Ballistic Missiles and Ballistic Missile Defense Capability in India

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Introduction

The relationship between national security and technology is well known. Reasons of security prompted India to develop nuclear weapons. Quite early in its nuclear programme, India established a reprocessing facility to extract plutonium from spent fuel rods of the CIRUS reactor, along with developing other critical technologies. This capability subsequently led to the conduct of a Peaceful Nuclear Explosion (PNE) in May 1974. In the following years, India continued to maintain a covert weapon development program.

Weapon systems evidently need appropriate delivery platforms to provide deterrent capability and to be used for retaliation, if a need arises. The 1974 PNE was a demonstration of technology and not a demonstration of a weapon system. Highly critical and negative international views surfaced after the test and India did not continue with further testing. However, the technology development programme continued and development of other materials like tritium, lithium and beryllium was taken up. The availability of supercomputing helped in advancing simulation and modelling capabilities. These proved to be valuable for several aspects of the design of subsystems, plutonium core shapes, tamper and reflector materials as well as weight reduction. The simulation also helped to understand the timing of the injection of neutrons to trigger the chain reaction. These efforts culminated finally in the conduct of five nuclear tests by India in May 1998 and India declaring itself as nuclear weapon state.[1] It is said that the tests yielded "critical data for the validation of our capability in the design of nuclear weapons of different yields for different applications and different delivery systems."[2]

Missile development in India: A brief history

In 1998, India had only aircraft available as delivery platforms for strategic weapons. The missile development had yet to gather steam.

When India carried out the nuclear tests in 1998, India's civil space programme had made significant progress in space transportation systems and its Polar Satellite Launch Vehicle (PSLV) was capable of placing a 1200 kg satellite in 800 km sun-synchronous polar orbit.[3] However, there was not much technical interaction between the civilian space and defence missile program.

Missile development activities were started with a specially constituted Special Weapons Development Team, which subsequently became the Defence Research and Development Laboratory (DRDL) in the early 1960s. The initial efforts at DRDL related to development of a wire-guided anti-tank missile and reverse engineering of the Russian medium range surface-to-air missile SA-75. Missile development got an organised focus only in July 1983 with the formation of the Integrated Missile Development Programme (IGMDP).

1 Prabhu Chawla. "India is a nuclear weapons state: Interview with PM Atal Behari Vajpayee," India Today, May 25, 1998.

2 Embassy of India (1998) Joint press statement by DAE and DRDO, May 25. Available at: https://indianembassyusa.gov.in/ArchivesDetails?id=222.

3 On 29 September 1997 the vehicle PSLV-C1 placed the remote sensing satellite IRS-1D into the 740 x 817 km orbit with an inclination of 98.6°. IRS-1D payload included 3 push-broom cameras and the satellite weighed 1250 kg.

Of the five missile systems taken up for development under IGMDP, two related to ballistic missiles – one was the SRBM Prithvi and the other was Agni Reentry Technology Demonstrator (Agni-TD, for short). The basis for the Prithvi was the liquid engine development project named Devil which had been taken up in DRDL. The Agni-TD was a two-stage system incorporating a solid propellant based on the satellite launch vehicle first stage and a stage incorporating the Prithvi engine as the second stage. The target range was 1000 km. Over time the performance of the Prithvi missile has improved and Agni has progressed from technology demonstration to operational phase comprising a series of missiles with range capability exceeding 5000 km.

True merit of deterrence becomes evident when you have the weapons as well as the means of delivering them over long distances. The Agni series of missiles provide a deterrence capability against India's nuclear capable neighbours. Immediately after the May 1998 nuclear weapon tests, India had declared a moratorium on further testing and also had declared a 'No First Use' (NFU) policy. The NFU policy would essentially result in India having to absorb the first strike in the event of a nuclear conflict, which in turn would necessitate putting in place strategies to protect the assets from an incoming strike and have adequate reserves to launch a retaliatory second strike.

India's need for BMD

A few Asian countries possess both nuclear weapons and missile capability, including India, Pakistan, Israel, China and North Korea. Many countries possess missiles of different ranges and some of them like Iran, South Korea and Japan have the technological capability to develop nuclear weapons. Among these Pakistan and China tend to be seen as posing main security threats to India. China has a series of ballistic missiles, falling into the short, medium, intermediate and ICBM classes. Besides having submarine-launched ballistic missiles (SLBMs), China reportedly has multiple independently targetable reentry vehicle (MIRV) capability with its DF-31 and JL-2 missiles. DF-21 or its variant with a reported range of 2150-2500 km would be the most likely missile used to target India.

