Ballistic Missile Defence: Likely Meaningful Completion or Irrational Indulgence?

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Abstract

The demand for an infallible missile and homeland defence against anticipatory threats from adversarial state actors as well as amorphous non-state actors has become accentuated in the US in the post-9/11 era. In consonance, the importance of anti-missile defence shield has grown in primacy and has witnessed a changing orientation to an amalgamation of an integrated Layered Defence System. However, the two main question on the development of such a system are whether it will reach a meaningful completion and whether such a system will be cost-effectived. The project has been facing considerable opposition both politically (internationally and nationally) and technically. Part of the technical opposition has been instrumental in inducing many changes in the system verification procedures and its likely architectural aspects. Some of the individual components of the system are still far from being deployed but many are nearing completion/are already deployed. Given the current determination of the Bush Administration and the state of testing, a rudimentary, nascent, North Korea-centric GMS may well be in place by 2005-2006. Due to an absence of a formatted comprehensive architecture and variables such as political will in future, cost estimates of the system have swung very widely (US$ 60 billion to US$ 238 billion to US$ 1 trillion!!). But the basic question has always remained — at what price the feeling of security? Especially in a security phobic post-9/11 era.

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The Ballistic Missile Defence system (BMDS) in its earlier media-publicised manifestation of the NMD had witnessed considerable debate and national/international focus. Its branding as a system with a futuristic trajectory, since the early days of the Strategic Defense Initiative (SDI) has on one hand created considerable doubts about its meaningful completion and on the other raised eyebrows in many an intended/effected state. The

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debate on both aspects has refused to die down despite many crests and troughs. On the completion aspect these ups and downs (atleast to the public mind) have been closely linked to the success/failures of the media hyped Integrated Flight Tests (IFTs) and the Bush Administration's determination to go ahead with the entire project while having a rudimentary system in place by end 2004.

On the international scenario, the opposition to ABM Treaty abrogation seems to have muted itself. This was not mainly because of the non-occurrence of the arms race, doomsday predictions of many an analyst, but due to the fructification of mutually beneficial deals especially with the vociferous opponents like China and Russia.

The possibility of a meaningful completion of the entire synthesised system or its components lies in the parameters of the term 'meaningful'. Would such a completion involve only the technological attainment of various degrees of capabilities in stated phases? Or additionally, will it also have the ability to provide value added defence against the vast budgetary allocations that have been made for the system for attainment of the required highest technological regime — a system requirement? An attempt is made in this paper at exploring these two moot questions.

An Expanding Missile Defence Shield and its Changing Orientation

Prior to exploring the ability and the likely prospects of the entire system to reach meaningful completion, it is essential to evaluate the background of the evolution of the BMD itself.

The idea of defending the CONUS against ballistic missiles with the help of anti-missile systems is not new but it received a giant impetus from President Reagan's March 1983, so called, 'Star Wars' speech. The subsequent SDI programme (Strategic Defence Initiative or the Star Wars Programme as it was commonly known) underwent many twists and turns through umpteen reviews and finally the NMD evolved in 1997 with many basic objectives that were similar.[1]

However, the break up of the Soviet Union and the dissipation of the Cold War led to a rethinking on threat perceptions. While the threat from missile attacks from a much weaker Russia reduced on the one hand, on the other, the Gulf War exposed the reality that US forces overseas and their allies faced a perceptible threat from Third World ballistic missiles of

relatively shorter ranges. This anticipation of an increasing number of missile-capable adversarial states set the tone for future threats from the so called 'rogue nations'. In addition, the emerging threat from the missile-capable Chinese (though unstated officially) was another important factor that accentuated the change of the thinking patterns. Thus, the changing world order coupled with this renewed threat perception led to a reorientation of the entire missile defence programme. Efforts were channelised into two distinct areas, i.e., the Theatre Missile Defense (TMD) Programme, mainly intended to protect US forces overseas and its allies anywhere in the world against short-range ballistic missiles, and the National Missile Defence (NMD) programme, for defence against long range ballistic missiles.

