Pacific Forum CSIS

Issues & Insights

US Missile Defense in the Age of Everything: From BMDS to IAMD

Challenges, Opportunities, and Recommendations for the Asia-Pacific Theater

By Stefan Soesanto

Issues & Insights
Vol. 16-No. 6

Brussels, Belgium
April 2016

James A. Kelly Korean Studies/Fellowship Program

The 'James A. Kelly Korean Studies/Fellowship Program' aims to consolidate, enhance, institutionalize, and build upon the Pacific Forum's Korea-oriented programs. Kelly Fellows focus on Korean Peninsula studies through participation in the Pacific Forum's Young Leaders program as a Non-Resident Fellow, and through in-residence research at the Pacific Forum as a Resident Fellow. The fellowship recognizes the exemplary efforts of former Assistant Secretary of State and Pacific Forum President Emeritus Jim Kelly to improve US-ROK relations and encourage the DPRK to denuclearize and join the international community of nations. The program encourages the study of Korean economic and security issues with particular focus on raising awareness among the next generation of scholars and officials in the US, ROK, and worldwide about the vital role the Korean Peninsula plays in regional and international affairs.

Pacific Forum CSIS

Based in Honolulu, the Pacific Forum CSIS (www.pacforum.org) operates as the autonomous Asia-Pacific arm of the Center for Strategic and International Studies in Washington, DC. The Forum's programs encompass current and emerging political, security, economic, business, and oceans policy issues through analysis and dialogue undertaken with the region's leaders in the academic, government, and corporate areas. Founded in 1975, it collaborates with a broad network of research institutes from around the Pacific Rim, drawing on Asian perspectives and disseminating project findings and recommendations to opinion leaders, governments, and members of the public throughout the region.

Table of Contents

List of Figures and Tables

Abstract

Over the last 15 years, the US ballistic missile defense system (US BMDS) has developed into a cornerstone of US alliance policies in the Asia-Pacific. However, given the long-term budgetary horizon and fiscal constraints resulting from sequestration, the Department of Defense was tasked to conduct a comprehensive review of US missile defense programs and capabilities, in an effort to develop a more cost-effective and sustainable ballistic missile defense strategy.

This study aims to contribute to the DoD's review with particular focus on the challenges, opportunities, and recommendations for the Asia-Pacific theater. In specific the study is geared to answer four distinct questions:

(1) What are the strategic and tactical objectives of the US BMDS in the Asia-Pacific?
(2) How does BMDS fit into the Integrated Air and Missile Defense (IAMD) 2020 vision?
(3) What role can regional US allies play in the context of IAMD?
(4) How will IAMD influence the strategic balance in the Asia-Pacific?

The study is organized into three chapters, each with its own policy recommendations. Chapter one sets the overall context for ballistic missile defense (BMD) in the Asia-Pacific by synthesizing the BMD capabilities of Japan, South Korea, Taiwan, and Australia, with a specific focus on the tactical objectives of forward-based US BMD elements. Chapter two assesses the strategic goals of the US BMDS in the Asia-Pacific, in relation to: (1) alliance reassurance, (2) strategic and regional stability, (3) deterrence, and (4) left- and right-of-launch missile defense options. Chapter three shifts to the concept of IAMD by focusing on defensive counter-air operations that are not part of the BMD threat portfolio, such as cruise missile defense (CMD), counter-unmanned aerial systems (CUAS), and counter-rockets, artillery, and mortar (C-RAM). The study concludes with final thoughts and summarizes answers to the four overarching questions.

