



DEPARTMENT OF DEFENSE
MISSILE DEFENSE AGENCY
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MEMORANDUM FOR UNDER SECRETARY OF DEFENSE, ACQUISITION,
TECHNOLOGY AND LOGISTICS

SUBJECT: Final Report of the Defense Science Board (DSB) Task Force on Science and
Technology Issues of Early Intercept Ballistic Missile Defense Feasibility

Thank you for the opportunity to respond to subject report of the Defense Science Board (DSB), forwarded under your signature, October 20, 2011.

The DSB Task Force on Early Intercept has recently posted its report on their website; however, even though the report has been publically released, I am responding to your original request for my comments by 15 December to ensure a record of MDA's comments. While the substance of the report is supportive of the tenets and architecture of MDA's Phased Adaptive Approach, the conclusions regarding Early Intercept are not in conformance with the Terms of Reference (TOR) under which the Task Force was convened nor reflect how we are employing Early Intercept to expand our missile defense battle space.

Specifically, the Task Force concludes that there is often confusion as to what Early Intercept means. However the TOR clearly defines Early Intercept as that period "from thrust termination to *final* [emphasis added] deployment of reentry vehicles and countermeasures." The Task Force chose to reinterpret Early Intercept as the time from thrust termination to "a canonical time of 100 seconds post boost." This is in direct contradiction to both the TOR and to the Task Force's own data (Figure RMS-1), which shows the last release of objects occurs up to 500 seconds after boost termination.

The Task Force only recognized the value of Early Intercept in terms of *denial* of the use of penetration aids or submunitions (i.e., interception before they are dispersed). The Task Force ignores the significant benefits of forcing an adversary to deploy those countermeasures earlier than their optimum deployment timeline. Among these benefits are: (1) placing doubt in the mind of the adversary war planner regarding when to initiate the deployment sequence; (2) decreasing the time available for, and therefore increasing the complexity of, countermeasure or submunition deployment; (3) increasing the ballistic error uncertainty of the deployed objects which will occur over a longer trajectory; (4) mitigating the defense challenges of engaging the threat during non-ballistic deployment maneuvers; (5) reducing the challenge of dealing with multiple, closely spaced objects just prior to intercept; (6) reducing the time of flight of the defending interceptor, resulting in lower interceptor insertion errors and less error propagation time of initial track errors; (7) providing longer viewing time of deployment maneuvers for forward-based sensors; and (8) providing robustness to depressed trajectory tactics, as a complement to the robustness of rearward based weapon sites (e.g., Ground-based Midcourse Defense) to lofted trajectory tactics.

In addition, the DSB concludes (page 3) that “the Early Intercept concept is not a particularly useful organizing principal [sic].” MDA has never proposed Early Intercept as an organizing principle, thus the TOR did not ask the Task Force to review BMDS organizing principles.

I agree with the majority of the technical content of the DSB Task Force Report. I recommend that the DSB reconsider its reinterpretation of the definition and acknowledge the additional benefits of Early Intercept. Detailed comments are provided in the attached comment review matrix.

My Point of Contact is my Director for Engineering, Mr. Keith Englander, (571) 231-8019, keith.englander@mda.mil.


PATRICK J. O'REILLY
Lieutenant General, USA
Director

Attachment
As stated

cc:
Defense Science Board – CDR Doug Reinhold, USN
DSB Chairman – Dr. Paul Kaminski
Co-Chairman – GEN Lester L. Lyles, USAF (Ret)
Co-Chairman – ADM William J. Fallon, USN (Ret)