In end 2001 the US gave notice for abrogating the strategically important ABM Treaty of 1972. Amongst others, the treaty ensured the maintenance of vulnerability of both the earlier Super Powers and restricted the development/deployment of missile defence shields — thus maintaining deterrence stability. The treaty was finally scrapped in June 2002, clearing the path for unrestricted development and deployment of the BMDS mainly the Ground-based Mid-course Segment and other upper tier systems, including setting up of the 'test bed' at Fort Greeley Alaska.[2]

In January 2002, the Bush Administration upgraded and redesignated the nodal BMDO as the Missile Defence Agency (MDA), increasing its national priority and importance especially in the post-9/11 scenario. Simultaneously, in an overview of the entire BMDS under the Department of Defense (DoD), the Administration also started exploring numerous architectural options and concepts. Presently, the concept of a 'layered architecture' seems to be dominant. This new reoriented thrust is intended to concentrate on the integration of the technologies involving land, sea, air and space-based platforms to counter ballistic missiles in all phases of their flight, i.e., boost, mid-course and terminal.[3] The aim is to provide multiple engagement opportunities to different engaging systems along each phase of the flight path.[4]

Apart from this, as part of the reorientation, the nomenclature of the BMD programmes have undergone a change even though the parameters of the individual programmes have more or less remained the same. The MDA has delineated the entire BMD into nine Program Elements (PE) mainly comprising the BMD System; the Terminal, Mid-Course and Boost

Defence Segments[5].

The other important aspect of the change in the policy that has a large significance towards the development of the programme, has been the near abandonment of the earlier norm of clearly marked activities, fixed milestones and demarcated phases showing the road to production. These have now been left flexible, erasing the time schedules and reducing the pressure on the programme developers to produce technological results within fixed time-frames[6].

Policy of Layered Defence

The layered defence concept, as a policy is not a new. Its applicability however, to the missile defence shield has received much more attention and focus than individual missile systems or the Family of Systems (FoS) like the erstwhile NMD or the TMD (Theatre Missile Defence), that were the foci of earlier media attention. *Prima facie,* this reorientation seems to have been a more logical outcome due to a shift in the nomenclature and in nuances, rather than any major fundamental aspect.

In 1998, Gen. J. Ralston, the Vice-Chairman of the Joint Chiefs of Staff, stated in a deposition to the Senate Armed Forces Committee that his department was pursuing a multilayered approach towards missile defence consisting of lower tier, upper tier and boost phase intercept systems. The main idea was to have the flexibility of approach in engaging an incoming missile threat in every phase of its flight, at times ranging from crisis to that of a war.[7]

More recently, in January 2002, US Secretary of Defense Donald Rumsfeld issued a memorandum outlining the future direction of the DoD missile defence programme in which he identified four main objectives:-[8]

- To defend US deployed forces, allies and friends
- To employ a Ballistic Missile Defence System (BMDS) that layers defences to intercept missiles in all phases of their flight
- To enable the services to field elements of the overall BMDS as soon as practicable
- To develop test technologies and improve the effectiveness of deployed capability by inserting new technologies as they become available or when threat warrants, on an accelerated basis.

The erstwhile BMDO (now MDA) has pursued the capability to intercept missiles in different phases of their flight, thus, technically hoping to involve different interceptors with complementary if not different KVs (Killer Vehicles), at different times of engagement with (possibly) a uniform central command and control component for the entire system.

Thus, we see the entire missile defence policy acquiring a reoriented policy with the concept of layered defence coming into fore in an effort to make the entire system more flexible, integrated and also achievable — a focused move towards its meaningful completion.

The Opposing Nay Sayers

After having very briefly explored the changing policy orientation of the anti-missile, it is necessary to have an objective overview of the powerful dissonance that exists against the development of the entire system prior to evaluating its chances of 'meaningful completion.'

As is evident there has been considerable international/political opinion against the deployment/development patterns of the missile defence system based on geopolitical imperatives and implications of such an eventuality.

The Russians have opposed the system as there is a feeling amongst them that it effects the strategic balance and the mutual vulnerability as was enshrined in the ABM Treaty that has been abrogated since 2002. The common Russian thinking that the system has considerable ability to influence the deterrence equation is a debatable point of view. This is because it is obvious to any serious analyst that even in its most advanced format the Russian missiles, given their large arsenal, can easily saturate the missile shield. The reduced power status of the Russians, their baggage of economic dependence on the US and the latter's efforts at rapprochement has largely helped in muting the opposition to this shield. The recent overtures by the US in getting the Russians to join the bandwagon and cooperate in the development of the shield[9] has not only muted the opposition further but 'queered the pitch' for the Chinese who wanted to join forces with the Russians and sought a 'common cause' on the issue.

