

Missile Defense

Getting to the Elusive “Right Side of the Cost Curve”

Brigadier General Kenneth E. Todorov (USAF ret.)¹

The specter of a ballistic missile attack on the United States and its allies, or at the very least the threat of such an attack, continues to grow. Threat systems from rogue nations such as North Korea and Iran continue to mature in quality and quantity. As potential adversaries improve their missile technologies, they are demonstrating more sophisticated and reliable systems with increasing complexity, range, and accuracy. The United States’ ability to develop field-robust yet *affordable* missile defense is, in a word, challenging.

Meeting the Mission, on Budget

Defense is an inherently expensive venture, and missile defense is no exception. The “cost curve” for missile defense, however, has received considerable scrutiny of late. The relative cost of missile defense interceptors is recently compared to the cost of threat missiles, and of course the former are significantly more expensive than the latter. Forsaking the missile defense mission, however, would be a grave mistake, and one taken at our own peril. How, after all, does one quantify the cost of a major U.S. city or of American lives?

The cost of not defending the nation and our interests around the world from this growing threat is simply too high. Then there is the deterrence message that a strong national missile defense sends to our adversaries and allies alike. The understanding of this tenuous balance between high cost and extreme risk among decisionmakers on Capitol Hill and in the Pentagon has grown. While in years past the policy to pursue missile defense for the nation was a partisan debate, today there is largely bipartisan support for the mission. Today, the debate centers on how much, not if.

“The cost curve is working against us. . . . We can expand R&D efforts to find a more cost-effective way of knocking down missiles that are in flight by essentially inverting the cost curve in the other direction.”²—Admiral James A. Winnefeld, U.S. Navy, vice chairman of the Joint Chiefs of Staff

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² James A. Winnefeld, “Adm. Winnefeld’s Remarks at the Center for Strategic and International Studies,” Speech (Washington, D.C.: CSIS, May 19, 2015), <http://www.jcs.mil/Media/Speeches/tabid/3890/Article/589289/adm-winnefelds-remarks-at-the-center-for-strategic-and-international-studies.aspx>.

Despite support for the mission, missile defense budgets continue to decline amid Department of Defense-wide budget strains. In FY 2016, the Missile Defense Agency (MDA) total budget was \$8.1 billion. However, in the president's budget request for FY 2017, MDA is slated for only \$7.5 billion. But for a problem like missile defense, where research and development (R&D) is key to future mission success, the overused adage "do more with less" has been replaced with a new approach: "do it differently with less."

Expectations from some leaders in DoD, particularly those with budget challenges of their own, are calling for new strategies heavily reliant on emerging technologies that depart from what they view as the "unsustainable" strategy of expensive "hit-to-kill" missile defense solutions. Through this lens, a new buzz phrase has emerged—the "cost curve"—and most leaders agree that getting to the "right side" of this curve, where cost and efficiency for missile defense are more affordable and sustainable, is the ideal place to be. In essence, defense thought leaders are urging the department to seek new, cutting-edge solutions in a more cost-effective manner.

*"With those right investments and those technologies paying off we can get on the correct side of the cost curve."*³—Admiral William E. Gortney, U.S. Navy, commander, U.S. Northern Command

DoD's *Integrated Air and Missile Defense: Vision 2020*, published by the chairman of the Joint Chiefs of Staff in 2013, offers a glimpse into what the future might look like, yet it was not designed to provide specificity.⁴ Though much has been said about the cost curve, few have offered details on exactly how we might get to the elusive right side of it. Ultimately, getting there will require a more specific prescription than much of the broad-brush commentary offered thus far.

A Prescription

Before offering a plan or prescription for getting to the right side of this cost curve, one should first put the problem in context. What is the outcome we desire? Where is it that we are trying to get? Today, DoD's efforts are centered on three broad concepts that are critical to keep in mind:

1. **Cost per kill:** Reducing the number of interceptors engaging a threat, thereby cutting the cost per kill.
2. **Target discrimination:** Ensuring that the target being engaged is, in fact, the threat and not a decoy or piece of debris.
3. **Left of launch:** Developing technologies and emerging concepts to reduce the number of incoming objects to engage.