US Missile Defense in the Age of Everything: From BMDS to IAMD

Challenges, Opportunities and Recommendations For the Asia-Pacific Theater

By Stefan Soesanto

We live in an era in which the demands for defense and security require unprecedented strategic flexibility and technological innovation. An era in which threats as diverse as global terrorism, cyber warfare, and the proliferation of missile technology[1] are increasingly growing "more transnational, more transregional, and cannot be addressed in isolation."[2] According to US Deputy Secretary of Defense Robert Work, we are living in the 'Age of Everything' "an era in which problems are connected in ways that we never really had to deal with before."[3] Consequentially, this new reality demands a new "[US] grand strategy to ensure defense needs are met and resources balance[d]."[4]

In the Asia-Pacific region, the challenges posed by the 'Age of Everything' are particularly pronounced. From Beijing's continuous development of anti-access/area-denial capabilities (A2/AD),[5] fielding and testing of MIRVed ICBMs,[6] and counter-space assets,[7] to Pyongyang's persistent nuclear and missile program,[8] the United States is facing "a progressively receding frontier of military dominance."[9]

For more than a decade, the US Department of Defense (DoD) has increasingly leveraged horizontal proliferation and research, development, testing, and evaluation (RDT&E) of ballistic missile defense systems (BMDS), to stay ahead of missile threats that might upend US technological superiority and the ability of the Joint Force to project power across the Asia-Pacific. However, given the long-term budgetary horizon, coupled with

---

[1] US Department of Defense. 2014. *Quadrennial Defense Review 2014*. As of Nov. 17, 2015: http://www.defense.gov/Portals/1/features/defenseReviews/QDR/2014_Quadrennial_Defense_Review.pdf, p. x-xi.

[2] Carter, Ashton B. 2015. 'Maintaining the Edge in the Age of Everything.' *DefenseOne*, Nov. 2, 2015. As of Nov. 17: http://www.defenseone.com/ideas/2015/11/maintaining-edge-age-everything/123313/

[3] Work, Robert. 2015. 'Closing Keynote: Managing the Age of Everything.' *DefenseOne Summit 2015*. As of Nov. 22, 2015: http://www.defenseone.com/ideas/2015/11/defense-one-summit-2015-age-everything/123168/

[4] Cronk, Terry Moon. 2015. 'Work Applauds Defense Funding Agreement.' *US Department of Defense News*, Nov. 3. As of Nov. 17, 2015: http://www.defense.gov/News-Article-View/Article/627554/work-applauds-defense-funding-agreement

[5] McCarthy, Christopher J. 2010. *Anti-Access/Area Denial: The Evolution of Modern Warfare*. US Naval War College: Luce.nt. As of Nov. 17, 2015: https://www.usnwc.edu/Lucent/OpenPdf.aspx?id=95

[6] US Department of Defense. 2015. *Annual Report to Congress – Military and Security Developments Involving the People's Republic of China 2015*. As of Nov. 17, 2015: http://www.defense.gov/pubs/2015_China_Military_Power_Report.pdf, p.31; O'Connor, Sean. 2015. 'China's ICBM modernization alters threat profile.' *IHS Jane's Intelligence Review*.

[7] Heginbotham, Eric et al. 2015. *The US-China Military Scorecard – Forces, Geography, and the Evolving Balance of Power 1996-2017*. Calif., Santa Monica: RAND Corporation, RR-392-AF. As of Nov. 17, 2015: http://www.rand.org/content/dam/rand/pubs/research_reports/RR300/RR392/RAND_RR392.pdf, p. 245-258.

[8] Arms Control Association. 2015. '*Arms Control and Proliferation Profile: North Korea*.' Fact Sheets & Briefs, Update October 2015. As of Nov. 17, 2015: https://www.armscontrol.org/factsheets/northkoreaprofile

[9] Heginbotham, Eric et al. 2015. *The US-China Military Scorecard – Forces, Geography, and the Evolving Balance of Power 1996 - 2017*. Calif., Santa Monica: RAND Corporation, RR-392-AF. As of Nov. 17, 2015: http://www.rand.org/content/dam/rand/pubs/research_reports/RR300/RR392/RAND_RR392.pdf, p. 342.