The Chinese had initially been one of the most vociferous opponents of the system deployment and development. Their view was – and probably not without justification — that the entire NMD was essentially directed against their arsenal and that the stated threat from rogue states had a large

element of façade built into it. While their initial apprehension had been about the Taiwan-based erstwhile TMD, it has now been realised by them that different systems from the layered defence programme deployed against them, can 'negate' not only their strategic arsenal but also their sub-strategic missile arsenal. Despite this realisation the opposition to the system has been remarkably muted at most crucial times betraying a desire to come to some mutually adjustable and beneficial deal with the US on the issue.

In addition, a few scientists and scientific organisations have opined that many individual components of the shield are unworkable and unviable technically as they do not qualify towards the 'aim sustenance' of the system. In this context concerned scientists have submitted alternative architectural options to overcome some of the lacunae. For example, the Garwin and Postol Boost Phase Proposal seeks to have sea-based interceptors on cargo ships rather than on Aegis class destroyers due to the perceived requirement of large interceptors to achieve a high V_{bo} (velocity burn out).[10]

One of the foremost critics to oppose the system and its accompanying cover-ups by the concerned authorities has been Prof. Theodore Postol of the MIT. He has charged the BMDO with 'elaborate scientific and technical blunders' that have been compounded by fraud and misconduct.[11] He also expressed serious misgivings about the NMD's "hitting a bullet with a bullet technology" (hit to kill technology). Additionally, he has been credited (to an extent) with uncovering the massive disinformation and cover-up regarding the success rate of the Patriot missiles fired during Gulf War I to counter Iraqi Scud missiles[12] and other exaggerated success claims of early missile tests of NMD conducted in late 1990s.[13]

Other groups like the Union of Concerned Scientists (UCS) have also expressed doubts regarding the efficacy of the developing system. They opined that the technology is not ready for realising the expanding aims of the BMD. They harbour grave reservations about the ability of the system to overcome countermeasures. It has also been felt by them that the security costs of developing and deploying such a complex system far outweigh the corresponding security benefits achievable.[14]

Coupled to such near continuous opposition from enlightened groups or individuals, there have been numerous other forms of opposition too. The most publicly and commonly visible aspect of the BMDS is the media-hyped IFTs, many of which have been declared failures in their stated

objectives. Each declared failure has always managed to awaken public consciousness that questions the need to spend vast sums of money on such failures. The public opinion often gets manifested into questions by senators/Congressmen who tow the public mood and often oppose the expensive nature of the system.

The Cost Factor – An Overview

Since the cost factor is one of the primary factors required to be satisfied to ensure the continuity of the entire programme (the other being the technical aspect), it is necessary to focus on factor.

The last official cost estimate of the NMD programme provided during the Clinton Administration was US$ 60 billion while the annual allocation towards the programme hovered around US$ 8 billion.[15] It was always known that the figure of US$ 60 billion was a very conservative one probably aimed more for local consumption than a serious attempt at studying the true costs. The Bush Administration moved away from this figure and never officially attempted to pin down the costs since the specific architecture of the Layered Defence Concept had not been finalised[16] making it easier to almost use it as an excuse for avoidance of such an exercise/study.

However, the Congressional Budget Office (CBO) carried out a study that was released in January 2002.[17] It presented a nascent picture of the potential costs (in 2001-dollar terms) of different types of BMD systems. Basically, it examines three types of probable architectures that were under consideration at the time of the report. These were: -

- A ground-based mid-course intercept system
- A stand-alone sea-based mid-course intercept system
- A space-based system consisting of a constellation of satellites with lasers and interceptors.

It estimated that a system of 100 ground-based interceptors deployed at a single site at Alaska would roughly cost about US$ 23 to 25 billion to deploy and operate through 2015. The same system however with another site consisting of an additional 150 interceptors along with other space based components would cost about US$ 51 to 58 billion.[18]

The report found the sea and space-based systems were more difficult to estimate as they were in nascent stages of development or in a technology demonstrator stage. In the same context it could not provide an estimate of the sea-based boost system as the DoD had not released a description of the architecture, however preliminary. But the report does provide an estimate of US$ 43 to 55 billion for a standalone sea-based mid-course intercept system to develop, deploy and operate through 2015. [19]

The CBO report estimated that a space-based laser system in low earth orbit (LEO) with a constellation of satellites would cost US$ 56 to 68 billion to 2025. The report finally concluded by adding that the total cost of the national missile defence could not be determined definitively due to the uncertainties involved in the final architecture that may be deployed.