³ William Gortney, "Department of Defense Press Briefing by Admiral Gortney in the Pentagon Briefing Room," Speech (Washington, D.C.: Pentagon, April 7, 2015), <http://www.defense.gov/News/News-Transcripts/Transcript-View/Article/607034>.

⁴ Martin E. Dempsey, *Joint Integrated Air and Missile Defense: Vision 2020*, Joint Chiefs of Staff, 2013, <http://www.jcs.mil/Portals/36/Documents/Publications/JointIAMDVision2020.pdf>.

Accomplishing these goals will require continued improvements in existing systems while seeking to approach the ballistic missile challenge in new lights, as well as using and integrating new technologies, strategies, and approaches. In essence, the Pentagon wants to make the existing system more effective and efficient, while continuing to integrate new concepts and tactics. To ignore one at the expense of the other would be an incomplete solution to a problem that demands more.

DoD's "Third Offset" approach toward innovative thinking, new operational concepts, new ways of organizing, and long-term strategies certainly applies toward this effort, although missile defense is too infrequently associated with the Third Offset. Now is the opportunity for a new generation of leaders, thinkers, and engineers to develop future elements of the ballistic missile defense system (BMDS), but we must pay equal attention to making the BMDS more efficient and effective.

The Prescription: Possible Paths to the Right Side of the Cost Curve

- **MDA returned to its core mission**
- **Strategic research and development**
- **Cost control**
- **A more holistic approach to integrated air and missile defense**
- **Passive missile defense**

MDA Returned to Its Core Mission

A victim of its own success, the Missile Defense Agency has seen its R&D budget, especially for the most innovative experimental technologies, eaten away in the interest of the Department's appetite for procurement and operations. The original intent in MDA's charter was to develop cutting-edge missile systems and then transfer operating responsibilities to the respective services.⁵ In almost all cases, however, this has not happened. Rather, the trend is increasing MDA's budgetary emphasis to cover operations and maintenance and procurement, versus research and development of new ones.

⁵ Department of Defense Directive 5134.9, "Missile Defense Agency (MDA)," October 9, 2004, http://www.usa-federal-forms.com/dod/3-pdf-forms_pubs/www.dtic.mil/whs/directives/corres/pdf/d51349_100904/d51349p.pdf.

