BALLISTIC MISSILE DEFENCE IN ASIA

ARJUN SUBRAMANIAN P.

The one continent where ballistic missiles have proliferated tremendously is Asia. There are some important factors that have been, and are, contributing to such a trend in the region. Firstly, the demand for the ballistic missile as it is a relatively cheap weapon to develop and deploy compared to a large and sophisticated air force. Also, this weapon is hard to counter even by the most technologically advanced countries. Secondly, the existing geo-political make-up where confrontation is between states that are at opposite poles of the power spectrum, where the weaker side finds such weapons most suitable to counter a technologically superior adversary. Thirdly, the ready availability of the technology and vital components through both legal and clandestine means. These factors have enabled states like North Korea with a less than meagre technology base to adapt the technology, of course, with tremendous assistance, to develop ballistic missile capability. With the rapid proliferation of these weapons in Asia, countries facing this threat have been looking for ways to counter it. Most have turned to some level of Ballistic Missile Defence (BMD). This paper attempts to study the ballistic missile threat and the missile defence efforts of the US and its allies in East Asia, China, Israel and India.

MISSILE DEFENCE IN EAST ASIA: US AND ALLIES

As far as ballistic missile defence in contemporary Asia is concerned, the

Arjun Subramanian P. is a Associate Fellow at the Centre for Air Power Studies, New Delhi.

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United States is the largest player in this arena. The US has deployed and continues to deploy missile defence components as part of its larger missile defence architecture. These deployments are linked to the larger geo-political game plan of the United States in the Asian continent linking key players in the region like Russia, China, Iran, Japan and North and South Korea. At present, the US maintains that its BMD effort in the region is not directed at China and that it is meant to intercept only North Korean missiles. However, the deployed components are capable of tracking and intercepting Chinese ballistic missiles as well. The United States and Japan in 2013 announced plans to deploy a long range X-band radar in the Kyoto Prefecture, southern Japan, to track and counter any missile launched from North Korea. Japan already has one such high frequency radar in northern Japan. In addition to this, Japan fields 17 Patriot Advanced Capability-3 (PAC-3) units, protecting key locations in Tokyo and throughout the archipelago, and has plans to deploy more of these systems.[1] Apart from the land based components, the United States Navy (USN) and Japanese Maritime Self-Defence Force (JMSDF) have deployed Aegis equipped ships to defend against ballistic missiles. These Aegis systems have S-band primary radars and X-band engagement radars and are capable of intercepting ballistic missiles of all ranges with unitary and separating warheads in the terminal phase, except Intercontinental Ballistic Missiles (ICBMs). They can provide terminal defence against Short Range Ballistic Missiles (SRBMs) and mid-course defence against Medium Range Ballistic Missiles (MRBMs) and Intermediate Range Ballistic Missiles (IRBMs). In addition to these sensors, the United States has deployed space-based tracking and surveillance systems which consist of two satellites (technology demonstrators) that scan for targets in the Infra-Red (IR) and visible regions of the spectrum. These space-based sensors can detect

1. Ian E. Rinehart, Steven A. Hildreth, Susan V. Lawrence, "Ballistic Missile Defence in the Asia-Pacific Region: Cooperation and Opposition", *Congressional Research Service (R43116)*, June 24, 2013, p. 9. See http://www.fas.org/sgp/crs/nuke/R43116.pdf

missiles in their boost phase where they emit high intensity short-wave IR radiations and can transmit information to other sensors and fire control systems.

The US has established cooperation in ballistic missile defence with the allies in East Asia. This cooperation is underpinned by the ballistic missile threat faced by the allies in the region. China has a huge inventory of ballistic missiles with varying ranges capable of reaching Taiwan, Japan and South Korea. The configuration of sensors, Command and Control (C2) centres, and missile interceptors in East Asia—in other words, the regional "architecture" of the US BMD—has slowly evolved in concert with contributions from treaty allies. Cooperation on regional BMD offers the potential for greater effectiveness and cost efficiency, but it is proceeding at different rates with different countries. The US-Australia partnership on early warning satellites dates back to the early Cold War and the Defence Support Programme (DSP) that began in 1970. The United States and Japan have been cooperating on BMD programmes since the 1990s and have a mature partnership. South Korea and Australia are beginning to acquire the necessary hardware and software for a more robust BMD capability to include missile interceptors.[2]

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North Korea (Democratic People's Republic of Korea – DPRK) too has developed ballistic missiles that have the range to target Japan and South Korea. In 2013, North Korea tested a nuclear weapon for the third time and in the tension that ensued, the DPRK threatened to launch nuclear armed ballistic missiles on South Korea and the United States. As a result of this threat, the US decided to deploy its Theatre High Altitude Advanced Air Defence (THAAD) system in Guam to protect its bases from missile attacks. However, the North Korean missile technology is not mature enough to attain the range sufficient to reach the continental United States or Guam despite such threats from North Korea. The ability of North Korea

2. Ibid., p. 2.

to miniaturise its nuclear warheads to fit into its ballistic missile is also doubted. Nevertheless, the US alerted and strengthened its BMD systems in the region, as a show of support to South Korea and to deter the DPRK from any further nuclear adventurism, it sent the nuclear capable B-2 stealth bombers on patrol to this region.