Since no in-depth publicly available, account of the US Government (CBO or the Defence Department or the MDA) was available that focused on the 'life cycle costs' of the all the concerned missile defence systems, a group of non-profit arms control organisations decided to rectify this lacunae. A recent comprehensive study released by the Centre for Arms Control and Non-Proliferation[20] has gone into the size, scope, costs and potential implications of the programme on the federal budget reveals startling figures.

The study report states: 'If the goal of full deployment of ground, sea and air-based systems by 2015, is to be met, half the costs — about US$ 500 billion — could be incurred in the next 13 years". Without an increase in the military budget, to cover missile defence programmes would, "displace nearly 6 per cent of other defence spending by 2005 and more than 12 per cent from 2007 through 2011" according to the report.[21] Thus, while bringing other spending down, missile defence programme spending could rise to anything between US$ 50 and 75 billion per year. This could also involve diverting spending from job training, environmental and social assistance programmes into this programme but political or technical reasons could slow down the spending on missile defence.

Richard Kaufman, a former general counsel with the Joint Economic Committee of the Congress and a co-author of the report states that nearly in all other weapons programmes (except in some secret 'black programmes') the "estimates of costs of completion are made known early in the process". However, there seems to be a "shroud of secrecy" that "has

been thrown over the missile defence"[22] that explains the lack of cost data and transparency.

The projections made by the study could be roughly tabulated as:

Table-1: Estimated Costs of Some BMDs Segments[23]

Segment/Specification	Acquisition/Operational Costs through 2015 (in US$ billions)	Life Cycle Costs through 2015 (in US$ billions)	Remarks
GMS			
Two Site	76-110	120-161	
Three Site	142-181	142-181	
SMS			
Missle Trap	27-31	42-58	
Strategic Defence	37-49	70-95	
Space-Based Laser			
48 satellites	126	310	
72 satellites	195	423	
Ground-Base Boost System			
Four Site	22.5	28	System not yet announced or official feasibility study conducted requires basing sites in Russia and Central Asia
Eight Site	30.1	41.8	
Sea-Based Boost System			
Cargo Ships24-Five Patrol Areas	61.4	-	Still on drawing board
Cargo Ships-Seven Patrol Areas	71	-	
Air Borne Laser			
Boeing 747s (7 aircraft)	11.2	19.3	Does not indude operating costs of fighter aircrafts for protection

However, it must also be stated that the conclusions of the elaborate cost study covering various aspects of the system could easily get nuanced or modified with any drastic change in the hypothetical architecture. Additionally, these projected conclusions are largely dependent on the political will/drive and leadership and could alter considerably if there is any large change with respect to these two aspects.

Meaningful Completion or Irrational Indulgence?

One of the primary questions that has followed the entire missile defence programme since the days of President Reagan's futuristic branded SDI speech of 1983 has been — will the concept ever fructify into something meaningful? The passing years have not seen this persistent query abating but instead has intensified due to the associated media attention that has followed the international opposition and internal debates resulting directly or indirectly from large budgetary allocations.

The question of its completion needs to be explored in its proper perspective. Earlier the missile shield was closely identified with either the land-based anti-ballistic missile component (the erstwhile NMD) or the lesser capable TMD elements. The international objections and debate mainly focussed around these two systems, depending on the geo- political/ security implications of the affected country. However, with the change in the policy and with the structured evolution of the system, the shield has come within the ambit of the layered defence concept. It has manifested itself into a complex amalgam of various independent anti-missile systems that are woven together with the objective of getting a foolproof robust and flexible shield. Thus, in a way, the individual systems have lost their singular relevance to an extent and have emerged as part of a larger system. Hence, implications for individual systems that had been forecasted earlier would probably warrant a review to account for the change in the basic policy. Thus, completion of the shield would mean not only a capable GMS (erstwhile NMD) or the SMS but also the other associated systems.

