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The Importance of Boost Phase Missile Defense

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Do we care about boost phase missile defense? Perhaps the topic is too esoteric. Or perhaps the perceptions that it is too hard to do successfully rule the day. Or, perhaps we do not appreciate how important being able to destroy attacking missiles early in flight really is. But the actions of the U.S. Congress and the Bush Administration leave open the question of whether the U.S. will ever deploy a defense capable of destroying attacking ballistic missiles while they are most vulnerable, thereby strengthening the entire defensive architecture for which so much time, energy, and resources have been expended.

In December 2002, President Bush committed the United States to "field missile defense capabilities to protect the United States, as well as our friends and allies."[1] He called on the Defense Department to begin "fielding an initial set of missile defense capabilities" which were further described as "modest" and "a starting point for improved and expanded capabilities later." Further elaborating on the decision, then Missile Defense Agency director Lt. Gen. Ronald Kadish explained that the objective was to develop a "multi-layered system."[2] In such as system, the U.S. would "have capability in the boost phase, the mid-course phase, and the terminal phase … so we could take shots … multiple times in all phases of a ballistic missile flight."

Taking multiple shots is the key to understanding why having a boost phase capability is so important. These missiles are most vulnerable right after they launch. They are easier to detect and track, are under enormous stress, and have limited ability to maneuver or deploy countermeasures or other defenses. But, because the boost phase lasts for only 3-5 minutes, a missile defense system must act quickly if it seeks a shot opportunity. Upon entering the midcourse phase, a ballistic missile can defend itself through maneuver and can deploy decoys or countermeasures that make it difficult to find. While these detection challenges are noteworthy and not to be discounted, surmounting them has been the focus of considerable effort on the part of the Missile Defense Agency (MDA) and others. The midcourse phase can last a relatively long time, 15-20 minutes or more, providing time to verify the track of the missile as well as fire several shots to destroy it, provided, of course, the maneuvering and discrimination challenges can be overcome. Finally, as the missile nears its target in the terminal phase, which lasts only 30 seconds, locating the missile becomes less of a challenge, but getting to it before it strikes its target becomes the obvious and immediate challenge.

Based on the President's call to action in 2002, the U.S. is constructing and operationalizing missile defense systems targeting the midcourse and terminal phases of flight. The Ground-based Midcourse Defense System (GMD), with interceptor fields in Alaska and California and perhaps eventually in Europe or elsewhere, and the sea-based Aegis Ballistic Missile Defense (BMD) systems provide options for intercepting missiles during the midcourse. The Patriot PAC-3, the Medium Extended Air Defense

System (MEADS), the Arrow, and the Terminal High Altitude Area Defense (THAAD) all focus on destroying missiles as they near their targets. To one extent or another, each of these systems is already in or is nearing deployment, meaning it is available "to protect the United States, as well as our friends and allies," referencing the President's goal enunciated five years ago.

Whether one believes these systems have been adequately tested or not, and there is considerable debate on that point, or whether one believes the threat justified the investment or not, and there is debate on that as well, there is no denying that considerable effort and resources have been devoted to meeting the objectives established in 2002. That is, with one exception. Where are the boost phase defenses? Where are the capabilities that can destroy attacking missiles when they are most vulnerable?

The challenge of intercepting in the boost phase, of course, is time, or the lack thereof. With only a few minutes available to determine (1) that a missile has launched; (2) that it is hostile; (3) that we want to destroy it; and (4) destroy it, boost phase defense represent significant, but not insurmountable challenges.

Space-Based Interceptors

During the 1980s and early 1990s, the U.S. investigated space-based systems designed for this purpose. One of the concepts that emerged from this work, known as *Brilliant Pebbles*, "consisted of a constellation of about 1000 satellites that combined its own early warning and tracking capability with high maneuverability to engage attacking ballistic missiles in all phases of their flight trajectory."[3] Though the program had advanced to the point of being on an acquisition path, a hostile political environment, concerns about cost, and changing perceptions of the threat led to the cancellation of space-based interceptor programs in 1993.[4] Missile defense investments continued thereafter, but boost phase programs never fully recovered.