The US has made BMD one of the key components of its strategic policy in the region because of the need to strengthen its alliance by showing its commitment to protect its allies, retain its strong presence and dominance in the region and protect its military bases which are within the strike range of the ballistic missiles of China and North Korea. Looking at the nature and characteristics of the BMD components in the region, it is evident that the deployments are not intended to alter the nuclear deterrence balance between the US and China as these system are capable of intercepting only SRBMs and MRBMs. However, technically speaking, these sensors deployed in the region are part of the overall BMD architecture of the United States. These forward deployed sensors are networked together and are capable of providing early warning and tracking data of any ICBM launch from China and handing over the details to the Ground-based Mid-course Defence (GMD) command centre for interception.

The other key player in the region and alliance partner with the United States is South Korea. But South Korea is not interested in taking part in the US missile defence network in the region. In October 2013, South Korea's Minister of National Defence Kim Kwan-jin said, "South Korea was 'obviously' not going to take part in the US missile defence system and would only be pursuing its own Korean Air and Missile Defence (KAMD) system."[3] South Korea has deployed the PAC-2 system, and the defence minister clarified that the state intends to upgrade the system to the capability of PAC-3, however, it will not be integrated with the overall BMD architecture of the US. Nevertheless, it is an open secret that the US hopes for integrated missile defence systems with Japan and South Korea

3. Park Byong-su and Ha Eo-young, "Minister Says no US Missile System for South Korea", *The Hankyoreh*, http://english.hani.co.kr/arti/english_edition/e_international/607467.html , October 17, 2013.

to enhance effectiveness and reduce costs.[4]

The other ally of the US in the region, Taiwan, also has some missile defence capability but not sufficient to protect all of Taiwan and its military installations. Taiwan too has the Patriot systems, the PAC-2, which are being upgraded to Capability- 3. Taiwan has deployed long range radars to provide early warning on missile launches. A Taiwan Air Force long range radar based in Hsinchu county, northern Taiwan, detected a North Korean missile launch in December 2012 minutes earlier than radars in Japan. Looking at the number of missiles deployed across the Taiwan Strait by China and the cost considerations of establishing a nationwide BMD cover, it would be preferable for Taiwan to opt for a sufficient number of systems just to cover its air bases and other vital military installations that could protect the airstrips to enable landing of US reinforcements during a conflict.

The United States plays the key role in missile defence in the East Asian region involving allies and friends. The US plans to expand on this by establishing more sensors in the region, including some in the Philippines in order to improve and expand its missile defence network, and also by networking all these system to the US National Missile Defence (NMD) to provide crucial early warning and trajectory data to prepare its GMD system to intercept the incoming missiles. The US BMD programme is also a way of reassuring and a show of strengthening its commitment for defending its allies in the region.

EXPERIMENTING WITH AVAILABLE TECHNOLOGY: CHINA

Ever since China was founded, it harboured a deep mistrust and hostility towards the United States of America: this hostility was rooted in the ideological struggle between the Communist bloc and the democratic Western bloc. Within 15 years of its foundation, the People's Republic of China (PRC) went nuclear by testing a nuclear weapon in 1964. Despite acquiring nuclear weapons, for the next couple of decades, China did

4. "S. Korea Requests Pentagon's Information on THAAD Missile Defense System: Source", *The Korea Herald*, http://www.koreaherald.com/view.php?ud=20131018000139, October 18, 2013.

not have efficient means (ICBMs) to deliver the nuclear weapons on the continental United States and, hence, the deterrence capability against the US was lacking with China. On several instances during the Cold War, the US had planned to use nuclear weapons on China. But, ever since China deployed the DF-5 ICBMs, it attained deterrence capability against the US. However, China only deployed a limited number of DF-5s and, hence, when the US announced the Star Wars (Strategic Defence Initiative) ballistic missile defence programme, it threatened the balance of Chinese deterrence against the US. Even today, China has fewer deployed ICBMs, though the numbers and variants are increasing slowly. The US too is aggressively working on its missile defence programmes and has made considerable progress in this area. While this is one of the primary reasons for China to start building its own ballistic missile defence system, there are other factors too. One is the national pride in having such a capability which only a few countries have. Second could be the Indian pursuit of a BMD system. And the third and the most important is the future vision for putting a functional national missile defence system in place. The major enabling factor is the technical knowhow acquired by China on radar systems and interceptors primarily through acquisition of air defence technology and systems from Russia. It is understood that building an indigenous BMD system requires quite a high level of technological maturity, particularly in building advanced and powerful radars, command and control systems and interceptors. At present, the only deployed Chinese BMD capable system is the imported Russian S-300 systems which according to the Russian manufacturer, is capable of intercepting SRBMs in the terminal phase. Among the S-300 series, the S-300PMU-2 has the best chance of intercepting an SRBM missile as it employs the 48N6E2 missile, which has a warhead optimised for destroying ballistic missiles, and numerous necessary radar design optimisations.[5] Otherwise, China has not yet developed a deployable BMD system. China's original BMD programme started in 1964, but there was barely any progress, possibly due to lack of technology. At present,

5. Dr. Martin Andrew, "China's Anti-Ballistic Missile Test: Much Ado About Nothing", *Air Power Australia NOTAM*, http://www.ausairpower.net/APA-NOTAM-140110-1.html, January 14, 2010.

there are some activities in China in the missile defence area. In this regard, the Chinese Anti-Satellite (ASAT) weapons test conducted in 2007 is of relevance. On January 11, 2007, China conducted an ASAT test using a direct ascent weapon which was reported to consist of a rocket booster and a Kinetic Kill Vehicle (KKV). In that test, a Chinese weather satellite – the Feng Yun 1C –was destroyed, leaving a huge amount of space debris. The booster is speculated to be either a modified DF-21 or a DF-31 and is designated as the SC-19. A study of this system is necessary to understand the BMD capabilities of China as the technology involved is more or less the same. However, the details available on the test are limited as the Chinese are known for not divulging enough details of their strategic weapons tests.