#	SECTION	PAGE	PARA	LINE(S)	ORIGINAL TEXT	PROPOSED CHANGE	Rationale for Change
1	DSB Chairman's Forwarding Memo	3	2	1-5	In the context of a regional BMD system, the task force concluded that the Early Intercept concept is not a particularly useful organizing principal. ...	DELETE	Early Intercept (EI) was never proposed as an "organizing principle" for missile defense, nor did the Task Force Terms of Reference (TOR) ask the DSB to review BMDs organizing principals. The Task Force finding implies that Early Intercept would replace or devalue the remainder of the BMDs architecture, and that is not MDA's proposal. We agree with the DSB that EI should be employed to expand the battlespace.
2	Fallon/Lyles Forwarding Memo	4	2	1-3	The task force concluded that there is often confusion as to what EI means and concluded that EI per se is not a particularly useful goal or protocol for design of a regional BMD system.	DELETE	EI was clearly defined in the Task Force TOR as "from thrust termination to the final deployment of reentry vehicles and countermeasures." The Task Force chose to reinterpret the end of useful EI to be less than 100 seconds after burnout. We disagree with that interpretation. Figure RMS-1 shows clearly that countermeasures (CMs) and re-entry vehicles (RVs) may be deployed as late as 500 seconds after burnout. The later an RV or CM is deployed, the more effective it is. Conversely, the earlier an RV or CM is deployed the less effective it may be, and the more difficult to deploy it is. Thus there is benefit to forcing an adversary to deploy RVs or CMs early, even if they are not destroyed by the defense.
3		5	2	1	The task force concluded that despite the confusion surrounding the concept of EI,	DELETE	See comment above. There should have been no confusion as to the definition included in the TOR.
4	Introduction and Summary	7	6	All	Overall , we conclude that EI per se is not a particularly useful goal or protocol for design of a regional BMD system. ...	DELETE AND REPLACE WITH: "The task force concludes that MDA's approach to developing and fielding a forward-based, highly networked regional BMD capability is sound, especially when measured by the traditional BMD attributes including Battlespace, Defended Area and Single Shot Probability of Kill. These attributes enable, respectively: [Continue with existing paragraph]"	Eliminates discussion of definition of EI and focuses on Task Force finding that MDA program approach is sound.
5	Introduction and Summary	7	6	Bullet #3	High single shot probability of kill - ...	MDA prefers to use the broader metric of Probability of Engagement Success (Pes) which includes the availability and reliability of the overall system, not just the interceptor, and also incorporates the effect of multiple shots in a salvo.	

#	SECTION	PAGE	PARA	LINE(S)	ORIGINAL TEXT	PROPOSED CHANGE	Rationale for Change
6	Chapter 1	9	1	1	<p>Possible Value of EI</p> <p>After much discussion and a number of briefings by MDA and others, the Task Force identified three potential areas in which EI, if achievable, might have considerable value.</p> <ul style="list-style-type: none"> • The ability to deny an adversary the use of penetration aids or early release of submunitions: While boost-phase intercept (currently not feasible) is a fundamental counter to either of these offense tactics, there could be some value in a post-boost intercept, provided it was early enough. • The ability to achieve a S-A-S firing doctrine: If the first shot by the defense could be made early enough in the ballistic missile trajectory, sufficient time might remain to assess the lethality of the first shot before firing an additional interceptor missile(s). As will be shown, a S-A-S firing doctrine offers the potential for cost savings by reducing required interceptors per enemy ballistic missile. • The ability to achieve a large defensive footprint or area of protection: By a suitable combination of interceptor location and interceptor velocity, an intercept early in the offensive trajectory can cast a large defensive "shadow" – i.e., the azimuth and elevation spread of outgoing ballistic missiles heading 	<p>This paragraph fails to point out several key advantages of the EI concept, including those directly associated with forcing an adversary to deploy countermeasures or submunitions early. Among these are: (1) placing doubt in the mind of the adversary war planner regarding when to initiate the deployment sequence; (2) decreasing the time available for, and therefore increasing the complexity of, countermeasure or submunition deployment; (3) increasing the ballistic error uncertainty of the deployed objects which will occur over a longer trajectory; (4) mitigating the defense challenges of engaging the threat during non-ballistic deployment maneuvers; (5) reducing the challenge of dealing with multiple, closely spaced objects just prior to intercept; (6) reducing the time of flight of the defending interceptor, resulting in lower interceptor insertion errors and less error propagation time of initial track errors; (7) providing longer viewing time of deployment maneuvers for forward-based sensors; and (8) providing robustness to depressed trajectory tactics, as a complement to the robustness of rearward based weapon sites to lofted trajectory tactics. In particular, the forward-based SM-3 IIB interceptor is a cost-effective complement to the Ground Based Midcourse (GMD) homeland defense capability.</p>	<p>Provides more balanced view of the advantages of EI. Does not limit the penaid argument to solely that of denying the ability to release.</p>
7	Chapter 1	9	2	1-6	Deny the Use of Penetration Aids or Early Release of Submunitions	<p>See comment above. The value of EI is not solely based on <i>denying</i> of use of penaid or submunitions. This entire section ignores the value of forcing an attacker to release submunitions earlier after boost than he might otherwise find optimum.</p>	
8	Chapter 1	10	1	1-3	<p>If the benefit of the defense's EI in countering release of ballistic missile penaid or submunitions is to be realized, then the defense must achieve its intercept, at the latest, within the time after burnout highlighted in blue.</p>		