Space remains an obvious choice for boost phase defense. The global reach of space-based systems has obvious advantages. The short window of opportunity to kill a missile during boost places a premium on speed and location. On-orbit kinetic energy interceptors may reach intercept speeds of 4-6 kilometers per second.[5] Constellations of satellites inclined at particular latitudes reduces the number of space-based interceptors required, which reduces cost, but also concentrates space-based interceptors at those areas of the world of greatest concern.[6]

Despite these advantages, using space for missile defense remains unacceptable to many. The FY 2008 budget request, for instance, included just $10 million to begin work on a testbed. The modest amount included in the president's budget request clearly recognized the importance of space to effective missile defense. The request states in part that "Space systems have advantages over terrestrial based systems through increased access to ballistic missile targets, independent of adversary country size and threat trajectory. We believe that a mix of terrestrial and space-basing offers the most effective global defense against ballistic missiles. Near term funding for the space test-bed program will be used to refine concepts and prepare to conduct focused experiments demonstrating the viability of the concepts."[7]

The Congress disagreed. The $10 million item was struck from the defense authorization bills in both the House and Senate. Its restoration is improbable unless the Administration and congressional champions are willing to take on a major fight for it. That may happen, but it is unlikely and even then the odds are long.

Kinetic Energy Interceptors

Attention has turned to other means to meet the mission. The two programs presently highlighted by the Missile Defense Agency as their boost phase defense programs are the Kinetic Energy Interceptor (KEI) and the Airborne Laser (ABL). In its initial form, the KEI is intended to provide a terrestrial, mobile boost phase capability, with plans to allow for sea-basing as well. The ABL obviously is an airborne capability, but also represents a much different approach to missile defense. Eschewing the traditional focus on kinetic interceptions, basically smashing objects into each other, the ABL would apply directed energy from a laser onto the attacking missile. And even with the acknowledgment that a layered defense is necessary, investment in both programs remains uncertain, leading one to question the commitment to boost phase defense.

From its inception, the KEI has faced an uncertain budgetary environment. The President's FY 2008 budget request for KEI was drastically reduced from the $358 million appropriated last year, to $228 million. In the face of significant congressional concerns and funding cuts last year, the program was narrowed to a single effort – developing and testing a fast, high-acceleration, heavy-lift booster. The planned budget reductions also resulted in changes in how the system would be used. The President's budget called for it to be capable of meeting any or all of three complimentary objectives: (1) to develop a midcourse interceptor capable of replacing the current fixed Ground-based Interceptor (GBI) when the deployed GBIs become obsolete; (2) to develop this interceptor so that it could be strategically deployed as an additional midcourse capability with mobile land- or sea-based launchers; and (3) to assume the boost- and ascent-phase intercept mission if the ABL fails to meet its performance objectives. The program is focused on achieving a flight test of this booster by the end of FY 2008. If that test is successful, KEI will continue testing toward its midcourse defense role, awaiting the outcome of the FY 2009 ABL test to determine whether or not it will also become MDA's sole boost-phase defense effort.

The Congress appears to be rejecting this proposed change. The House Appropriations Committee recently added $145 million to the request for a total budget of $372 million.[8] Specifically, the Committee noted its disagreement with the proposed shift in the mission of the KEI to a midcourse replacement booster from its original boost phase mission and said it "provided additional funding in an effort to accelerate this much-needed capability."

KEI has completed a series of successful rocket motor firing tests and is moving toward a booster flight test in 2008,[9] but there are no public plans for an intercept knowledge point. The explanation lies squarely with the indeterminacy of its resource base. Prior to the Administration's planned cut for FY 2008, it was the Congress that was skeptical of the program and who trimmed back its funds, leading to changes in the schedule and pace of activities.

Deploying the KEI at sea, perhaps on the next generation of naval vessels, would complement the existing Aegis capabilities, which are designed for the midcourse mission, and benefit from the inherent mobility and flexibility of sea-based assets.[10] Land-based deployment would limit where the system could go by virtue of geography and the need to defend and supply it. Nevertheless, the dual-use nature of the system, meaning that it may have the ability to intercept missiles in both the boost and midcourse, offers added capabilities that extend its utility as a ground-based asset. Regardless, so long as elements of the missile defense system are land-based, the need for ever faster interceptors will exist.