For both BMD and ASAT, the requirements are long range tracking radars, guidance radars and an interceptor with range sufficient to reach and destroy the target at the designated altitude. Before the 2007 test, two more tests were reportedly undertaken by China, but no satellites were destroyed. In July 7, 2005, an SC-19 was launched and it reached an unknown altitude; this was followed by another launch in 2006 where the interceptor is believed to have just passed near a satellite.[6] These tests are speculated to be preliminary tests of the ASAT systems to evaluate the efficiency of the rocket and the tracking and guidance radar systems. Looking at the ASAT test conducted in 2007, the interception of the satellite occurred at an altitude of 865 km.[7] This shows that the interceptor has sufficient range to intercept a ballistic missile at this altitude. Looking at the apogee of ballistic missiles of various ranges, it can be said that this interceptor is capable of intercepting MRBMs and IRBMs in the descending phase. Theoretically speaking, the interceptor could intercept an ICBM at the extreme final stage of its descending phase of its mid-course flight and just before reentry. But practically, it is quite impossible for China to achieve this at this stage as it needs a long range high frequency radar to detect and track an ICBM

6. Michael R. Gordon and David S. Cloud, "U.S. Knew of China's Missile Test, but Kept Silent", *The New York Times*, http://www.nytimes.com/2007/04/23/washington/23satellite.html?pagewanted=print&_r=1& , April 23, 2007.
7. Brian Weeden, "Anti-Satellite Test in Space – The Case of China, Security World Foundation", p. 3, http://swfound.org/media/115643/China_ASAT_Testing_Fact_Sheet_Aug2013.pdf , August 29, 2013.

An ASAT capability doesn't translate into BMD capability as it is relatively easier to predict the trajectory of a satellite than of a ballistic missile target.

target and a fire control system to launch the interceptor at the appropriate time and position it at a suitable place to utilise the time window. A rough estimation would suggest that the radar should have the power to detect and track a target at least at an altitude of 2,000-3,000 km (elevation) and the high frequency would be necessary considering the low Radar Cross-Section (RCS) of a reentry vehicle owing to its shape and various possible aspect angles that might be acquired by the radar.

Even the ASAT capability of China is limited according to Desmond Ball, "Direct-ascent weapons only threaten satellites in Low Earth Orbit (LEO) that come within their range and the range of their associated ground-based radar tracking stations. Weapons launched from China are also restricted to high-inclination polar-orbiting satellites, being unable to reach those in low-inclination equatorial orbits."[8] Also, highly elliptical satellites, with perigees of a few hundred kilometres and apogees of as high as 40,000 km [such as the Soviet/Russian Molniya communications satellites and US Jumpseat/Trumpet Signals Intelligence (SIGNT) satellites], are only vulnerable to direct-ascent weapons launched from China if their perigees are over northeast Asia, where they mostly have their apogees, and even then, their relatively high speed at perigee would defy interception by either direct-ascent or co-orbital weapons."[9] Nevertheless, an ASAT capability doesn't translate into BMD capability as it is relatively easier to predict the trajectory of a satellite than of a ballistic missile target. Additionally, a satellite will have a large RCS unlike a ballistic missile target, making it relatively easy for the radar and homing system to acquire and track.

On January 11, 2010, China conducted an anti-ballistic missile test and is reported to have successfully intercepted and destroyed a ballistic missile target. There are some speculations that the target missile was the B6 11

8. Desmond Ball, "Assessing China's ASAT Program", *Nautilus Institute APSNet Special Reports*, http://nautilus.org/apsnet/assessing-chinas-asat-program/#axzz2sAzikzab, June 14, 2007.
9. Ibid.

(CSS-X-11) SRBM with a range of 250 km, but looking at the reported interception altitude (250 km), it appears that a different and more powerful booster might have been used. The test also reportedly involved a hit-to-kill system boosted by a modified DF-21 solid rocket motor. In 2013, another mid-course interception of a ballistic missile was successfully conducted at an unknown altitude and the target missile is also not known. When the United States, the world's leader in ballistic missile technology, is itself struggling to perfect the technology, the consecutive successful tests at the start itself is startling and combined with the Chinese secretiveness on the details of the test leads to speculation on the nature of the test, the environment under which the test was conducted and the overall qualification of the tested systems. All these factors raise doubts on the actual effectiveness of the Chinese BMD capability. These tests could best be viewed as trials on exploring their own capability and feasibility for building a ballistic missile defence system to intercept incoming MRBMs, IRBMs and possibly ICBMs. According to the Chinese *Global Times*, a senior colonel from the PLA Second Artillery Command College, told people.com.cn that China's ground based mid-course interception test was aimed at intercepting ICBMs.[10] For military analysts to further monitor China's progress in this direction, the PRC's focus on sensor development, both radar and optical, should be followed. Their acquisition of weapon systems from foreign manufactures which has sensor components that could be possibly adopted for missile defence applications should also be looked at.