financial pressures resulting from sequestration, then Army Chief of Staff Gen. Odierno and Chief of Naval Operations Adm. Greenert noted in November 2014 that "our present acquisition-based strategy is unsustainable […] and favors forward deployment of assets in lieu of deterrence-based options to meet contingency demands."[10] As such, a holistic, cost-effective approach to missile defense is needed to "incorporate […] 'left-of-launch' and other non-kinetic means of defense."[11]

This candid "vote of no confidence"[12] – the description of ranking member of the House Armed Services Strategic Forces Subcommittee Jim Cooper (D-Tenn.) – comes as no surprise to many defense analysts involved in the BMDS debate. In fact, while public attention has been gradually shifting to acknowledge missile defense systems like the Terminal High Altitude Area Defense (THAAD), AEGIS ashore, and the modernization and expansion of the Ground-based Midcourse Defense (GMD), the military services have been laying the groundwork for a system-of-systems, the so-called Integrated Air and Missile Defense (IAMD). According to then Chairman of the Joint Chiefs of Staff Gen. Dempsey, IAMD is an envisioned superstructure in which "all capabilities – defensive, passive, offensive, kinetic, non-kinetic – are melded into a comprehensive joint and combined force capable of preventing an adversary from effectively employing any of its offensive air and missile weapons."[13]

In light of Gen. Dempsey's IAMD 2020 vision and the Odierno-Greenert memo, the Department of Defense announced in March 2015 its intention to conduct a comprehensive review of US missile defense programs and capabilities, which is ongoing.[14]

This study aims to contribute to the DoD's missile defense review with particular focus on the challenges, opportunities, and recommendations for the Asia-Pacific theater. In specific the study is geared to answer four distinct questions:

(1) What are the strategic and tactical objectives of the US BMDS in the Asia-Pacific?
(2) How does BMDS fit into the IAMD 2020 vision?
(3) What role can regional US allies play in the context of IAMD? and
(4) How will IAMD influence the strategic balance in the Asia-Pacific?

[10] Odierno, Raymond T. & Jonathan W. Greenert. 2014. *Memorandum for Secretary of Defense - Subject: Adjusting the Ballistic Missile Defense Strategy*. As of Nov. 21, 2015: http://news.usni.org/2015/03/19/document-army-navy-memo-on-need-for-ballistic-missile-defense-strategy
[11] Odierno, Raymond T. & Jonathan W. Greenert. 2014. *Memorandum for Secretary of Defense - Subject: Adjusting the Ballistic Missile Defense Strategy*. As of Nov. 21, 2015: http://news.usni.org/2015/03/19/document-army-navy-memo-on-need-for-ballistic-missile-defense-strategy
[12] Reif, Kingston. 2015. 'Missile defense cost rise amid concerns.' *Arms Control Today*, April. As of Nov. 20, 2015: https://www.armscontrol.org/ACT/2015_04/News/Missile-Defense-Cost-Rises-Amid-Concerns
[13] Joint Chiefs of Staff. 2013. *Joint Integrated Air and Missile Defense: Vision 2020*. As of Nov. 21, 2015: http://www.jcs.mil/Portals/36/Documents/Publications/JointIAMDVision2020.pdf, p. 1.
[14] Shahal, Andrea. 2015. 'Pentagon plans hard look at missile defense programs.' *Reuters*, March 17. As of Nov. 20, 2015: http://www.reuters.com/article/2015/03/18/us-usa-military-missiledefense-idUSKBN0ME0AD20150318

Methodology

The study is organized into three chapters, each with its own policy recommendations. Chapter one sets the overall context for ballistic missile defense (BMD) in the Asia-Pacific by synthesizing the BMD capabilities of Japan, South Korea, Taiwan, and Australia, with a specific focus on the tactical objectives of forward-based US BMD elements. Chapter two assesses the strategic goals of the US ballistic missile defense system (BMDS) in the Asia-Pacific, in relation to: (1) alliance reassurance, (2) strategic and regional stability, (3) deterrence, and (4) left- and right-of-launch missile defense options. Chapter three shifts to the concept of Integrated Air and Missile Defense (IAMD) by focusing on defensive counter-air operations that are not part of the BMD threat portfolio, such as cruise missile defense (CMD), counter-unmanned aerial systems (CUAS), and counter-rockets, artillery, and mortar (C-RAM). The study concludes with a section on final thoughts and summarizes the answers to the four overarching questions posed in the introduction.