The FY17 Budget Request for the Missile Defense Agency

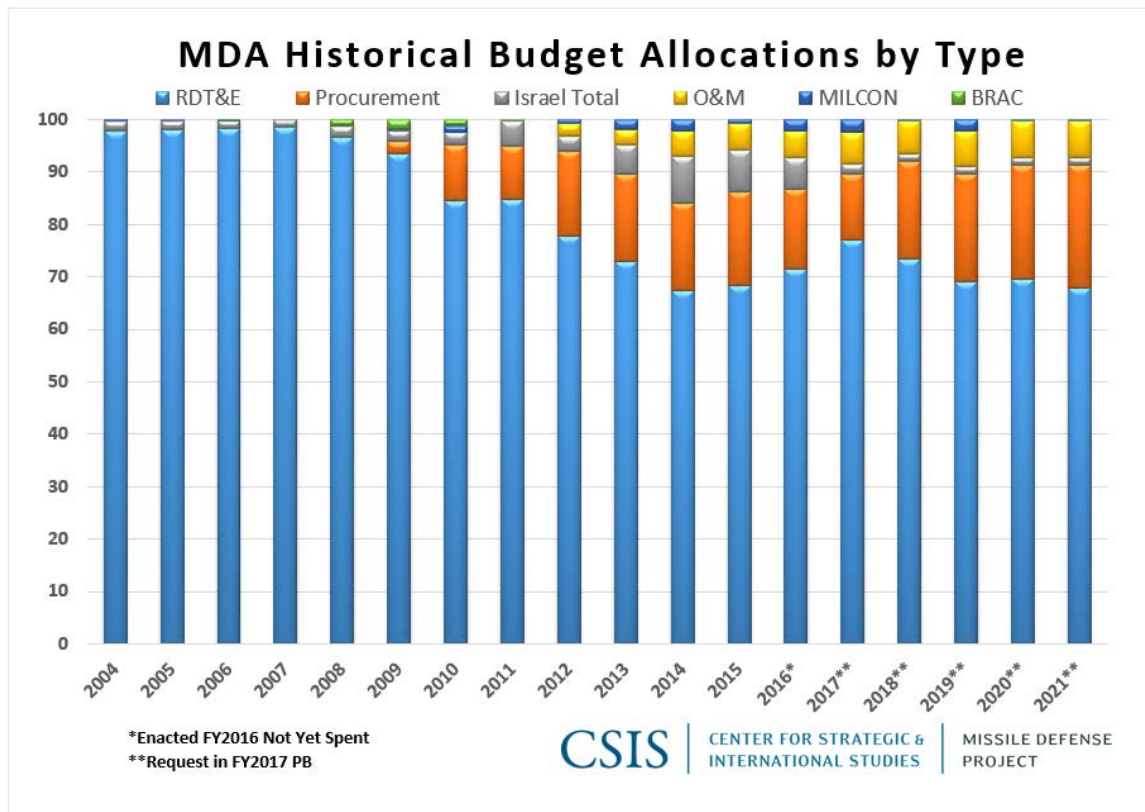
"The \$7.5 billion FY17 budget request for MDA represents an \$822 million reduction from last year's enacted budget. These cuts are essentially divided between procurement (\$501 million) and research and development (\$322 million) as compared to the \$8.3 billion MDA budget enacted by Congress for FY16.

"While cutbacks to procurement obviously reduce capacity available to the warfighter, the squeeze on research and development reflects a larger but insufficiently appreciated trend that could impair the ability to outpace foreign missile threats.

"Some of the reductions had been projected in the FY16 five-year outlay, which presupposed a FY17 request of \$7.8 billion, down from \$8.13 billion requested for FY16. Another tranche of cuts, however, was implemented by the November 2015 budget agreement. . . . The cuts to the overall DoD budget of \$523.9 billion represents a 4 percent reduction; by comparison, MDA's share represents a 10.8 percent reduction."

Source: Thomas Karako, "FY17 Budget Squeezes MDA's Research and Development," *CSIS Commentary*, March 18, 2016, <http://csis.org/publication/fy17-budget-squeezes-mdas-research-and-development>.

So that all important discovery takes place in order to make missile defense more affordable, lawmakers and DoD should allow MDA to return to its roots and be the true leader in developing new technologies through rigorous research and development efforts. To get to the right side of the cost curve, it is imperative that MDA be allowed to revert to focusing on what it was chartered to do.



In 2011, MDA's research, development, technology, and evaluation (RDT&E) budget comprised nearly 86 percent of its total annual budget. That number has fallen to roughly 70 percent today, and is being replaced by operations, maintenance, and procurement funding requirements never intended for the agency. In terms of percentages, this may not sound significant, but when compared to the budget, it is a delta of roughly \$750 million annually. This is not to fault MDA leadership; many of the changes are dictated by the services' unwillingness to accept both the cost and operational burdens for the systems they now own. Further, MDA has had to take its share—arguably more than its share—of cuts based on overall downward trends in the defense budget writ large. Still, without topline relief for MDA, the R&D necessary to outpace future threats will continue to face greater fiscal pressure.

*"What you'll see in '17 is disproportionate hits to modernization, R&D and procurement."*⁶—Frank Kendall, undersecretary of defense, acquisitions, technology and logistics

Top acquisition officials at the Pentagon publicly acknowledged these trends for the department, referring to "disproportionate" cuts to modernization and research and development funding in its FY 2017 budget request.

For MDA to have the bandwidth to improve the existing BMDS while reaching for new and innovative ways to reduce the cost per kill of an incoming ballistic missile, DoD must reverse course on these trends, or Congress must consider mandating a solution.