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WEST ASIAN SCENARIO AND ISRAELI BMD

Israel is a Jewish Middle Eastern state, surrounded by Islamic countries that are hostile and virtually in a state of constant war with it. Israel has fought

10. Xu Tianran, "China's Anti-Missile Test Successful: Govt", *Global Times*, www.globaltimes.cn/content/758804.shtml , January 29, 2013.

several wars of various magnitudes with its neighbours and in most of the wars for its survival, it has come out spectacularly victorious as a result of its superior strategy and weaponry. But a new kind of threat has emerged for Israel which is hard to defend against and that is the acquisition and development of ballistic missiles, especially SRBMs by its adversaries in the Middle East which are Iraq, Iran, Syria, Libya, Egypt and possibly Saudi Arabia.

Syria possesses a huge arsenal of ballistic missiles; the foundation of Syria's arsenal is the Scud, of which Syria possesses three variations. Syria first received the Scud-B from North Korea in the late 1980s, and the Scud-C shortly thereafter. With assistance from North Korea and Iran, Syria established its own production line, and now assembles, maintains, and repairs its Scud-B and C missiles. Capable of producing approximately 30 Scud-B/Cs per year, Syria nonetheless remains dependent on foreign assistance for advanced missile components and technologies. Syria is believed to possess several hundred Scud-Bs and Scud-Cs, but has fewer than 50 launchers for each system.[11]

Iran is progressing rapidly in developing and deploying longer range ballistic missiles that are capable of reaching Israel and it is also alleged that Iran is secretly developing nuclear weapons. It has grown increasingly self-sufficient in the production of SRBMs, but it still probably relies on others for some key components. Iran is developing and producing MRBM capabilities with ranges estimated up to about 2,000 km, sufficient to strike targets throughout the Middle East. US intelligence assessments state that such missiles are inherently capable of carrying a nuclear warhead. Although the number of Iran's MRBMs is thought to be relatively small by official US estimates, it is expected to continue to build more capable MRBMs. Iran has also constructed an underground network of bunkers and underground silo-like missile launch facilities, and is seeking improved air defences, presumably to enhance the survivability of the MRBMs against

11. "Syrian Missile", *Nuclear Threat Initiative*, http://www.nti.org/country-profiles/syria/delivery-systems/ , September 2013.

preemptive attack.[12] In early February 2014, Iran successfully tested a long range ballistic missile which, according to Brig Gen Hosseni Dehqan, has radar evading capabilities.[13]

Israel is a state which had already suffered ballistic missile strikes during the Gulf War when Iraq launched several Scud missile attacks on its territory. During the Gulf War, 39 out of the 42 Al Husseins (Iraqi-modified Scud-B SRBMs) fired by Iraq landed in Israel. Altogether, Iraq fired a total of 92 Al Husseins at Israel and Saudi Arabia.[14] These missiles were conventionally armed and resulted in some casualties for Israel. However, the psychological impact of the attack was quite high on the Israeli population. In the present times, the threat has exacerbated as Iran is suspected to be pursuing nuclear weapons capability. When it comes to defending against nuclear weapons, the gravity of the situation and the precision requirements for intercepting a ballistic missile are demanding.

Additionally, some countries surrounding Israel possess chemical and biological weapons. So what kind of response does Israel have to counter these threats? Having been a realist state till date, Israel is working to meet the threat using a wide variety of possibilities, from political, military to technological means. Former Israeli Defence Minister Yitzhaq Mordechai, speaking at the Galili Centre for Strategy and National Security, described Israel's five tiered strategic defence system that is set up to deal with the threats:

> The first is prevention of war through greater peace efforts. The second is building a reliable deterrent capability. The third component is active defense based on the Arrow missile…[T]he fourth defense component is the need to carry out a preemptive attack on the missiles and the ballistic missile launchers inside their bases…

12. Steven A. Hildreth, "Iran's Ballistic Missile and Space Launch Programs", *US Congressional Research Service*, https://www.fas.org/sgp/crs/nuke/R42849.pdf, December 6, 2012.
13. Parisa Hafezi, "Iran Test-Fires Long-Range Missile: Minister", *Reuters*, http://www.reuters.com/article/2014/02/10/us-iran-missile-idUSBREA191R220140210, 10 February 2014.
14. Guermantes E. Lailari, "Homa: Israel's National Missile Defense Strategy", Air Command and Staff College, Air University Maxwell AFB (Alabama: United States), April 2001, p 39.