Limitations of the study: The study was limited by the availability of open source information and the inherent complexity of the still-evolving IAMD system-of-systems concept. As such it does not touch upon offensive counter-air operations, nor can it with certainty paint a full picture of all defensive counter-air systems currently maintained, operated, or developed by the US, Japan, South Korea, Taiwan, and Australia. The research therefore serves as a starting point for the discussion of BMDS and IAMD developments in the Asia-Pacific.

This study defines the Asia-Pacific region as the geographic theater covering North and East Asia, Southeast Asia, Oceania, and North America. Within this domain, the study focuses on the United States, Japan, South Korea, Taiwan, and Australia.

US BMDS in the Asia-Pacific Theater

The US Department of Defense (DoD) defines ballistic missile defense (BMD) as a defensive counter-air component that is being leveraged in reaction to (1) the growing threat of ballistic missile proliferation around the globe,[15] (2) continuous technological advancements made to make missiles "more flexible, mobile, survivable, reliable and accurate,"[16] and (3) the transfer of missile technology to countries that are deemed hostile to the United Stated and its allies.[17]

To successfully defend against this global ballistic missile threat, the Bush administration tasked the Missile Defense Agency (MDA) in January 2002 with managing, directing, and executing the development of a multilayered ballistic missile defense system (BMDS) aimed at "defend[ing] the Unites States, deployed forces, allies, and friends from ballistic missile attacks of all ranges in all phases of flight."[18] In June of the same year, the United States officially withdrew from the Anti-Ballistic Missile Treaty (ABM), removing the last Cold-War legal barrier for the unrestrained development and deployment of strategic and theater missile defense systems.[19] As Welch & Briggs summarily note, "relief from these treaty constraints permitted a move towards a unified, global BMDS […]."[20]

In accordance with the National Missile Defense Act of 1999, the MDA was specifically directed to "enable the fielding of elements of the BMDS as soon as practicable."[21] BMDS was consequentially exempted from the DoD's traditional 5000 series acquisition directives, Joint Staff requirement processes, such as the Joint Capabilities Integration Development System (JCIDS) and the Joint Requirements Oversight Council (JROC) approval process, as well as budgetary reviews and program assessments under the auspices of the Office of the Secretary of Defense (OSD).[22] Figure 1 shows the historical

---

[15] Raytheon. n.d. 'Army Navy/Transportable Radar Surveillance (AN/TPY-2) – Countering the growing ballistic missile threat.' As of Nov. 12, 2015: http://www.raytheon.com/capabilities/products/antpy2/

[16] US Department of Defense. 2010. *Ballistic Missile Defense Review Report*. As of Nov. 12, 2015: http://www.defense.gov/Portals/1/features/defenseReviews/BMDR/BMDR_as_of_26JAN10_0630_for_web.pdf, Executive Summary, p. iii.

[17] US Missile Defense Agency. n.d. 'The Threat – Technology Transfer.' As of Nov. 12, 2015: http://www.mda.mil/system/threat.html

[18] US Department of Defense. 2009. *Directive 5134.09 – Missile Defense Agency (MDA)*. As of Nov. 12, 2015: http://www.dtic.mil/whs/directives/corres/pdf/513409p.pdf
Note: Ballistic missile trajectories are divided into four phases: Boost, Ascent, Midcourse, and Terminal. For more information see: US Missile Defense Agency. n.d. 'A system of elements.' As of Nov. 30, 2015: http://www.mda.mil/system/elements.html

[19] Rusten, Lynn R. 2010. *U.S. Withdrawal from the Antiballistic Missile Treaty*. National Defense University: Center for the Study of Weapons of Mass Destruction. As of Nov. 14, 2015: http://ndupress.ndu.edu/Portals/68/Documents/casestudies/CSWMD_CaseStudy-2.pdf

