India’s Missile Programme: Augmenting Firepower

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New Delhi . South Asia's feeble political and strategic equations are reflected in the volatility of its security arrangements. The evolution of elements that have been crucial towards galvanizing India's strategic response crucially include its missile programme as an unassailable part of that strategy.

The past decades have witnessed phenomenal surges in missile technology and intrusions into outer space. India, however did not have a credible missile programme by means of which it could boast of a sturdy arsenal of missile systems of that point. India's missile programme can be stated to be an offshoot of its space programme, beginning 1967. Subsequently, in 1972, Rohini- a 560 two-stage, solid propulsion sounding rocket was developed and test fired, capable of reaching an altitude of 334 km with a 100 kg payload. India first launched its small 17-tonne SLV-3 space booster (300km/40 kg) in 1979 and thereafter successfully injected the 35 kg Rohini I satellite into near-earth orbit in 1980. By 1987, an augmented booster, the 35-tonne ASLV (4,000 Km /150kg in low earth orbit), which primarily are three SLV-3's strapped together, had begun flight testing.

In what could be described as a 'decisive shift' in missile development plans, the missile capability of Indian armed forces received a major fillip from Defence Research and Development Organisation (DRDO) following the launching of the Integrated Guided Missile Development Programme (IGMDP) in 1983. The principal aim was to develop a family of strategic and tactical guided missiles based on local design and development for three defence services. DRDO accorded particular priority to development of sophisticated guidance technology.

The Indian missile arsenal boasts a range of systems and the current thrust areas of the DRDO include Internal Ram Rocket Engines, Multi-target tracking capability, Homing guidance using seeker and networking of radars. Concurrently, the DRDO has consistently worked towards enhancing and upgrading the following missile system further:

Agni-I is a single stage, solid fuel, road and rail mobile, medium-range ballistic missiles (MRBM) using solid propulsion upper stage, derived from Prithvi, essentially to prove the re-entry structure, control and guidance. The strap-down inertial navigation system adopts explicit guidance—attempted for the first time globally. Using carbon composite structure for protecting payload during its re-entry phase, the first flight was conducted in May 1989, thus establishing the re-entry technology and precise guidance to reach the specific targets. This shorter ranger missile is specially designed to strike targets in Pakistan.

Agni II is an operational version of Agni I and is an intermediate range ballistic missile (IRBM) with two solid fuel stages and a Post Boost Vehicle (PBV) integrated into the missile's Reentry Vehicle (RV) with mobile launch capability test-fired in April 1999.

The range for Agni II is more than 2000 km. Quick deployment of the Agni II was possible, by building on the earlier Agni-TD programme that provided proven critical technologies and designs required for long range ballistic missiles. The Agni II missile was last test fired in May 2009. A new variant of the Agni II called the Agni IIIA is presently under development.

Additionally, **Agni III**, an intermediate-range ballistic missile was developed by India as the successor to Agni II. Intended to be a two-stage ballistic missile capable of nuclear weapons delivery, it is touted as India's nuclear deterrent against China. The missile is likely to support a wide range of warhead configurations, with a 3,500 km range and a total payload weight of 2490 kg. The two-stage solid fuel missile is compact and small enough for easy mobility and flexible deployment on various surface/sub-surface platforms. The last development test of Agni III was conducted in August 2009 before being handed over to the army for user trails.

Agni V, believed to be an upgraded version of the Agni III is currently being worked upon by the DRDO. The inter-continental ballistic missile shall have a range of about 5000-6000 km and the first test flight is expected around 2010 end. Agni V would be a three stage solid fueled missile with composite motor casing in the third stage. Agni V will be able to carry multiple warheads and would also display countermeasures against anti-ballistic missile systems.

The **Trishul** (Trident) is a short range, quick reaction, all weather surface-to-air missile designed to counter a low-level attack. In fact, Trishul was one of the longestrunning DRDO missile development programme. It can also be used as an anti-sea skimmer from a ship against low flying attacking missiles. The missile can engage targets like aircraft and helicopters, flying between 300 m/s and 500 m/s by using its radar commandto- line-of-sight guidance. Powered by a two-stage solid propellant system, with a highly powered HTBP-type propellant similar to the ones used in the Patriot, the Trishul has necessary electronic counter-counter measures against all known aircraft jammers. Trishul, with its quickest reaction time, high frequency operation, high manoeuverability, high lethal capability and multi-roles for three services, is state-of-the-art system providing considerable advantage to the Indian armed forces.

The **Akash** system is a medium range surface-to-air missile with multi-target engagement capability. It can carry a 55-kg multiple warhead capable of targeting five aircraft simultaneously up to 25 km and is said to be comparable to the US Patriot as an air defence missile. It uses high-energy solid propellant for the booster and ram-rocket propulsion for the sustainer phase. The propulsion system provides higher level of energy with minimum mass, compared to conventional solid/ liquid rocket motor, which has better performance with minimum weight of the missile. It has a dual mode guidance, initially on command mode from phased array radar and later radar homing guidance with unique software developed for high accuracy. The phased array radar provides capability for multiple target tracking and simultaneous deployment of missiles to attack four targets at the same time, in each battery.