He qualified these remarks by adding that this component is limited by political considerations. The fifth tier, the defence minister said, "is passive defence, which consists of the procurement of protective kits and the construction of bomb shelters."[15]

At the operational and technological levels, Israel has adopted a multi-tier defence method. Firstly, the pre-launch phase destruction of the missiles and missile launch vehicle. There are two stages in this: one, destroying the missile production, storage and fixed launch sites, and the other, destroying the launcher after a missile has been fired. The challenge at both these levels is that it requires persistent and wide area surveillance to detect, locate and pass on the coordinates to the strike platform in real-time. The other requirement is to have a strike platform to perform this within the permitted strike window as missile launch units are mobile. The first level of defence is more complicated as the enemy might use camouflaging and other counter-measures to evade the surveillance and reconnaissance platforms. The second level, i.e. to destroy the launcher after a missile is fired, is relatively easy compared to the first level as the high intensity short wave IR radiation released by the missile exhaust can be easily picked up by the optical sensors of the satellites and other air platforms and a coordinated hunt and strike can by performed. Or, in case the detecting platform and the strike platform are the same (a single aircraft), the possibility of a kill is very high.

Secondly, to shoot the ballistic missile in its boost phase, where it is easiest to kill due to its slow speed, large RCS and high IR signature. Moreover, the kill can be performed over enemy territory from where the missile is launched. It again requires persistent surveillance, particularly with optical sensors, and a strike platform on station to fire the interceptor. In this case, a blast fragment warhead is sufficient to perform the kill. Thirdly, to deploy the theatre ballistic missile defence system for terminal defence against ballistic missiles. Israel has three current systems deployed to destroy ballistic missiles: the Hawk, Patriot Advanced Capability Level 3 (Patriot

15. Ibid., p. 16.

PAC-3), and the Arrow Weapon System (AWS).[16] The AWS currently forms the key part of the Israeli defence against the Scud variants and the other long range variants being deployed by its adversaries.

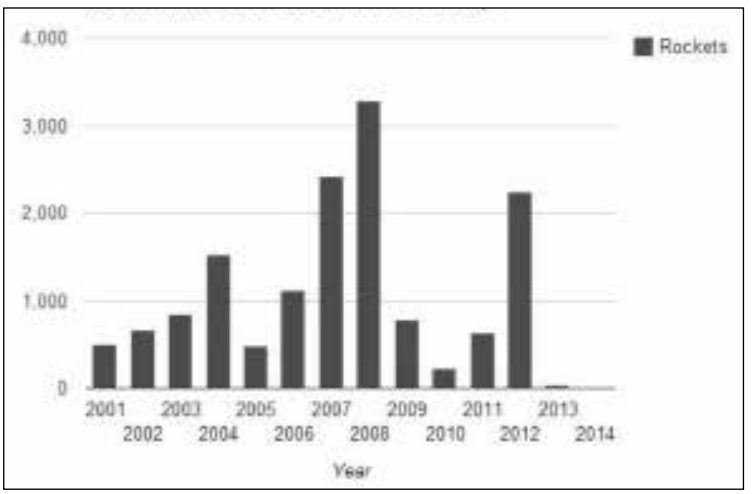
The Arrow Missile Defence System

The Arrow missile defence systems are the components which are designed to create a national missile defence shield for Israel. The system is being built specifically to suit Israeli operational requirements. Since, Israel is a geographically small country, the Theatre Missile Defence (TMD)-based architecture has been adopted to build its NMD. The Arrow system is a two-tier system where the Arrow 2 programme is for the lower tier defence and the Arrow 3 for the upper tier defence. The Arrow project is a collaboration of Boeing and Israel Aircraft Industry (IAI) to produce the missile interceptors that accompany the required radars, satellites, and command and control systems.[17] The Arrow-2 is centred on the Israeli-made Green Pine Long Range Tracking Radar and the Citron Tree Battle Management Centre (BMC). Unlike the US Patriot system, the Israeli interceptor uses the radio proximity fused fragmentation warhead method to intercept targets. The Arrow 2 interceptor is designed for endo-atmospheric interception of ballistic missile targets. The two-stage missile is equipped with a solid propellant booster and sustainer motors. The missile uses an initial burn to carry out a vertical hot launch from the container and a secondary burn to sustain the missile's trajectory towards the target at a maximum speed of Mach 9, or 2.5 km/s. The intercept altitudes are from a minimum of 10 km up to a maximum of 50 km. The maximum intercept range is approximately 90 km.[18] The Arrow 3 is meant for exo-atmospheric interception and it completed its first flight in February 2013 and the second flight in January 2014.[19]

16. Ibid., p. 19.
17. "Israel's Arrow Theatre Missile Defence", *Defense Industry Daily*, http://www.defenseindustrydaily.com/israel-successfully-tests-arrow-theater-missile-defense-01571/ , February 22, 2011.
18. "Arrow 2 Theatre Ballistic Missile Defence System, Israel", http://www.army-technology.com/projects/arrow2/, accessed on February 4, 2014.
19. Ibid.

Apart from these missile threats, Israel suffers from frequent rocket and mortar attacks from several militant groups like Hamas and Hezbollah. Ever since Israel withdrew from the Gaza Strip in 2005, terrorists have fired more than 8,000 rockets into Israel. Over 3.5 million Israelis are currently living under threat of rocket attacks. More than half a million Israelis have less than 60 seconds to find shelter after a rocket is launched from Gaza into Israel. Most rockets launched from Gaza into Israel are capable of reaching Israel's biggest southern cities.[20] Fig 1 gives an estimate of the rocket attacks on Israel from Gaza alone.