Airborne Laser

The ABL is the vanguard of a revolution. While the phrase "revolution in military affairs" is overused, the emergence of systems utilizing directed energy for tangible war-fighting applications is worth noting. Housed on a Boeing 747, the ABL uses a high-energy chemical oxygen iodine laser (COIL) to achieve the megawatt-class power necessary to strike missiles at a distance.[11] The ABL is among the first generation of deployable directed energy weapons and, if allowed to proceed to its test its full capabilities, will present the U.S. with a new capability to destroy ballistic missiles, but more importantly, a foundation on which to build an entirely new defense architecture.

Over the past few years, the high-energy laser was tested successfully on the ground and will now be integrated into the aircraft for a planned flight test to demonstrate the lethality of the system in 2009. More recently, the ABL aircraft has tested the systems needed to track and illuminate its target as well as testing the optical systems that will be used to correct for atmospheric distortion and hold the chemical laser on an intended target.[12] In doing so, the ABL program accomplished feats never before performed in the air and never against a moving target. These tests performed in July 2007 involved flying the ABL airplane in tandem with the U.S. Air Force's NC-135E "Big Crow" test aircraft.[13] The COIL laser was extensively ground tested, with more than 70 successful firings.

Congress fully funded the President's FY 2007 budget request for ABL of $632 million. This funding assumed that the Airborne Laser program would be able meet its test objectives, including an interception test in FY 2008. In November 2006, the lethality test was delayed to the fourth quarter of FY 2009. Supporters of ABL can argue that funding levels are consistent with previous budget submissions, and that the program continues to make progress toward a lethality demonstration. There were concerns, however, that the delayed test signals doubts about ABL's technical feasibility, that it pushes the program further out as a far-term development effort, and that the concept of operations (CONOPS) for the program is still unclear.

The FY 2008 budget request for ABL was $549 million, $83 million less than the $632 million requested and appropriated last year. In the spring, the House and Senate Armed Services Committees recommended cuts to the ABL budget of $250 and $200 million respectively.[14] These cuts, and those to several other areas of the missile defense budget, were justified by the claim that they were re-orienting the program from "longer-term technologies that do not address the current national security needs of the United States…"[15] towards those systems that address near-term ballistic missile threats.

The House Appropriations Committee restored all but $50 million of the president's request in their proposal approved in late July. Further, the Committee made note of the "technical progress that the Airborne Laser program has made over the last three years" and that "these technical challenges were accomplished while the program stayed within the government determined schedule and budget."[16]

The appropriators' actions are a welcomed development. The authorizers' concerns with providing defenses for the American public as soon as possible are refreshing as they indicate a major shift in the debates over missile defense. The debate over whether the U.S. should deploy a defense against ballistic missile threats is over and the question is now what kind of defense do we deploy and at what pace. Unfortunately, in their enthusiasm to address near term security concerns, they would sacrifice critical capabilities to defeat missiles when they are weakest and most easily detected. And in the case of the ABL, at the point in time when it is finally able to show whether or not the years of investment will bear fruit.

Still, concerns persist about the sustainability and predictability of the resource base as the ABL moves toward the intercept test. Some believe that deploying the ABL will prove too costly and conclude that pushing back the intercept test delays having to make a decision on whether to proceed to production and the purchase of additional aircraft. Such views are short-sighted. Foremost, further delaying the intercept test pushes back the date when boost phase defense option would be available for use. Perhaps more importantly, the delays hinder the broader progress underway with respect to the development of directed energy systems for defense purposes. The intercept test will mark a significant milestone for this first generation system and, whether ABL is ever deployed for missile defense purposes or not, demonstrating the capability is a significant achievement for U.S. directed energy research and development.