Taking some of the systems individually, the Air-Based Laser (ABL, within the Boost Phase Segment, BDS) involves the use of a fleet of modified Boeing 747-400Fs. It will have an initial operational capability (IOC) involving three aircrafts, by Fiscal Year (FY) 2009. Full operational capability (FOC) with all seven platforms will be achieved by FY 2011. However, it has been stated that even though the system presently is in the early stages of its development, an initial emergency ABL-capable aircraft may well be ready by 2005 though a fully operational and capable aircraft is likely to be ready a decade later.[25] Thus, the aim of achieving their FOC will obviously depend largely on extensive testing results that are likely to follow the initial/nascent deployment. Another conceived system in this segment, the Space-Based Laser programme is still in its conceptual stage.

In contrast, the BPI for the sea-based systems seems to have reached an advanced experimental stage and on completion this system will have major strategic implications as and when deployed.[26]

The Mid-Course Segment (MDS) has the primary component of the GMS (erstwhile NMD) and much of the public perception of the shield's success or failure is still hinged to this system. The highly publicised IFTs (Integrated Flight Tests), eight of which were completed and three have been declared successes, have been in the public mind. Prior to the reorganisation of the programme, the following pathway had been planned. The IOC of the CRD[27] Cap 1 capability with 20 to 100 interceptors based at Alaska was supposed to be around 2004-2005. The Cap 2 capability (or expanded Cap 1) with 100 interceptors at Alaska was to have an IOC by 2007. The final and most complex Cap 3 capability with 125 interceptors at two bases each (Alaska and probably North Dakota) was supposed to be achieved by 2010-2015.

However, with the present level of technological progress and the recent decision to avoid undue publicity regarding the testing programme (probably due to lack of progress), it is unlikely that the above roadmap will be followed. Instead, President Bush has categorically declared that a rudimentary missile defence system will be in place by October 2004.[28] This system, primarily structured to provide protection from North Korean launches, in all likelihood would comprise six land-based interceptors at Alaska and four at California. Ten sea-based interceptors on three Aegis class destroyers would later supplement this system.[29]

Having shed its futuristic trajectory of the early 1980s, presently, the system has certainly come a long way, though may not have achieved the success that it had hoped to. At the current juncture it is not difficult to predict that a nascent system with minimal capabilities of a land-based and sea-based system will be in place by mid or end 2005 and this will undoubtedly be an important step in its evolutionary progress. However, a guess regarding the Cap 2 and Cap 3 systems, or their associated present equivalents will be more difficult to make as they will depend largely on the 'capabilities desired' vis-à-vis the results of the testing. A decade for the final evolution of the Cap 3 system may be too optimistic and an estimate of atleast 15-20 years more to attain that status would be none pragmatic.

The Theatre High Altitude Area Defence (THAAD), that is basically intended to provide defence against short and medium range missiles and engage them in their terminal phase at high altitudes, is expected to have an IOC of around FY2007. On the other hand, the Arrow Weapon System (AWS) that is expected to provide the Israelis a formidable defence against medium and short-range ballistic missiles (in addition to defending US troops in the region), was declared operational a month after a successful intercept test in September 2000. Israel is thought to have two operational Arrow batteries: one at the testing site on the coast at the Palmachim base, south of Tel Aviv; the other covering the central part of the country to the east of the town of Hadera.[30]

The PAC-2 (Patriot Advanced Capability) has already seen deployment in various theatres including the 'hot spot' of Taiwan. It has had its advanced version the PAC-3 extensively tested and is expected to enter US Army service soon.[31] It is to be used for defending forward deployed forces against cruise missiles and tactical ballistic missiles (TBMs) and the successful testing has prompted, Germany and the Netherlands to seek purchase of 300 and 128 of these PAC-3 missiles respectively, at a projected cost of US$ 2.4 million per round.[32] Had there been any apprehension in completion of the project, such advance orders from the countries were unlikely to have fructified.

The MEADS (Medium Extended Air Defence System) system on the other hand is expected to achieve IOC in 2012 and is expected to replace the Patriot system with the US Army by 2028 while providing mobile defence to the German and Italian forces [33]

Thus, we see from the foregoing, that the term 'meaningful completion' in the context of the anti-missile shield has many aspects and nuances to it. Its restricted parameters as understood earlier have undergone a change and have seen an expansion when viewed within the ambit of the 'layered defence concept'. While it may take some time to be deployed as a whole shield, various individual important components have already been developed and deployed or are in various stages of development nearing completion. No doubt some of the component systems may still seem fanciful now and are still on the 'proof of concept' stage but the important elements are well on their way to completion, albeit some with compromised capabilities. To use an illustrative synonym the patches of the quilt are nearing completion and it is a matter of time when the whole

quilt materialises. It has however to be admitted that the process of development is not without hurdles given the cutting edge technologies that go into the system. But with the sustained political will, determination of the US Administration, the prevailing feeling of insecurity post-9/11 and the vast amounts of financial allocations, success may be far but is not an elusive dream any longer.