Another missile under IGMDP development is the **Nag**, an antiarmor weapon employing sensor fusion technologies for flight guidance first tested in November 1990. The Nag is a third generation 'fire-and-forget' anti-tank missile developed in India with a range of 4 to 8 km. Nag uses Imaging Infra-Red (IIR) guidance with day and night capability. Mode of launch for the IIR seeker is LOBL (Lock on before Launch). Nag was successfully test fired in August 2008 marking the completion of the developmental tests. Nag is expected to be the first weapon of its kind to be inducted into the army by December 2009. The Army urgently needs the more advanced Nag to improve kill probability as the missile using a high explosive warhead to penetrate the armor in modern tanks.

The **Prithvi** is a surface-tosurface battle field missile using a single state, twin-engine liquid propulsion system and strap-down inertial guidance with real-time software incorporated in the onboard computer to achieve the desired accuracy during impact. Prithvi demonstrates higher lethal effects as compared to any equivalent class of missiles in the world. Prithvi could well be termed as a unique missile since it displays manoeuverable trajectory and high level capability with field interchangeable warheads. Its accuracy has been demonstrated in the development flight trials. Flight trails for the air force has been completed and the system is now being configured for launching from ship, thereby increasing its capability as a sea mobile system.

Significant additions also include the Multi-Barrel Rocket System **PINAKA**, an area weapon system to supplement the existing artillery gun at ranges beyond 30 km, having quick reaction time and high rate of fire has been accepted by the user after extensive trials. BrahMos being jointly developed with Russia, is a supersonic cruise missile that can be launched from submarines, ships, aircraft or land.

BrahMos is among the fastest supersonic cruise missiles in the world, at speeds ranging between Mach 2.5 to 2.8, being about three and a half times faster than the American subsonic Tomahawk cruise missile. Although BrahMos is primarily an anti-ship missile, it is also capable of engaging land-based targets. DRDO has claimed that BrahMos would be able to start deliveries of the 240 missiles ordered by the army in two years from now as per the original schedule. It was reported in January 2009 that two Indian Air Force Sukhoi-30MKI fighter jets were sent to Russia for a retrofit programme that would enable them to launch the aerial version of the BrahMos missile.

When compared with other weapon systems of its class, BrahMos continues to remain the most cost effective option. It is plausible to assume that cruise missiles constitute an important element of the military arsenals for many nations including India owing to the costs, both absolute and in comparison with other aerial weapons. Thus the contribution of the BrahMos to India's defence is fundamentally significant in a quest to maximise its firepower potential to counter a future military attack. In fact, India is the only country in the world to have inducted the supersonic landattack cruise missile in its army.

Yet another cruise missile, the **Nirbhay** was announced in 2007—a subsonic missile with a range of 1000 km. Capable of being launched from multiple platforms on land, sea and air, the missile is being developed to be tested in 2009. Nirbhay will be a terrain hugging, stealth missile capable of delivering 24 different types of warheads depending on mission requirements and will use inertial navigation system for guidance. In fact, Nirbhay will supplement BrahMos in the sense that it would enable delivery of warheads farther than the 300 km range of BrahMos, according to reports.

In 2008, New Delhi announced the end of the IGMDP with the focus now shifting towards serial production of missiles developed under this programme. Notwithstanding that the need for a systematically planned long-term doctrine has to be underlined, given that future wars would be autonomous and network centric, India needs more BrahMos like weapons systems which has emerged as the perfect strike weapon with a fine combination of speed, precision, power, kinetic energy and reaction time attributes.

Delhi has also taken steps toward achieving submarine launched ballistic missile capability, with the first test of the K-15 (Sagarika) taking place in February 2008 from a submerged barge with a range of 750 km. Moreover, a landbased variant of the K-15 Sagarika named **Shaurya**, which can be stored in underground silos for longer time and can be launched using gas canisters as booster was successfully test-fired in November 2008. This nuclear-capable missile aims to enhance India's second-strike capability and the Indian Navy plans to introduce the missile into service by the end of 2010. Sagarika missile is being integrated with India's nuclearpowered Arihant class submarine that began sea trials in July 2009.

Also under development is the sea-based **Dhanush**, which has been tested several times in recent years believed to be a short-range, sea-based, liquid-propellant ballistic missile—perhaps a naval variant of the Prithvi series. According to reports, the possibility of a two stage version, the first being solid fueled and the second liquid fueled is expected—thus providing the missile with a maximum range of approximately 300 km.

It would be apposite to conclude by stating that India's missile programme represents an iconic image demonstrating sovereignty and self-reliance vis-à-vis its technological achievements. Resultant of nearly three decades of research, India's guided missile programme has assumed a self-sustaining character and become fundamentally crucial to New Delhi's proposed minimal deterrent.

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