **It is currently being evaluated by the Indian Navy and the Indian Paramilitary forces as well.**

The DRDO is also going ahead with its plans to develop a new class of UAVs.

These draw upon the experience gained via the Nishant programme, and will be substantially more capable.

Referred to by the **HALE (High Altitude Long Endurance)** and **MALE (Medium Altitude Long Endurance)** designations. The MALE UAV has been tentatively named the **Rustom**.

DRDO Abhyas
DRDO AURA
DRDO Fluffy
DRDO Imperial Eagle
DRDO Kapothaka
DRDO Lakshya
DRDO Netra
DRDO Nishant
Pawan UAV
DRDO Rustom
DRDO Ulka

DRONE IN INDIA

May 2015, **Mumbai became the first city to have a margarita pizza** delivered via drone. Under current regulations, the use of drones for commercial purposes is still illegal in India.

Perhaps inspired by the delivery of the margarita pizza, e-retail behemoth Amazon plans to use Mumbai and Bangalore as the trial launch pad for their PrimeAir delivery system.

Drones are becoming serious business in India, both in the commercial and military spheres. As the country becomes a big player in the drone game, here's what you need to know:

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INDIA'S MILITARY DRONES

India **first used military drones during the 1999 Kargil War** with Pakistan. Army search and reconnaissance missions proved to be incredibly difficult, if not nearly impossible, without air support.

The Indian Air Force deployed manned English **Canberra PR57 aircraft** for photo reconnaissance along the Line of Control, but this system proved highly inefficient and strategically weak over the mountainous Kargil terrain.

After India lost a Canberra PR57 to Pakistani infrared homing missiles, Israel discreetly supplied the Indian Air Force with IAI Heron and Searcher drones, which were useful for acquiring target information along the Line of Control.

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India's Defense Research and Development Organization has also developed its own domestic UAV program. The project aims to develop a domestic arsenal to replace and augment the existing fleet of IAI vehicles. Here is a list of completed and pending DRDO projects:

DRDO Lakshya: a **target drone** used for discreet aerial reconnaissance and target acquisition. It is launched by solid propellant rocket motor and sustained by a turbojet engine in flight.

DRDO Nishant: primarily designed for intelligence-gathering over enemy territory and also for reconnaissance, training, surveillance, target designation, artillery fire correction, and damage assessment. The Nishant has completed its developmental phase and user trials.

Helicopters of India

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Aircraft	Photo	Origin	Role	Version	Comment
HAL Rudra		India	Attack helicopter	ALH-WSI	**Status**: Inducted/Under Trials. 40 more are on order.
Kamov Ka-226		Russia	Utility helicopter	Ka-226T	**Status**: 200 to be built in India at HAL Helicopter Manufacturing plant, which is being built at Tumkuru.
HAL Dhruv		India	Utility helicopter		**Status**: Inducted. Total of 151 are on order.

HAL Cheetah, Cheetal & Lancer		India	Utility helicopter Utility helicopter Counter-insurgency	Cheetah Cheetal Lancer	**Status**: Inducted. It is expected that they are to be replaced by Kamov 226T Helicopters in the near future and thereafter by indigenously being developed HAL Light Utility Helicopter.
HAL Chetak & Chetan		India	Utility helicopter	Chetak	**Status**: Inducted. Being withdrawn from service and getting replaced by HAL Dhruv.
HAL Light Combat Helicopter		India	Attack helicopter	LCH	**Status**: Under Trails (Completed by 2016). 114 are on order.[68] It has completed all of its initial test. Trails of missile firing were supposed to be held in mid 2016.
HAL Light Utility Helicopter		India	Utility helicopter /Observation Helicopter	LUH	**Status**: Under Development/Reading for Testing. Trails to be held in mid 2016.

Pinaka: Multi Barrel Rocket Launcher

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Pinaka is a **multiple rocket launcher** produced in India and developed by the DRDO for the Indian Army. The system has a maximum range of 39–40 km.

Pinaka saw service during the Kargil War, where it was successful in neutralizing enemy positions on the mountain tops. It has since been inducted into the Indian Army in large numbers.

Pinaka is a complete MBRL system,

Modes of operation

The launcher can operate in the following modes:

1. **Autonomous mode.**
2. **Stand-alone mode:**
3. **Remote mode:**
4. **Manual mode**

The Pinaka was tested in the Kargil conflict and proved its effectiveness. Since then it has been inducted into the Indian Army and series production has been ordered. The Pinaka MBRL is stated to be cheaper than other systems.

Sukhoi Su-30

The **Sukhoi Su-30** is a **twin-engine, multi-role military aircraft** developed by Russia's **Sukhoi Aviation Corporation**.

It is a **two-seat**, dual-role fighter for **all-weather, air-to-air and air-to-surface deep interdiction missions**. The Su-30 was introduced into operational service in 1996.

AWACS systems

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What is the Phalcon?

The Phalcon is an Israeli manufactured **Airborne Early Warning, Command and Control (AEWC&C) system**. It is one of the most powerful such systems in the world.

What does the Phalcon do?