The proliferation of both nuclear and missile technology from China to Pakistan has been widely discussed and commented upon.[4] Technology transfer of the Chinese M-11 along with missile production capabilities is also widely reported.[5] In addition, Pakistan has obtained the No Dong missile technology from North Korea and the Pakistani version goes by the name Ghauri. Pakistan has over time developed a series of missiles with a range as high as 2750 km for Shaheen-3 and has claimed that in the Ababeel Missile, it has tested MIRV capability. Pakistan also has a tactical weapon system Nasr in the 70 km range, besides land attack and submarine-launched cruise missiles.[6] Pakistan's nuclear and missile force is entirely India-centric.

Added to that, the history of previous conflicts and the use of terrorism as an instrument of state policy by Pakistan adds to increased threat perception from across the border. And the increased pace of acquisition of strategic weapons[7] for its many platforms combined with a stated First Use policy puts a major burden on India's security preparedness. Also, there could be a continuation of the missile technology proliferation from China.[8]

4 Pervez Hoodbhoy (2019) Abdus Salam in China, Down, November 30. Available at: https://www.dawn.com/news/1519654.

5 Federation of American Scientists (1999) Coverage of Pakistan missiles in *WMD Around the World* section. Available at: https://fas.org/nuke/guide/pakistan/missile/index.html.

6 International Strategic and Security Studies Programme (2018). Available at: http://isssp.in.

7 Arms Control Association (2020) Nuclear Weapons: Who Has What at a Glance. Available at: https://www.armscontrol.org/factsheets/Nuclearweaponswhohaswhat.

8 Syed Shoaib Hasan (2010)

A large part of the Indian territory is within reach of Pakistan's missiles – covering from 700 to 2750 km range between Shaheen-1 and Shaheen-3. Similarly, targets in India are within the reach of the Chinese DF-21 class of missiles.[9] The flight time of the DF-21 missile could be in the range of 15 to 18 minutes while missiles launched from Pakistan would have much less flight time. This leaves precious little time for acquiring, tracking and taking remedial action.

Indian BMD capability

While the nuclear and missile capability scenario in the region is outlined in the previous section combined with India's stated NFU policy, India has to plan and implement steps to ensure the survivability of its nuclear forces. In this regard, India's nuclear doctrine and operational arrangements governing India's nuclear assets including the command-and-control structure were shared with the public in January 2003.[10]

One obvious need is early detection of an adversary ballistic missile launch and determination of its trajectory and likely target. The Israeli Green Pine multi-functional radars, which functioned as part of the Arrow-2 BMD system served the purpose and were procured. Simultaneously India incorporated essential indigenous elements in the Green Pine radar to derive its own long range tracking radar called Swordfish. Besides providing long range tracking capabilities, the radar can be used for guiding interceptor missiles to engage aerial targets at altitudes above 80 km. The radar is capable of detecting small targets in the 600-800 km range.[11] The tracking radar is used for target acquisition as well as for fire control. The radar is capable of tracking 200 targets within a range of 600 km.[12] In 2012 an improved version of Swordfish with a range of 1500 km was available. The longer range is helpful in early detection of inbound threats.[13]

Since the advent of IGMDP in 1983 DRDO had developed many missile subsystems and it was well within its capability to develop systems suitable for ballistic missile defence. Within the constraints of the overall systems, it was possible to develop an interception system for the terminal phase of the ballistic missile flight. This was prudent also from considerations of the short flight time of inbound missiles fired from Pakistan. DRDO developed two systems, the Prithvi Air Defence (PAD) for exo-atmospheric interception of the adversary re-entry vehicle (RV) and the Advanced Air Defence (AAD) for endo-atmospheric interception of the adversary RV.

The PAD is a two-stage missile system consisting of a liquid propellant first stage derived from the Prithvi missile and a second solid propellant stage reaching velocity of 1.7 km/sec in the powered phase. The PAD system is capable of intercepting incoming ballistic missiles at altitudes of 50-80 km and ranges of 150-200 km.

PDV is an improved version of PAD with 30% performance gain over PAD. The improved powerplant and control and guidance system combined with the Swordfish radar have enabled interception at 75 km. The missile is equipped with a gimballed directional warhead and interception at higher as well as lower altitudes is possible through trajectory optimization. An improved version of PDV was used in India's ASAT test.

Pakistan's growing nuclear programme, BBC News, 1 December. Available at: https://www.bbc.com/news/world-south-asia-11888973.

9 Alexei Arbatov and Vladimir Dvorkin, Eds (2013) Missile Defense: Confrontation and Cooperation, Moscow: Carnegie Moscow Center, 2013, 302.