The other important question that needs to be answered is, will the entire system prove to be cost effective in providing the desired level of security in view of the large budgetary allocation every year? This question is in a way linked to the eternal philosophical debate regarding "Security at what price, or rather, what is the appropriate price for ensuring security especially in a security-phobic post-9/11 era?" Obviously, a philosophical debate on this issue is quite outside the scope of this paper but it can be stated that the cutting edge technologies being used by the system demand heavy financial investments and flexible goals. There is little doubt that the initial estimates of US$ 60 billion were grossly understated but the cost study figure of US$ 1 trillion may also be at the other end of the spectrum. Without having decided on a specific architecture and with the political will that may change due to internal compulsions, none of these two figures are likely to form a benchmark. As a spokesman for the MDA, Lt Col Rick Lehner has stated quite aptly, "For anything that comes after FY 05, that's going to be a decision for our national leaders." The immediate question that would arise out of this surmise is, "Would the national leadership choose to forgo or delay a program that has already seen heavy financial and more importantly political investments?" A question that only time can answer precisely.[34] Whatever be the case, the fact remains that this system is a hugely expensive affair and that even if it does reach its zenith of designed capability, it can never ever provide a totally foolproof security against missile threats like any other mechanical system. The probability that a missile may well slip through will always remain. Thus, its ability to deter and raise the stakes of deterrence will always remain more at a psychological level than a practical one.

There can be no doubt that US too is feeling the pinch of the vast allocations made to this programme as it is keen to involve like-minded allies and technologically capable friends like India[35] into developing the system or its components, logically sharing some of the heavy financial burden in the hope of garnering the fruits at the end. However, since the

introduction of the missile defence system components in the South Asian region, (mainly India) is expected to have considerable effect on the regional security calculus, US is also somewhat hesitant on sharing either the technology or the crucial components of the shield. (Implications of the regional introduction of components of the missile defence shield are outside the scope of the present article and will be dealt with in a subsequent paper.)

Conclusion

The demand for an infallible missile and homeland defence against anticipatory threats from adversarial state actors as well as the amorphous non-state actors has grown in the US. In consonance, with the growing importance of anti-missile defence, the shield has grown in primacy and has witnessed a changing orientation. Vast amounts of budgetary allocations have ensured development of most of the components of the entire layered defence concept. While many of these components have actually been developed and deployed, many others like the GMD along with its sea-based counterpart SMD (dealing with shorter range of missiles), are in testing stage and may well be deployed in the near future. Given the cutting edge technologies of the entire system, it is but inevitable that hurdles be faced and at times thresholds be reduced to achieve capabilities and the time period of testing be extended. Overall, it is the inevitability factor that will hopefully win through.

The development of such cutting edge technologies requires heavy financial investments and budgetary allocations that have been a point of considerable debate and speculation regarding its projected costs. Detailed cost study efforts at this stage can provide indications on the likely final figure but go no further due to associated variables like undecided architecture, future course of political will and technological successes/failures. Thus, a realistic, evaluation of the cost-effectiveness factor may harbour the age-old 'guns versus the butter' debate in a globally security sensitive environment — post-9/11. On a more pragmatic level, the pinch of the financial burden may already have been felt so as to welcome like-minded allies and technologically capable friends like India into partaking in the development of the system or its components along with sharing of a minor portion of the financial burden. The implications of such a move are considerable given the regional geopolitical realities. These need to be studied closely.

References/End Notes

1 Also see P.K. Ghosh, Layered Defence Concept and some Architectural Options for an Expanding BMD. IDSA Fellows Seminar. New Delhi, August 24, 2002. Institute for Defence Studies and Analyses, New Delhi, 2002. (Unpublished).

2 See P.K. Ghosh, Rajesh Rajagopalan, M.V. Rappai, Abrogating the ABM. *The Hindu*. January 01, 2002.

3 For a typical intercontinental ballistic missile a boost phase lasts between 100 to 300 seconds, followed by ascent 500-600 seconds, midcourse depends to an extent on the target range but could be 1200 seconds approximately, and finally, the terminal phase is about 30 seconds.