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9	Chapter 1	10	2	1	Save defense missile assets with a S-A-S firing doctrine. In general, for realistic values of single-shot kill probability (P_{ssk}), if the ballistic missile defense is to achieve low leakage, multiple shots will be required against each incoming enemy ballistic missile. For example, if the defense system can achieve a P_{ssk} of 0.85 for each missile it shoots, and this statistic is independent shot-to-shot, achieving a 50% probability of no leakers against a raid of 30 tactical ballistic missiles (TBMs) will require the defense to shoot three missiles at each incoming TBM. In order to achieve a 90% probability of no leakers, four defense missiles must be devoted to each incoming offense missile. This obviously can become a very expensive requirement for the defense. If, as an alternative to simply firing salvos of defense missiles at each incoming missile, time is available to fire one missile, observe what happens from that engagement, and then fire the remaining missile(s) only if the assessment is made that the first shot was not successful, then the potential exists to save significant defense resources. For the P_{ssk} of 0.85 that we used above, the probability that the first missile will not be successful is 0.15 ($1-0.85$) and thus only 15% of the time will the other missiles have to be fired. For the 0.5 probability of no leakage against the example	MDA uses a metric for the probability of engagement success against each attacking missile which includes the overall system availability, reliability, target selection capability and the effects of shot to shot correlation and the effects of shot to shot correlation effects to determine overall system capability against raids. MDA was not able to replicate the 50% or 90% probability of no leaker (PNL) values using the P_{ssk} value of 0.85 for the quoted 3 and 4 shots. Changing the P_{ssk} to 0.75 and using a PNL equation that is solely dependent on the number of attacking missiles, P_{ssk} and the number of shots at each missile does replicate the 50% and 90% values for PNL. proposed change: Replace 0.85 with 0.75 for quoted P_{ssk}	
10	Chapter 1	11	1	4	We note that it is the time available before the first possible and the last possible shot that is important – not necessarily the ability to shoot “early,” although this will certainly help. We call this time interval “battlespace,” and it is the all-important attribute in having the time available to do S-A-S.	Add point that earlier shot could potentially have higher P_{KSS} because less error propagation time and less weapon insertion error	
11	Chapter 1	14	1	All	<u>The difficulty in achieving intercepts within 100 seconds of burnout</u> (Entire Section)	Intercepts of up to 500 seconds after burnout are within the parameters defined by the TOR. Expand this section to examine the effects of such intercepts and the multiple advantages of forcing an adversary to deploy earlier in a trajectory.	The Task Force Report ignores the multiple benefits cited above of forcing an adversary to deploy earlier in the trajectory.
12	Chapter 1	16	2	6-7	This measure of radar capability is appropriate, since it is assumed that because satellite cueing is available to aid in detection, track rather than search is the dominant requirement.	This measure of radar capability is appropriate, since it is assumed that because satellite precision cues are available to aid in detection, track rather than search is the dominant requirement. These cues are produced by the BMDS OPIR Architecture, which will be discussed later in this report.	Focused search plans based upon satellite detections would consume considerable resources. Precision cues are produced by the BMDS OPIR Architecture, and this is an opportune time in the report to establish this connection.
13	Chapter 1	20	Fig RMS-11	Y-Axis	Potential Cost Savings	It appears that the ordinate axis is mislabeled in Figure RMS-11. In particular, savings appear to go down as P_{ssk} increase. Should this be labeled “Missile Expenditure” or “Normalized Cost?”	Accuracy