Strategic Research and Development

Assuming the declining R&D budget trend can be corrected in future budgets, the Pentagon should increase its resources and efforts on the most promising technologies that will augment the existing BMDS and provide new solutions for the future. MDA must have sufficient resources to develop emerging concepts that can invert the cost curve in favor of our nation's defense. No one solution will get us there—we must develop a balanced and integrated architecture approach with flexibility to evolve and accept a broad range of emerging concepts over time. This path must be pursued with rigor, technical knowledge, and a foundation of sound system-engineering practices.

There are two meaningful ways this can be accomplished: one, reduce the number of interceptors required to destroy each credible, lethal object in the raid; and two, reduce the number of targets that have to be engaged. Advanced technology efforts are progressing to inform future nonkinetic capabilities that can shift the cost curve in both areas. For example, MDA is developing concepts for directed energy as a possible nonkinetic solution. The idea is not without its challenges—sufficient power, beam control, employment platform, required booster lethality, for example—yet this possible option for future warfighters should be more aggressively pursued than the current budget allows.

⁶ Aaron Mehta, "Kendall: 'Disproportionate' Cuts Planned to Modernization, R&D," *Defense News*, December 3, 2015, <http://www.defensenews.com/story/breaking-news/2015/12/02/kendall-disproportionate-cuts-planned-modernization-rd/76657622/>.

Directed energy, with its goal of substantially reducing the number of lethal objects entering the battlespace by destroying potential incoming threats during the boost phase (where we might knock down an incoming missile shortly after launch) would significantly reduce the number of relatively expensive interceptors needed to address increasingly complex threats. Boost-phase defenses have the potential to defeat ballistic missiles of all ranges, including intercontinental ballistic missiles (ICBMs), but it is also the most difficult phase in which to engage a missile. The intercept “window” is short. Although the missile is easiest to detect and track in the boost phase because its exhaust is bright and hot, missile defense interceptors and sensors must be close to the missile launch. Early detection in the boost phase allows for a rapid response and intercept early in its flight, possibly before any countermeasures can be deployed. If properly resourced and explored, challenges to boost-phase intercepts could be addressed.

Given that an adversary may be able to launch large numbers of relatively inexpensive yet increasingly complex missiles, reducing the cost to produce very expensive weapons systems or finding less expensive ways to intercept these adversarial missiles is paramount. As part of this effort, MDA is pursuing a Redesigned Kill Vehicle (RKV), and a Multi-Object Kill Vehicle (MOKV) to increase the system’s reliability and raid capacity. The RKV will improve hit-to-kill technology in the near term, while the MOKV will allow more than one kill vehicle to be launched from a single booster and has the potential to greatly enhance shot efficiency. While still in its infancy, the program holds promise and should be vigorously pursued. A single booster armed with multiple kinetic warheads to seek and eliminate a complex threat is a cost-effective and feasible solution that expands upon proven, existing technology.

Other ideas in the works, such as the electromagnetic rail gun or nonkinetic cyber actions (where it may be possible to get inside an adversary’s networks before they launch), must be further developed to achieve the same end state. While many of these ideas are in their early stages of development, each of them deserves the full attention of the nation’s best and brightest minds.

Cost Control

So that the nation can truly maximize the opportunity to get to the right side of the cost curve, industry partners must be willing to collaborate with their competitors to derive more cost-effective solutions—and this responsibility does not reside solely with the end user. Now more than ever, moving from proprietary, stovepiped systems toward more open architecture that allows users (Pentagon and allies) to plug and play with complementary and interdependent systems is key. Think of your iPhone, which communicates with your iPad and even with your PC. Industry partners should be encouraged to share ideas and build their systems to interoperate in a similar way.

MDA has facilitated this approach with the advent of the Redesigned Kill Vehicle (RKV). A cross-industry team, with DoD as the design authority, will develop the system. Further, federally funded research and development centers (FFRDCs) and university-affiliated research centers (UARCs) will support its design and development. In the end, MDA will determine the overall best design solution based on cost, schedule, performance, and risks.