4 Unclassified released transcript of the deposition of the Director BMDO, Lt. Gen. Ronald T Kadish USAF, before the House Armed Services Committee on July 19, 2001.

5 The nine PE comprise of the BMD System; the Terminal, Mid-course and Boost Defence Segments; Sensors; Technology; Pentagon Reservation Maintenance Fund; Small Business Innovation Research; and Headquarters.

6 This transformation could have been in part due to the various Coyle reports wherein the Administration may have finally realised its mistakes/shortcomings of the programme. Philip Coyle who was the Director of Operational Testing and Evaluation (DOT&E) in the Pentagon until February 2001 issued a series of reports (many of which were classified) critical of the Clinton Administration's NMD programme. His 1999 annual report to the Congress found that, "undo pressure has been placed on the [NMD] program to meet an artificial decision point in the development process… This is driving the program to be 'schedule' rather than 'event' driven. This pattern has historically resulted in a negative effect on virtually every troubled DoD development program." Coyle's 2000 report continued to criticise the testing schedule, noting that, "none of the (testing) scenarios were completely operationally realistic" and that, "the program is not aggressive enough to match the pace of acquisition to support deployment and the test content does not yet address important operational questions." In 2001, after months of requests by members of Congress, the Pentagon finally released an unclassified but even more detailed report by Coyle, further explaining his concerns about the NMD programme.

7 Transcript of "Statement of Gen. Joseph W Ralston, Vice-Chairman, Joint Chiefs of Staff, before Senate Armed Services Committee – October 2, 1998" at http//www.fas.org html under 1998 Congressional Hearings Special Weapons, Nuclear Chemical Biological and Missile.

8 Secretary of Defense Donald Rumsfeld, "Missile Defence Program Direction" Memorandum Office of Secretary of Defense, January 02, 2002 at http//www.defenselink.mil/news/jan2002/b01042002_bt008-02.html.

9 See "Bush Putin to discuss Missile Defence", May 04, 2003, Associated Press, at www.foxnews.com and Jeremy Feiler, US Russia take Different Views on Missile Defence Cooperation. *Inside Missile Defence*. **9** (7) 1, 13.

10 Richard Garwin and Theodore Postol have argued that off-the-shelf interceptor warheads capable of BPI of long range ballistic missiles, have necessarily to be large sized and heavy. This is due to the requirement of achieving the last second KV acceleration and axial divert movements that is needed to catch the target missile that is still in the process of rapid acceleration in the final stages of its burn. To provide a rough indication of how big a BPI interceptor will be, the notional interceptors used in their analysis resembles a Spartan Missile that weighs between 25,000 and 29,000 pounds with a height of more than 51 feet. This being in comparison to the largest Naval NTW interceptor currently under development, the SM-3/Block I that weighs only 3,100 pounds and has a height of about 26 feet. See Theodore Postol in a letter to the Editor, Foreign Policy. Sept-Oct 2000, 8. For details of the Garwin and Postol Boost Phase Proposal that seeks to have sea-based interceptors on cargo ships rather than on the Aegis class for localised boost phase interception that required the political cooperation of the Russians, see Garwin's National Missile Defense. Testimony to Senate Foreign Relations Committee, May 4, 1999 and Postol's A Russian-US Boost Phase Defense to Defend Russia and the US from Postulated Rogue State ICBMs. Washington DC, Carnegie Endowment for International Peace, October 12, 1999. For a detailed approach to the sea-based mobile layer, its concept and implications see P.K. Ghosh, Navy NMD: The Concept of Expanding NMD Seawards. *Strategic Analysis*. November 2001, 906, 915

11 Taubes, Gary, Postol vs. the Pentagon. Technology Review. April 2002, at http//www.technologyreview.com/articles/taubes0402.asp. Postol's work has been described as "the best work that anybody has done outside the bowels of Pentagon", by Philip Coyle, former Assistant Secretary of Defense.

12 An independent review of the scenario by the American Physical Society vindicated Postol's analysis that the initial results of success were fudged. Also see Gary Taubes, no. 11.

13 See GAO Report to Congressional Requestors, Missile Defense, "Review of Allegations about an Early National Missile Defense Test", February 2002 and Ted Postol, "Why Missile Defence won't Work". *Technology Review*. April 2002 at http//www.technologyreview.com/articles/postol0402.asp.