Conclusion

Will the ABL or KEI ever be deployed? More fundamentally, will the U.S. move to deploy a boost phase missile defense? Assuming the KEI and ABL meet their test expectations, then some future Congress and President will have to make that decision, which will be influenced by expectations about cost. There are other ways to fulfill the boost phase mission. Space is one and use of UAVs is another. The importance of constructing a viable, robust and effective boost defense demands exploration of those possibilities as well. In the end, policy makers wrestling with whether to support the budgets for the ABL and the KEI or considering whether to initiate a space-based interceptor program should not lose sight of the reasons why such investments are critically important.

With millions of lives at stake and growing missile arsenals, what kind of future do we want to have? One free of the fear that a peer competitor, a rogue state, or a terrorist could use a ballistic missile to threaten us or one where our leaders have the means to defend us. We know what choice the people would make. It is up to our government to make it so.

Notes

1. "President Announces Progress in Missile Defense Capabilities." (White House: Office of the Press Secretary, December 17, 2002).
2. "Missile Defense Deployment Announcement Briefing." (U.S. Department of Defense: News Transcript, December 17, 2002).
3. Independent Working Group on Missile Defense, Space, and the 21st Century. (2006). (Institute for Foreign Policy Analysis: Washington, D.C.): 23.
4. Baucom, Donald. (2004). "The Rise and Fall of Brilliant Pebbles." *Journal of Social, Political and Economic Studies* (September 2004): 145-190.
5. O'Hern, Wayne. (2004). *Feasibility of a Space-Based Boost Phase Kinetic Energy Interceptor*. Briefing before the George C. Marshall Institute. ***http://www.marshall.org/pdf/materials/260.pdf***; and Canavan, Gregory. (2003). *Missile Defense for the 21st Century*. (Heritage Foundation: Washington, D.C.): 129-136.
6. Canavan, Gregory. (2004). *Estimates of Performance and Cost for Boost Phase Intercept*. (George C. Marshall Institute: Washington, D.C.).
7. Missile Defense Agency Exhibit R2-A RDT&E Project Justification, February 2007, pg. 1023.
8. House Report 110-279-Department of Defense Appropriations Bill, 2008. ***http://thomas.loc.gov/cgi-bin/cpquery/R?cp110:FLD010:@1(hr279)***.
9. "Northrop Grumman Team Completes Third Successful KEI Motor Fire Test," June 14, 2008, ***http://www.irconnect.com/noc/press/pages/news_releases.html?d=121408***.
10. Sherman, Jason. (2004). "New U.S. Ships Take Shape." *Defense News*, April 5, 2004: 1; and Goure, Daniel. (2007). *Want Real Missile Defense Soon? Put KEI to Sea*. Lexington Institute Issue Brief, April 23.
11. Some have suggested that solid state lasers offer a more promising alternative than the COIL. Solid state lasers require additional work before they will reach the power levels required for ballistic missile intercepts. For example, a U.S. Army R&D

program has set a goal of achieving 100 kw via a solid state laser (Joint High Power Solid-State Laser (JHPSSL)).

12. Missile Defense Agency. (2007). "Airborne Laser Completes Successful Fire Control Loop for Missile Engagement Sequence." *Press Release* – July 9, 2007; "Airborne Laser Successfully Targets Simulated Missile in Flight." *Press Release* – July 13, 2007; and Boeing. (2007). "Boeing-led Airborne Laser Team Actively Tracks Airborne Target, Compensates for Atmospheric Turbulence and Fires Surrogate High-Energy Laser." *Press Release* – July 16, 2007.

13. Ironically, it is the availability of the Big Crow aircraft which appears to be determining the pace of test activity for the ABL. The test aircraft is in high demand and subject to availability limits. The ABL intercept flight test schedule has moved backwards 90 days, for example, in response to other demands on the Big Crow.

14. As of August 2007, the House has approved its authorization bill, but the Senate has not. The Senate Defense Appropriations Subcommittee has yet to mark up its bill.

15. House Armed Services Committee. "House Armed Services Committee Approves Fiscal Year 2008 Defense Authorization Bill." *Press Release* — May 9, 2007: 38.

16. House Report 110-279-Department of Defense Appropriations Bill, 2008. ***http://thomas.loc.gov/cgi-bin/cpquery/R?cp110:FLD010:@1(hr279)***.