RKV advances will improve the reliability of the BMDS, ultimately increasing interceptor reliability, increasing performance, and addressing the evolving threat by improving availability, maintainability, testability, producibility, fleet standardization, and manufacturing cost. With increased reliability comes the promise of a refined warfighter shot doctrine that would reduce the number of interceptors expended per incoming threat. While there is an upfront cost for RKV, savings will be derived by way of fewer interceptors needed, lowering the cost per kill.

*"I believe that the path we're on to not just inform MOKV with those design principles, but to be able to take a highly reliable kill vehicle and get it fielded back to the current fleet to sustain it for decades to come, is the right path."*⁷—Vice Admiral James Syring, director, Missile Defense Agency

Approaches like the one being undertaken for RKV mean DoD can implement affordable change, one that more effectively allows for technological upgrades—rather than throwing out previous investments. It also allows for continued development at greatly reduced cost. It also employs evolutionary acquisition and spiral development approaches, which allows adjustments to meet the evolving threat, and inserts technological innovations into the system as they become available. RKV is a necessary step that puts us on a logical path toward MOKV development.

In essence, the system can evolve over time in an affordable way in response to the threat, technical progress, and understanding of how the warfighter needs to employ the system. All of these attributes help get DoD closer to the "right side of the cost curve."

Beyond BMD: A More Holistic Integrated Air and Missile Defense Approach

For years, the conversation about missile defense has centered solely on defeating incoming ballistic missiles. Increasingly, the United States and its partners will face not only ballistic threats but also low-cross-section cruise missiles and other air-breathing threats, both abroad and for the homeland.

Wars are not fought in stovepipes, yet we are largely developing capabilities that way, without putting much thought into how to fold in other elements of the integrated air equation. Future development of Integrated Air and Missile Defense (IAMD) systems needs to demonstrate more commonality in sensors, shooters, and command and control. The nation needs to respond to a range of threats—missile and air—and not just one domain or the other.

Take, for instance, Russia's recent actions in Syria, where last fall more than 20 cruise missiles were fired from Russian warships in the Caspian Sea at Syrian targets more than 1,000 miles away.⁸ We have long known that the Russians have cruise missiles, but this was our first opportunity to witness

⁷ James D. Syring, "Ballistic Missile Defense System Update," Speech, Ballistic Missile Defense System Update (Washington, D.C.: CSIS, January 19, 2016), http://csis.org/files/attachments/160119_ballistic_transcript.pdf.

⁸ Richard Johnson, "How Russia Fired Missiles at Syria from 1,000 Miles Away," *Washington Post*, October 23, 2015, <https://www.washingtonpost.com/graphics/world/russian-cruise-missile/>.

their operational use at such an extended range, a fact not lost on those who defend our U.S. homeland.⁹

Recently, key members of Congress pulled the plug on continued funding for the Joint Land Attack Cruise Missile Defense Elevated Netted Sensor (JLENS) system's three-year operational exercise. Lawmakers noted problems with the tethered dirigible, rather than considering the elements of the test that matter. This kind of program is key, however, to developing holistic solutions that go beyond ballistic missile threats and to addressing dangerous air and cruise missile threats to the homeland. While the program's well-publicized issues must be addressed, similar kinds of capabilities will be important for a future IAMD force.

Tests and exercises are meant to uncover problems, help discover and prove out new capabilities, and inform the future. The Wright Brothers were not forced to give up when the early airplanes they were developing met with less than complete success, and the same logic must hold true for sensor systems like JLENS. Developing separate systems to defeat different kinds of threats will prove costly and puts the nation on an unsustainable path. To get to the right side of the cost curve, all mission areas need to be looked at holistically.

The Army's Terminal High Altitude Area Defense (THAAD) system, which provides a globally transportable, rapidly deployable capability to intercept and destroy ballistic missiles inside or outside the atmosphere during their final (or terminal) phase of flight, is another example of a system in which we must invest. THAAD's track record of operational success demonstrates the system serves both BMD and IAMD mission needs and should be part of a more holistic solution set for the warfighter.