Fig 1: Rocket Attacks on Israel From the Gaza Strip



Source: http://www.idfblog.com/facts-figures/rocket-attacks-toward-israel/

Israel's response to the rocket attacks has been to launch punitive air and ground offensives to deter its adversaries. However, this policy of Israel has not deterred the militant organisations from repeating the attacks. In the face of these attacks, Israel has developed the Iron Dome system. Firing of rockets by Hezbollah during the Second Lebanon War in 2006 led to the development of the Iron Dome. Nearly 4,000 rockets, mostly of the short-range Katyusha type, were fired on Haifa and other northern

20. "Rocket Attacks on Israel from Gaza", *Israel Defense Force*, http://www.idfblog.com/facts-figures/rocket-attacks-toward-israel/ , accessed on February 6 , 2014.

regions of Israel.[21]The Iron Dome is an effective, truck-towed mobile air defence system developed by Rafael Advanced Defence Systems. The system has been developed to counter very short range rockets and artillery shells (155 mm) with ranges up to 70 km. It can be operated in all weather conditions, including fog, dust storms, low clouds and rain. The Iron Dome is composed of three fundamental elements: detection and tracking radar, Battle Management and Weapon Control (BMC) system and a Missile Firing Unit (MFU).[22] In March 2012, the Iron Dome succeeded in its first real battle test, when it intercepted more than 60 rockets fired by Hamas. Since 2010, the US has budgeted more than $800 million for Iron Dome batteries. In August 2013, Israel stationed additional Iron Dome batteries in the north of the country as well as in the Haifa and Tel Aviv region to protect against possible missile threats from Syria.[23]

To bridge the Iron Dome (short range interceptor) with the Arrow System, Israel has developed the David's Sling system which is capable of intercepting targets with ranges between 63-185 miles. "David's Sling was developed as a flexible, multipurpose weapon capable of engaging aircraft, cruise missiles, and ballistic guided missiles. David's Sling was designed to target incoming missiles during their terminal phase unlike the Iron Dome which intercepts missiles at their highest trajectory. Its primary role will be to intercept medium- and long-range ballistic and guided rockets, such as the Iranian Fajr-5 and BM-25 as well as the Syrian M-600 and Yakhont supersonic cruise missile."[24]

One major issue with rocket-based interceptors is the high cost factor as the cost of a single interceptor is several times higher than the utterly cheap rockets and mortars being fired from across the border. One answer to this is to switch over to Directed Energy Weapon (DEW)-based interceptors. Towards this, Israel has made a major leap in missile defence technology by integrating laser guns to its systems. However, the planned system, at

21. See http://www.army-technology.com/projects/irondomeairdefencemi/ , accessed on February 6, 2014.
22. Ibid.
23. http://www.jewishvirtuallibrary.org/jsource/talking/88_missiledefense.html, accessed on February 6, 2014.
24. Ibid.

"The US Navy unveiled a ship-borne laser weapon whose shots cost about $1 a piece, which radically changes the cost calculation of offense and defense."

present, is intended to intercept and destroy incoming rockets and mortars, but it will, in a way, act as a concept demonstrator to prove the efficacy of using laser guns to intercept ballistic missiles. Lasers have certain advantages over rocket powered interceptors. Firstly, they are cheaper. "The US Navy unveiled a ship-borne laser weapon whose shots cost about $1 a piece, which radically changes the cost calculation of offense and defense."[25] Secondly, the entire process of guiding the rocket powered missile interceptor is removed in a laser-based system as the system just needs to adjust the angle of the laser transmitter. Thirdly, the magazine is unlimited, as the laser gun can keep firing as long as the power supply remains. All these advantages make laser guns a promising weapon for missile defence. However, there are, at present, challenges in using lasers for long range and high altitude interception of ballistic missiles because of the difficulty in building a solid state laser gun that could generate sufficient laser power to have that reach. And also the scattering of the laser and reduction in intensity when it has to reach a very high altitude is another challenge as enough power needs to be delivered on the target for the required time to effect a kill.

Being a state that strongly believes in realism and force, Israel is leaving no stone unturned to help itself in its continuing fight for survival as a state. The future shift in this area will be largely towards advanced and new technology and strong collaboration and partnership with countries like the United States and India.

ATTEMPTING A BIG LEAP: INDIAN BMD

The trigger for the Indian BMD programme was the Pakistani acquisition

25. Kelsey D. Atherton, "Laser to Join Israel's Missile Defense System", *Popular Science*, January 22, 2014. See http://www.popsci.com/article/technology/lasers-join-israels-missile-defense-system

of M-11 missiles from China.[26] The Indian BMD programme was initiated in 1995[27] and the first successful test firing was conducted in 2006. There has been a total of eight test firings so far and only the fourth test was aborted as the target missile deviated from its path, while the other seven tests were successful.[28] This is a remarkable achievement considering that only five countries have demonstrated successful interception of ballistic missiles. The last test in November 2012 was more significant and difficult than the previous tests as two targets were engaged simultaneously, though one was simulated.

India is the only nation to share land borders with two nuclear armed states with which it has serious territorial disputes and other security issues, and one among them (Pakistan) has a first use policy.

The Nuclear Threat Scenario

In no other part of the world are there three nuclear armed countries sharing land borders with each other.[29] More importantly, India is the only nation to share land borders with two nuclear armed states with which it has serious territorial disputes and other security issues, and one among them (Pakistan) has a first use policy. Pakistan has never declared a No-First-Use (NFU) intent, and on several occasions, has threatened to use nuclear weapons (first strike) against India or Indian forces in its territory. Pakistan is using its nuclear weapons capability as a hedge to continue its policy of bleeding India with a thousand cuts through proxy war. In other words, Pakistan is using its nuclear capability as a safeguard against any punitive conventional offensive from India in retaliation to any of its state-sponsored terrorist activities.