10 Ministry of External Affairs, Government of India (2003) The Cabinet Committee on Security Reviews perationalization of India's Nuclear Doctrine.

11 Army Technology (2021) DRDO Ballistic Missile Defence System, February 19. Available at: https://www.army-technology.com/projects/drdo-bmd/.

12 Ibid.

13 Defence Update (2021) Why do we need super- swordfish radar, February 19. Available at: http://defenceupdate.in/why-do-we-need-super-swordfish-radar/.

The AAD on the other hand comprises a single solid propellant stage capable of reaching speeds up to 1 km/sec during the powered phase of flight with interception altitude and range up to 30 km each.[14]

Some limited BMD capability may be available with the S-400 missile system India is purchasing from Russia. While essentially effective against aircraft and cruise missiles, ballistic missile targets at 30 km altitude and range of 400 km are also within the missile system capability, if the missile system is equipped with hit-to-kill capability.

Besides terrestrial sensors, India needs to have space-based early warning systems. Its constellation of earth observation satellites, both optical as well as synthetic aperture radar satellites, provide some element of surveillance capabilities. While providing useful surveillance information this system is inadequate as an early-warning system. One needs to detect the missile at launch or in the early boost phase for early warning. Such a detection will help in gaining precious time, especially when adversary missile flight times are short to fashion the appropriate response. Steps in harnessing such technologies seem to be on the anvil. For example, one of the payloads on board GSAT-29, a communication satellite launched by the Indian Space Research Organisation (ISRO) on 14 November 2018 is a Geo-High-Resolution camera. The camera is to help in high resolution imaging and in surveillance over the Indian Ocean.[15]

Further, in early 2020, ISRO plans to launch the Geo Imaging Satellite (GISAT), which may supplement the early warning capability. The satellite imaging payload is capable of providing multi-spectral (visible, near infrared and thermal) and multi-resolution (50 m to 1.5 km) imagery over areas of interest in near real time.[16] The primary function of the satellite is to carry out continuous observation of the country including near real time monitoring of natural hazards and disasters. According to an article in Global Security, GISAT will provide near real time pictures of large areas under cloud free conditions, at frequent intervals. That is, selected sector-wise an image every 5 minutes and entire Indian landmass image every 30 minutes at 50 m spatial resolution should be available.[17] As the satellite footprint will cover regions beyond the Indian landmass, this capability can be used for surveillance of known missile launch sites. Further, an early warning potential exists with thermal imaging capability for detecting missile launches.

(Note: Due to technical and Covid 19 pandemic reasons the launch of GISAT got postponed and it is now slated for launch in 2021)

India understands that both in terms of ability and cost the placement of BMD systems has to be selective and based on priority. In the first phase, the national capital Delhi and the financial capital Mumbai have been chosen to come under the BMD net. According to a news report dated 22 April 2019, two indigenous long-range radars have been deployed and a formal nod of the Central Government for deployment of active missile was expected to be forthcoming.[18]

14 Alexei Arbatov and Vladimir Dvorkin, Eds (2013) Missile Defense: Confrontation and Cooperation, Moscow: Carnegie Moscow Center, 2013, 306.

15 Sangeeta Nair (2018) ISRO successfully launches communication satellite GSAT-29, Jagran Josh, November 15. Available at: https://www.jagranjosh.com/current-affairs/isro-launches-communication-satellite-gsat29-1542197661-1.

16 Gunter's Space Page (2021) GISAT 1,2 (EOS-3), February 19. Available at: https://space.skyrocket.de/doc_sdat/gisat-1.htm.

17 Global Security (2021) Geostationary Imaging Satellite (GISAT), February 19. Available at: https://www.globalsecurity.org/space/world/india/gisat.htm.

18 Snehesh Philip (2019) India completes phase 1 of ballistic missile defence programme, nod for missiles awaited The Print, April 22. Available at: https://theprint.in/defence/india-completes-phase-one-of-ballistic-missile-defence-programme-nod-for-missiles-awaited/224959/.

Conclusion

India happens to be in a neighbourhood where co-operation, competition, unsettled border issues and hostility coexist. The three countries in the neighbourhood are nuclear weapon states and one of them subscribes to the First Use doctrine. In this environment, India has to ensure the survivability of its nuclear forces and be in a position to launch a retaliatory second strike. Indian missile forces are therefore designed for mobility, massive retaliation and an assured second strike capability. Ballistic Missile Defence is an active element of this requirement and India has an operational BMD programme comprising land based sensors, hit-to-kill missiles and command & control structure in place. In view of the short adversary missile flight times, India needs to work on boost phase detection technologies to get an incremental increase in the response time.

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