It provides real time surveillance of a few hundred kilometres of territory and also command and control. It can pick up a low flying aircraft, a missile or communication and provide advance warning after correlation. It will help the Indian Air Force to maintain air superiority in a battle. It can pick up an incoming object in all weather conditions, reportedly up to some 300 miles. It can also pick up all sorts of communications from air, sea or land. All the information collected can be conveyed live to the control centre in the headquarters.

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Stealth technology

Stealth technology also known as **LO technology** (**low observable technology**) is a sub-discipline of military tactics and passive electronic countermeasures, which cover a range of techniques used with personnel, aircraft, ships, submarines, and missiles, in order to make them less visible (ideally invisible) to radar, infrared, sonar and other detection methods.

Stealth principles -

Stealth technology (or LO for "low observability") is not a single technology. It is a combination of technologies that attempt to greatly reduce the distances at which a person or vehicle can be detected; in particular radar cross section reductions, but also acoustic, thermal, and other aspects.

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Non-metallic airframe

Dielectric composites are more transparent to radar, whereas electrically conductive materials such as metals and carbon fibers reflect electromagnetic energy incident on the material's surface. Composites may also contain ferrites to optimize the dielectric and magnetic properties of the material for its application.

Radar-absorbing material

Radar-absorbent material (RAM), often as paints, are used especially on the edges of metal surfaces. While the material and thickness of RAM coatings is classified, the material seeks to absorb radiated energy from a ground or air based radar station into the coating and convert it to heat rather than reflect it back.

Anti-satellite weapon

India had identified development of ASAT weapons "for electronic or physical destruction of satellites in both LEO (2,000-km altitude above earth's surface) and the higher geosynchronous orbit" as a thrust area in its long-term integrated perspective plan (2012-2027) under the management of DRDO.

Interceptor

An **interceptor aircraft** (or simply **interceptor**) is a type of **fighter aircraft** designed specifically to intercept and destroy enemy **aircraft**, particularly **bombers**, usually relying on great speed. A number of such aircraft were built in the period starting just prior to **World War II** and ending in the late 1960s, when they became less important due to the shifting of the **strategic bombing** role to Inter Continental Ballistic Missiles (I**CBMs**).

Sonars

DRDO, BEL and the Indian Navy have developed and productionized a range of Sonars and related systems for the Indian Navy's frontline combat ships.

The Shivalik class of frigates contain significant DRDO developed systems

These include the:

- **APSOH (Advanced Panoramic SOnar Hull mounted)**
- **HUMVAD (Hull Mounted Variable Depth sonar)**
- **HUMSA (Follow on to the APSOH series; the acronym HUMSA stands for Hull Mounted Sonar Array)**
- **Nagan (Towed Array Sonar)**
- **Panchendriya (Submarine sonar and fire control system).**

Other sonars such as **the airborne sonar Mihir**, are in trials, whilst work is proceeding apace on a new generation of sonars. Sonars may be considered one of DRDO's most successful achievements as the Indian Navy's most powerful ships rely on DRDO made sonars.

Torpedoes

DRDO is currently engaged in **developing multiple torpedo designs**.

lightweight torpedo that has been accepted by the Navy and cleared for production).

heavy weight wire-guided torpedo called the **Varunastra** and the **Takshak** thermal torpedo suitable for use against both ships and submarines.

The electrically powered Varunastra is now stated to be also in production.

Shyena is an **advanced experimental torpedo** developed by the Naval Scientific and Technological Laboratory, India's Defence Research and Development Organisation (DRDO) wing. Development was started in 1990.

INDIAN DEFENCE JOINT EXERCISES OF NAVY, ARMY, AND AIR FORCE

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Indian navy joint exercises

Varuna naval exercise is joint exercise of navies of France and India.
SLINEX srilanka India naval exercise.
INDRA is a joint, bi-annual military exercise condueby India and Russia.
Exercise **Malabar** is a bilateral naval exercise which involves the United States and India.
Simbex indian Navy with republic of Singapore navy.
IBSAMAR with Brazil and South African navies.
KONKAN a bilateral naval exercise between indian navy and royal navy of Britain.
AUSINDEX indian and Australian navy bilateral maritime exercise.
Sahyog-kaijin joint exercise of coast guards of Indian and Japan.
Naseem Al Bahr joint navy exercise of India and Oman.

Dr. Ravi P. Agrahari

Indian air force exercises:

The joint India UK air exercises are known as the "**Indradhanush**" or "**Rainbow**".
India France air exercise "**Garuda**".
Avia Indra 2014 the indian Russia maiden aerial exercise.

Indian army joint exercises:

Mithra Shakti exercise India and Sri Lanka.
Hand-in-hand India and China joint military training exercise.
Exercise **Shakti** India and France armies.
Exercise

Nomadic Elephant indian army exercises with the Mongolian army.

Exercise **Yuddh Abhyas** is the name of the series of joint exercises between the indian and united armies since 2005.

Surya Kiran India Nepal joint military exercise.

LAMITYE India and Seychelles.

Prabal Dostyk India Kazakhstan joint exercise.

THANK YOU