China which has a stated policy of NFU has very recently created a great deal of ambiguity and concern by not mentioning it in its recent defence

26. Pravin Sawhney, "Games DRDO Plays," *Force*, April 4, 2011.
27. Ibid.
28. http://idp.justthe80.com/missiles/ballistic-missile-defense-bmd-system , accessed on
29. Pakistan shares a land link with China through the occupied part of Kashmir controlled by it.

White Paper.[30] However, Col Yang Yujun, a spokesman for China's Ministry of Defence, clarified on this question unambiguously during a briefing on April 25, 2013, when he stated: "China repeatedly reaffirms that it has always pursued no-first-use nuclear weapons policy, upholds its nuclear strategy of self-defence, and never takes part in any form of nuclear arms race with any country. The policy has never been changed. The concern about changes of China's nuclear policy is unnecessary."[31] Yet there is a possibility that China is rethinking on its NFU policy largely due to the improving US conventional precision strike capability and BMD efforts. Nevertheless, ambiguity, particularly in nuclear weapons employment doctrine, is more dangerous than a clearly stated first use policy.

Pakistan and China have an advanced ballistic missile programme which was developed primarily for delivery of nuclear weapons. China has the longest and the most advanced ballistic missile programme in Asia after Russia. A recent report of the US National Air and Space Intelligence Centre (NASIC) says that "China has the most active and diverse ballistic missile development programme in the world." It further states, "It (China) is developing and testing offensive missiles, forming additional missile units, qualitatively upgrading missile systems and developing methods to counter ballistic missile defences. The Chinese ballistic missile force is expanding in both size and types of missiles."[32] China has developed and deployed various versions of ballistic missiles like the short range DF- 11, DF-15 and DF-18. Very recently, China inducted another SRBMs, the DF-12, which reportedly is a copied version of the Russian Iskander missile. In the MRBM category, China has three to four versions of the DF-21s among which the DF- 21C has a very high Circular Error Probable (CE P) of around 30m which indicates that it would be largely used for conventional strikes. The DF-21D is an anti-ship version designed to target large ships like aircraft carriers. The rest

30. James M. Acton, "Debating China's No-First-Use Commitment: James Acton Responds," *Proliferation Analysis*, Carnegie Endowment, April 22, 2013. Available at: http://carnegieendowment.org/2013/04/22/debating-china-s-no-first-use-commitment-jamesacton-responds/g0lx
31. Hui Zhang, "China's No-First-Policy Promotes Disarmament," The *Diplomat*, May 22, 2013.
32. "Ballistic & Cruise Missile Threat," National Air and Space Intelligence Centre, 2013. Available at: http://www.fas.org/programs/ssp/nukes/nuclearweapons/NASIC 2013_050813.pdf

of the DF-21 versions could be for nuclear strikes.[33] Pakistan, a recipient of covert nuclear and missile technology transfer and assistance from China also has advanced variants of ballistic missiles in its inventory.[34] Its nuclear doctrine and strategy is *wholly and solely India-centric,* designed to address perceived conventional and nuclear threats from India. Consequently, the nature and function of the Pakistani nuclear deterrent (including delivery mechanisms), as also its rules of employment and deployment, are all tailored to meet this one requirement.[35] Added to this, there is also the danger of the Pakistani nuclear weapons falling into the hands of Islamic radicals either within the state institution or outside. The attack on the Pakistan Naval Station (PNS) Mehran, is an example where the terrorist attack is believed to have taken place with insider help. It is also believed that the base is a storage site for the Pakistani nuclear arsenal.[36] Moreover, if Pakistan deploys its tactical battlefield nuclear missile, the Nasr, which by its nature should have a decentralised command and control, then the possibility of radical elements gaining access to tactical nuclear weapons is high, leading to possible unauthorised use.

Indian interest in acquiring BMD capability started in the mid-Nineties when Pakistan acquired advanced Chinese SRBMs. Initially, India had considered all options, from developing an indigenous BMD system to acquiring the systems from other countries. For indigenous development, the Akash low-to-medium range surface-to-air missile system was considered as the base line system. The plan was to deploy a system capable of shooting down ballistic missiles with ranges up to 2,000 km. For this requirement, the range of the Rajendra phased array radar which was just 50 km had to be increased to 500–600 km. Foreign systems, including the Russian S-300s and the Israeli Arrow systems, were also considered initially. India began negotiations with the Russians for acquiring the S-300 SAM technology,

33. The CEPs of other DF-21 versions other than DF-21C and DF-21 D are comparatively large and, hence, could be used for nuclear delivery, while the more accurate ones will be suitable for conventional precision attacks.
34. Duncan Lennox, *Jane's Strategic Weapons Systems* (Surrey, UK, 2011), issue 55.
35. Manpreet Sethi, *Nuclear Strategy: India's March Towards Credible Deterrence* (New Delhi: Knowledge World, 2009), p. 45 (pp. 43-86).
36. Kelsey Davenport, "Militants Attack Pakistani Base," *Arms Control Today*, September 2012.