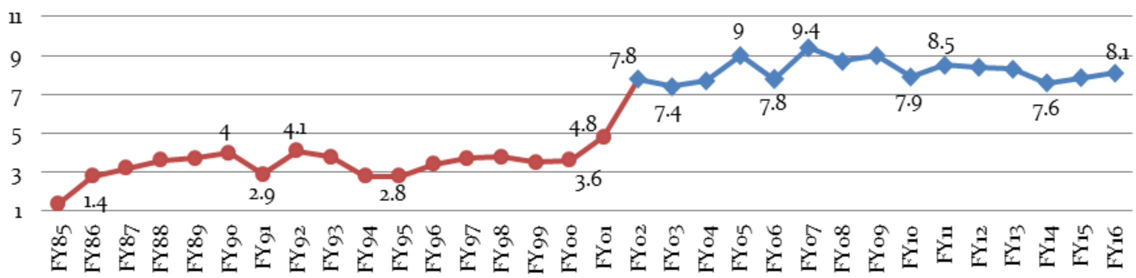
[20] Welch, Larry & David Briggs. 2008. *Study on the Mission, Roles, and Structure of the Missile Defense Agency (MDA)*. Institute for Defense Analyses, IDA Paper P-4374, p. II-3.

[21] US Congress. 1999. *National Missile Defense Act of 1999*. Public Law 106-38, 106th Congress. As of Nov. 12, 2015: https://www.congress.gov/106/plaws/publ38/PLAW-106publ38.pdf; US Department of Defense. 2009. *Directive 5134.09 – Missile Defense Agency (MDA)*. As of Nov. 12, 2015: http://www.dtic.mil/whs/directives/corres/pdf/513409p.pdf

[22] Welch, Larry & David Briggs. 2008. *Study on the Mission, Roles, and Structure of the Missile Defense Agency (MDA)*. Institute for Defense Analyses, IDA Paper P-4374, p. ES-2 & II-3.

development of the MDA budget (FY02-FY16) in comparison to spending devoted to predecessor organizations such as the SDIO (FY85-FY93) and BMDO (FY94-FY01).

Figure 1. MDA budget (FY85-FY16) in billion USD



Source: MDA (n.d., Budget information)

Within 14 years, the MDA has achieved considerable progress in developing and handing over BMDS components to the Lead Services. Table 1 provides an overview of current US BMDS elements relevant to the Asia-Pacific theater.

Table 1. US BMDS components relevant to the Asia-Pacific theater

Segment	BMDS elements[23]	Lead Service
Midcourse* & Terminal	AEGIS Ballistic Missile Defense (sea-based AEGIS BMD) [Standard Missile 3 interceptors (SM-3 blocks)]	US Navy
Midcourse	Ground-based Midcourse Defense (GMD) [Ground-based Interceptors (GBI)]	US Army
Terminal	Terminal High Altitude Area Defense (THAAD) [THAAD Interceptor]	US Army
Terminal	Patriot Advanced Capability-3 (PAC-3) [PAC-3 Interceptors (PAC-3 Baseline; PAC-3 MSE)]	US Army
Sensors		
SPY-1 Radar [AEGIS Radar]		US Navy
Sea Based X-Band Radar (SBX) [Stand-alone floating X-Band radar]		US Navy
Army Navy/Transportable Radar Surveillance system (AN/TPY-2) [THAAD Radar]		US Army
Cobra Dane Radar [GMD Radar]		US Air Force
Space Tracking and Surveillance System (STSS)		US Air Force
Upgraded Early Warning Radars (UEWR)		US Air Force
Long Range Discriminating Radar (LRDR) – *pending*		*None*
Command & Control		
Command, Control, Battle Management and Communications (C2BMC)- *pending*		*None*

Source: Welch & Briggs (2008, V-6); GAO (2011, 7), Thornton (2015), MDA (n.d. The System)
* Due to range limits, the current SM-3 interceptors are not capable of intercepting ICBMs

[23] Note: The AEGIS Ashore Missile Defense test complex at the Pacific Missile Range Facility in Kauai, Hawaii, is not an operational element of the US BMDS.