There are other systems that need continued development. Both the Navy's Aegis and Army's Patriot systems will continue to contribute to the warfighter's necessary mix of IAMD capabilities for the future. While the Navy continues to make developmental progress with its Standard Missile 2A, MDA has been forced to take procurement risk on the number of interceptors it will buy to fund other priorities. The Army has done even poorer with its efforts to modernize Patriot, certainly a critical cog in the IAMD solution for the future.

Finally, much of the recent conversation surrounding missile defense of the homeland has been focused on the merits of a third interceptor site on the East Coast of the United States. The current Ground-based Midcourse Defense (GMD) system deploys interceptors at Ft. Greely, Alaska, and Vandenberg Air Force Base, California. While military leaders agree the third site would provide improved battlespace and additional opportunities to engage incoming threats, the site would be too expensive at this point given the budget realities, and the other priorities MDA has requested. Other ideas, such as a transportable interceptor or the possibility that an Aegis-ashore weapons system might accomplish the same result at a lower cost, should be fully explored before making any investment decision.

⁹ Gortney, "Department of Defense Press Briefing by Admiral Gortney in the Pentagon Briefing Room."

Regardless of the choices the United States makes, the reality that the conflicts of the future will not be fought in stovepipes is a given. To develop capabilities independent of others will not only be expensive, it will prove ineffective on the battlefield.

Do Not Neglect Passive Missile Defense

One of the most overlooked and inexpensive ideas that gets DoD closer to the right side of the cost curve is the use of passive defense measures to address potential shortfalls in air and missile defense. Given the complexity of defensive technology required to succeed, the systems cannot be expected to be flawless—no system is. Passive defense measures such as denial, deception, mobility, hardening, and information operations, coupled with active defensive and offensive operations, serve as force multipliers facilitating mission success. Failure to fully integrate and coordinate offensive, active, and passive actions places joint-force objectives and resources at unnecessary risk.

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The planning required to take full advantage of these passive missile defense measures must occur before fielding and employment of the systems takes place. To take maximum economic advantage of the values of these measures, requirements makers, material developers, and industry partners must work more closely together with end-users to be mindful of how best to take advantage of these opportunities. More consideration should be given to rethinking tactical firing doctrine, modeling U.S. tactics in cooperation with the Israelis, accepting near misses of incoming missiles if they would land harmlessly (as opposed to expending precious and expensive interceptor inventory on threats that might land in remote areas of the battlefield). The more robust the countermeasures, hardening, deception, and other passive missile defense methods, the greater the potential movement toward the right side of the cost curve.

The Need for a Mix of Capabilities

These possible prescriptions are meant to continue the ongoing conversation about getting to the elusive right side of the missile defense cost curve. Certainly other good ideas will emerge as well. Better cooperation with allies and partners, for instance, is an area ripe for smart reductions to stovepiping and to cost. Simply buying more and more expensive interceptors to buy our way out of the problem is unsustainable, but at the same time the true affordability equation includes the value of the defended asset.

There is a cautionary tale here, however. While novel technologies and concepts hold great promise for making missile defenses more affordable, the immediate prospects remain relatively modest for abandoning “hit-to-kill” technologies altogether. The temptation is certainly understandable, since as mentioned, the cost of the interceptor will often exceed that of the threat missile. The notion that the

United States might be able to transition its missile defense toward an exclusive set of nonkinetic capabilities is alluring, but “hit-to-kill” will always be part of the missile defense equation. Notions that “left of launch” or nonkinetic efforts can be a panacea are therefore probably dangerous. “Left of launch” efforts, for instance, will continue to facilitate defenses “right of launch,” but will never be a solution on their own—just as one would not play hockey without a goalie.

Inverting or at least bending the missile defense cost curve will require a broader mix of capabilities and approaches. This mix will include both defense and offense, passive and active measures, and kinetic and nonkinetic technologies. And all of this will need to be integrated and exercised in an effective joint and combined force.

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