which also has the capability to engage SRBMs.[37] "An Indian delegation, led by the minister of defence, reportedly observed the testing of the S-300V system in August 1995 at Russia's Kapustin Yar firing range. In addition, Russia displayed the S-300PMU-1 at India's second international military equipment exhibition in March 1996. At the end of 1996, Oleg Sidorenko, deputy director general of Rosvoroozhenie, Russia's arms export agency, stated: "Negotiations are more than half way through and we expect to sell the systems to India very soon."[38]After much consideration, India chose the Arrow technology over the Russian system probably because the Israeli system is a dedicated Anti-Theatre Ballistic Missile (ATBM) system unlike the S-300 which is primarily an anti-aircraft system. In the Nineties, there was the problem of US approval as it was a joint programme between the US and Israel. However, India acquired the technology of the Israeli Green Pine Long Range Tracking Radar (LRTR) and adopted the technology for the Indian BMD system along with a Thales built fire control and battle management radar. The purely indigenous components in the Indian system are the two interceptors: one, endo-atmospheric, and other, exo-atmospheric.

A total of eight tests was conducted, out of which seven were successful. Only the fourth test was a failure because of the target missile malfunction. The interceptors are based on the Prithvi and Akash air defence system with a radio-proximity fuse. In all the tests, the target missile was a Prithvi missile with its trajectory modified to simulate the trajectory of a 600 km range missile. The Defence Research and Development Organisation (DRDO) scientists claim that the system is ready for deployment and they propose Delhi and Mumbai, the national capital and the commercial capital respectively, to be the first sites to be protected. However, the deployment decision would be political. Is the system actually ready for deployment? A technical analysis of the tests shows that the system will not be effective at the present stage and is not ready for deployment. All the tests have been conducted under highly scripted and controlled conditions. Despite all

37. Gregory Koblentz, "Viewpoint: Theatre Missile Defence and South Asia: A Volatile Mix," *The Nonproliferation Review*, Spring-Summer 1997, p. 55.
38. Ibid.

these shortcomings, it is still a major achievement considering the fact that the programme was started from scratch, without even the technological base to develop such a complex weapon system. Though technology was bought from foreign sources, it gives the Indian scientists the knowhow and experience in building and integrating the components of the system. With this as the foundation, India should focus on attaining the capability to develop core technologies that will lay the foundation for better innovation and mastering of better system design and development. The knowhow created out of indigenous Research and Development (R&D) would help in developing future systems and also in improving the existing system.

Reactions from Across the Border

Pakistan has reacted by going for an increase in its nuclear arsenal citing the Indian BMD project. The chances of Pakistan responding by initiating the development of a BMD system of its own is out of the question, in view of its far inferior technology base, and the fact that no country except China would be ready to provide it with the technology required to build such systems. The question of Pakistan procuring the system off the shelf is not practical given the state of its economy, as the cost of the system would be enormous. Besides that, China is the only country that could provide Pakistan with such a system, most probably its reengineered version of the S-300: the HQ-9 system which is claimed to have the capability to shoot down SRBMs. Across the northern border, there seems to be not much reaction from the Chinese government on the Indian efforts to acquire BMD capability. However, according to Dr. Lora Saalman, a significant number of Chinese articles in academic and strategic journals since 2005 have focussed on India's missile defence developments, independently from their traditional competitor, the United States. There has been a shift in the Chinese academic community's interest from the technical developments in India's missile defence programme to its strategic implications in regional politics.[39]

39. "Chinese Views on India's Ballistic Missile Defense", http://www.csc.iitm.ac.in/?q=node/313, April 25, 2013.

The Indian capability in BMD is not mature enough and at best can be described as baby steps. India has a long way to go in acquiring true BMD capability. It would be beneficial for India to go for deeper collaboration in this area with Israel and the United States. The Indian government should invest more money in R&D to indigenously develop the capability to design and manufacture core components required for the system. It is to be noted that the present BMD project is funded by the Indian Air Force.

CONCLUSION

The effectiveness of ballistic missile defence systems is a subject of a major debate internationally. Offence has an upper hand at present as slight modifications and additions to the ballistic missiles, which are relatively easy to achieve, can defeat any defence system. This has made defence against ballistic missiles much more complicated. Most of the missile defence tests the world over were conducted under heavily managed conditions which is evident from the various independent technical analyses of the declared test details. However, though there are doubts, the progress of technology in this area has been quite impressive, given the complex nature of the technology requirements. In Asia, Israel, in collaboration with the United States, is leading in this area, followed by Japan, China and India. The encouraging factor is that these countries believe in missile defence technology to protect against ballistic missile attacks. One primary reason for this is that other options do not guarantee complete protection against ballistic missile attacks. Missile defence too does not offer complete protection at present. However, as technology evolves, it can be expected to become more effective in the future. One other factor to be noted is that, in Asia, of the countries that are pursuing BMD technology, none except China, perceives a threat of ICBM strikes. Japan, South Korea, Taiwan, India and Israel are facing threats from SRBMs, MRBMs and IRBMs and their BMD pursuits are expected to be restricted to defend against these threats. Another reality is that the United States will continue to have its presence with heavy involvement in the missile defence efforts in collaboration with allies and friends in the Asian continent.