Given the vastness of the Asia-Pacific theater, it is not surprising to note that the various US BMDS elements are strategically scattered across the US Pacific Command (USPACOM) and US Northern Command (USNORTHCOM) Area of Responsibility (AoR). Overall the strategic framework for US BMDS in the Asia-Pacific theater is guided by four overarching mission objectives outlined in the DoD's 2010 Ballistic Missile Defense Review (BMDR): (1) homeland defense, (2) regional missile defense, (3) regional BMD capability integration, and (4) strengthening of international missile defense cooperation.[24]

The Army's Ground-based Midcourse Defense (GMD) for example, protects the US homeland against limited ICBM attacks and is emplaced at Fort Greely (Alaska) and Vandenberg Air Force Base (California), with additional fire control nodes located at Schriever AFB (Colorado).[25] In contrast, the road-mobile Terminal High Area Altitude Defense (THAAD) is fielded at Fort Bliss (Texas) with permanent rotational deployments to Guam,[26] and the Patriot Advanced Capability-3 (PAC-3) serves as a pin-point defense to safeguard US forces and Air Force bases in Japan and South Korea.[27] The Navy's AEGIS BMD meanwhile steams across the Pacific, protecting Hawaii and supporting the defense of Japan.[28] In the absence of any air-based ballistic missile intercepting systems, the role of the US Air Force is currently limited to operating Early Warning Radars (EWR), the Cobra Dane radar, and Space Tracking and Surveillance System (STSS).[29]

All US BMDS elements, including those outside the USPACOM and USNORTHCOM AoR, are synchronized by the Joint Functional Component Command for Integrated Missile Defense (JFCC-IMD) at the US Strategic Command (USSTRATCOM).[30]

---

[24] US Department of Defense. 2010. *Ballistic Missile Defense Review Report*. As of Nov. 12, 2015: http://www.defense.gov/Portals/1/features/defenseReviews/BMDR/BMDR_as_of_26JAN10_0630_for_web.pdf, Executive Summary, p. 11-12.

[25] Defense Industry Daily. 2015. 'Missile Defense: Next Steps for the USA's GMD.' *Defense Industry Daily*, June 1. As of Nov. 30, 2015: http://www.defenseindustrydaily.com/3979m-next-step-or-last-step-for-gmd-05229/

[26] Menzies, Kimberly. 2015. '94th AAMDC THAAD Battery in Guam transfers authority to its sister unit.' *Army.mil*, March 5. As of Nov. 30, 2015: http://www.army.mil/article/143951/94th_AAMDC_THAAD_Battery_in_Guam_transfers_authority_to_its_sister_unit/?from=RSS; US Missile Defense Agency. n.d. 'THAAD.' As of Nov. 30, 2015: http://www.mda.mil/system/thaad.html

[27] IHS Jane's. 2015. 'Patriot PAC-3.' *Land Warfare Platforms: Artillery & Air Defence*, May 19; Harrell, Casey. 2011. 'Senior commander visits 35th ADA Brigade for UFG.' *Army.mil*, August 30. As of Nov. 30, 2015: http://www.army.mil/article/64504; Kunsan Air Base. 2013. 'Alpha Battery, 2nd Battalion, 1st Air Defense Artillery.' *Kunsan.af.mil*, April 23. As of Nov. 30, 2015: http://www.kunsan.af.mil/AboutUs/FactSheets/tabid/1943/Article/412719/alpha-battery-2nd-battalion-1st-air-defense-artillery.aspx