14 See "Missile Defense" at http.www.ucsusa.org/security/0missile.htm for a more detailed view of the UCS.

15 In FY01 the total BMD programme had a budget of $5.289 billion. This included $610.7 million for Aerospace (that included, ABL, SBL, SBIRS Low), $727.4million for sea-based systems (included NTW and Navy Area) and $881.2 million for BMDS Common. For FY 2002 the house provided for $8.2 billion of the $8.3 billion (of which $1.3 billion was to be transferred to Lower tier systems) requested for missile defence. This included $1060.1 million for

Aerospace (that included, ABL, SBL, SBIRS Low), $1041.5 million for sea-based systems (included NTW and Navy Area), and $1159 million for BMDS.

16 For likely architectural options of the Layered Defence Concept, see no.1

17 Congressional Budget Office (CBO), "Estimated Costs and Technical Characteristics of Selected National Missile Defence Systems", January 2002 at http//www.cbo.gov

18 Ibid p. 9.

19 Ibid. pp. 2, 3.

20 The report "The Full Costs of Ballistic Missile Defence", released by Centre for Arms Control and Non- Proliferation and Economists Allied for Arms Reduction at a conference of American Economic Association on 03 January 2003 as cited in Jeremy Feiler, Fully Deployed Missile Defence System Could Cost Upto $I trillion, study says. *Inside Missile Defence*. January 8, 2003, **9** (1) 1

21 Ibid. p.8

22 "Bush Putin to discuss Missile Defence", no.9

23 Duffy, Thomas, Kadish: ABL could be Headed For 20%Cost Over run. *Inside Missile Defence*. April 16, 2003, **9** (8) 1.

24 For implications of sea based systems, see P.K. Ghosh, Navy NMD: The Concept of Expanding NMD Seawards, no.10, pp.897-920.

25 The land-based erstwhile NMD system was required to develop its programme through the evolution of three levels of capability or threshold levels as was specified in the Capstone Requirement Document (CRD). While the precise technical specifications of CRD threshold levels were classified and hence unavailable but it was generally believed that Capability 1(C 1) level implied defence against a "few simple" missiles. This could mean an attack from five single warhead missiles with unsophisticated decoys plus chaff and other simple countermeasures could be discriminated. The systems should have achieved this status by 2003. Capability 2 (or C2) implies defence against 'few complex' missiles. This has been interpreted as an attack of five single warhead missile with complex decoys (upto four) with numerous other counter measures. Cap 3 (or C3) satisfies the entire CRD objective. It implies defence against "many complex" missiles which has been understood as defence against twenty single warhead missiles equipped with upto five credible decoys each a host of other counter measures.

26 "Bush Gives go ahead to Missile Defence".December, 17, 2002, BBC News at http://news.bbc.co.uk/2/hi/americas/2584069.stm and also Jonathan Marcus "Missile defence Strategy", December, 17, 2002 at http://news.bbc.co.uk/2/hi/americas/2584527.stm.

27 Graham, Bradley, "Missile Defence to Start in 2004", December 18 2002, p A01 at www.washingtonpost.com and Jeremy Feiler, Vitter Introduces Two Bills Supporting Missile Defense Deployment. *Inside Missile Defence*. April 16, 2003, **9** (8) 8.

28 Marcus, Jonathan, "Analysis Israel's New Missile Defence" January 7, 2003 at http://news.bbc.co.uk/2/hi/middle_east/2631295.stm.

29 During the recent Iraq War 2003 it has been reported that it was a PAC-3 that had shot down a Tornado in a case of friendly fire and in another similar incident it locked on to a F-16 that managed to escape. This would imply that the PAC 3 is already being used by the US Army. However, this needs further confirmation and study. Also see Tom Infield, "Friendly Fire remains a Problem for US" Review News Service, April 19, 2003 at www.globalsecurity.org under Iraq Latest.

30 Hewish, Mark, Back in the Melting Pot. *Jane's International Defence Review*. March 2002, **35** 21.

31 See List of Major Defense Programs. *Inside Missile Defence*. June 12, 2002, **8** (12) 24-25.

32 Feiler, Jeremy, no. 20, p. 8.

33 Thapar, Vishal, "India on US Missile defence Band Wagon" at www.hindustantimes.com on May 27, 2002.

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