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14	Chapter 1	23	1	1-a	<p>1. In a regional context there is little measurable value in achieving EI per se.</p> <p>a. A determined adversary can deny the potential benefit of intercepting missiles before they can dispense their lethal munitions or penails.</p>	<p>Add another sentence:</p> <p>The potential of early intercept causing the adversary to deploy early can be beneficial to the defense by preventing challenges induced by late deployments. In particular, these include: (1) placing doubt in the mind of the adversary war planner regarding when to initiate the deployment sequence; (2) decreasing the time available for, and therefore increasing the complexity of, countermeasure or submunition deployment; (3) increasing the ballistic error uncertainty of the deployed objects which will occur over a longer trajectory; (4) mitigating the defense challenges of engaging the threat during non-ballistic deployment maneuvers; (5) reducing the challenge of dealing with multiple, closely spaced objects just prior to intercept; (6) reducing the time of flight of the defending interceptor, resulting in lower interceptor insertion errors and less error propagation time of initial track errors; (7) providing longer viewing time of deployment maneuvers for forward-based sensors; and (8) providing robustness to depressed trajectory tactics</p>	
15	Chapter 1	23	2	2	<p>2. In a homeland defense context, there is a significant potential cost and effectiveness advantage of achieving an intercept by forward-based regional assets prior to having to commit rearward homeland protection assets such as GBIs. However, just as in the regional case, robust kill assessment is a crucial enabler. In addition, the feasibility of achieving the very high regional missile burnout velocity, depending upon siting, far in excess of what has currently been achieved, to provide this benefit over a large portion of the U.S. is uncertain. Finally, the performance benefit of earlier forward based intercept launch of the interceptor (e.g. even prior to booster burnout) in this scenario was minimal compared with the benefit of achieving a very high regional missile burnout velocity.</p>	<p>Insert after achieving:</p> <p>An early intercept provided by the forward based weapon site.....</p>	

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16	Chapter 1	23	3	3	3. Aside from these negative or qualifying comments on EI as a fundamental performance goal, it would appear that the feasibility of achieving the basic objectives of the PAA has been well established by the current and planned MDA program – no fundamental roadblocks or major technical barriers to success were uncovered by the Task Force.	3. Delete "Aside from.....performance goal,"	
17	Chapter 2				Review of Math	MDA concurs with qualitative depictions given the simplifying assumptions of $P_{HL} = [1 - (1 - P_{KSS})^{N_{SHOTS} \cdot N_{RVS}}]$	
18	Chapter 3	27	4	4-6	Yet discrimination in the exo-atmosphere is still not a completely solved problem.	Yet discrimination in the exo-atmosphere is still not a completely solved problem. Joint discrimination exploiting both precision radar data and multiple-color seeker capabilities are critical to successfully addressing this challenge. MDA has a program in place to incrementally introduce discrimination capabilities over time.	Recognizes importance of seeker developments
19	Chapter 3	28	2	2-4	In terms of future technology needs, adversary efforts to defeat, disrupt, and/or deny such networking need to be anticipated, mitigated, and protected against.	In terms of future technology needs, adversary efforts to defeat, disrupt, and/or deny such networking need to be anticipated, mitigated, and protected against. MDA has plans in place to address this anticipated threat. Finally, effective overall sensor resource management is an essential element of this networking to balance the sensor resources consumed by threat acquisition, tracking, discrimination, and kill assessment.	Recognizes existence of MDA's attention to this challenge. Also recognizes need for effective overall sensor resource management to balance needs for acquisition, tracking, discrimination, and kill assessment as a key assumption on which the analyses in this report are based.
20	Findings and Recommendations	33	1	All	EI in and of itself is not a useful objective for missile defense in general of for any particular missile defense system. ...	DELETE and replace with: The Task Force finds that the Missile Defense Agency is on a path to achieve effective regional ballistic defense. The Agency's approach will also enhance U.S. homeland defense in a cost-effective manner.	Emphasizes findings that MDA approach is endorsed by Task Force.
21	Findings and Recommendations	33	2	All	Nor does EI itself provide the capability to defend a large area. ...	DELETE - replace with: The architecture being pursued by the Missile Defense Agency known as the Phased Adaptive Approach has the potential to be effective, flexible and cost effective. In particular, the forward basing of high speed interceptors, in conjunction with high performance, forward based radars, infrared sensors and a highly interconnected command and control infrastructure will facilitate a S-A-S firing doctrine leading to larger defended areas and a potentially more cost effective defense against ballistic missiles.	Brings out architectural tenets endorsed by Task Force.

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22	Findings and Recommendations	33	6		In summary, pursuit of the current plans for regional ballistic missile defense, such as envisioned in the PAA, if pursued to completion, will provide an effective regional defense capability - those plans are technically feasible, are making good progress, and enjoy broad political support. ... We endorse current efforts within MDA to bring this to fruition.	Move to front of "Findings" section (pg 33), paragraph 6 of "Introduction and Summary" (pg 7), and synopsize in both of the forwarding Memoranda.	Emphasis.