[28] Rinehart, Ian et al. 2015. *Ballistic Missile Defense in the Asia-Pacific Region: Cooperation and Opposition*. Congressional Research Service, April 3. As of Nov. 30, 2015: https://www.fas.org/sgp/crs/nuke/R43116.pdf, p. 9; Clements, Richard. 2013. 'Pentagon deploys anti-ballistic missile defense system to Guam while North Korea announces nuclear attack on US.' *The Aviationist*, April 3. As of Nov. 30, 2015: http://theaviationist.com/2013/04/03/thaad-north-korea/; Ellison, Riki & Ian Williams. 2015. *Japan: Priorities for Missile Defense Development and US Partnership*. Missile Defense Advocacy Alliance, Country Brief. As of Nov. 30, 2015: http://missiledefenseadvocacy.org/wp-content/uploads/2015/04/Japan-BMD-Report.pdf, p. 3.

[29] Note**:** The Air Force's Air-Launched Hit-to-Kill (ALHK) capability was adopted by the Army and the Airborne Laser (ABL) was sent back to the drawing board.

[30] US House of Representatives. 2014. *Statement by Lieutenant General David L. Mann before the Committee on Armed Services - Strategic Forces Subcommittee*. US House of Representatives, March 25. As of Nov. 30, 2015:

Formed in 2005, the JFCC-IMD "synchronizes missile defense plans, conducts BMD operations support, and advocates for missile defense capabilities in support of USSTRATCOM, Combatant Commands, the Services, and appropriate U.S. Government Agencies, to deter and defend the U.S., deployed forces, and its allies against ballistic missile attacks."[31]

The operational challenge for the JFCC-IMD is that the global Combatant Command demand for missile defense systems exceeds the available US BMD inventory. As a result, Lt. Gen. Mann, Commander of the JFCC-IMD and the US Army Space and Missile Defense Command, noted in 2014 that "all sourcing decisions have a direct and significant impact to other combatant commanders' campaign and contingency plans" and that "we must continue to address this mismatch using mobile and re-locatable missile defenses and a comprehensive force management process."[32]

When it comes to missile defense, particularly in the Western-Pacific, the Pentagon is relying upon allied missile defense infrastructure to enable regional capability integration and facilitate balanced alliance burden sharing. The majority of US treaty allies in the Asia-Pacific have made considerable investments into acquiring and upgrading US BMD systems to mitigate existing defense vulnerabilities and increase technical interoperability with US theater forces.

Japan

More than any other nation in the Western-Pacific, Japan has been pro-actively procuring and upgrading its BMD capabilities in response to the medium- and long-range missile threats emanating from the DPRK.[33] Additionally, Japan's 2015 Defense White Paper cites Beijing's anti-satellite tests, the expansion of anti-access/area-denial (A2/AD) capabilities, and the development of hypersonic glide vehicles to overcome missile defenses, as increasing concerns to Tokyo.[34]

Currently, the Japanese Air Self-Defense Force (JASDF) is fielding six battalions equipped with PAC-3 and PAC-2 systems,[35] and maintains a series of FPS-3 and FPS-5

---

http://docs.house.gov/meetings/AS/AS29/20140325/101945/HHRG-113-AS29-Wstate-MannUSArmyD-20140325.pdf, p. 10.

[31] Joint Functional Component Command for Integrated Missile Defense. 2015. *Factsheet: JFCC IMD*. As of Feb. 28, 2016: http://www.smdc.army.mil/FactSheets/JFCC-IMD.pdf

[32] US House of Representatives. 2014. *Statement by Lieutenant General David L. Mann before the Committee on Armed Services - Strategic Forces Subcommittee*. US House of Representatives, March 25. As of Nov. 30, 2015: http://docs.house.gov/meetings/AS/AS29/20140325/101945/HHRG-113-AS29-Wstate-MannUSArmyD-20140325.pdf, p. 10.

[33] Note: Tokyo's interest in BMD started as early as 1993, when the DPRK fired a medium-range Nodong missile into the Sea of Japan. It was reinforce in 1998 when the DPRK launched an intermediate-range Taepodong-1 missile over Japanese territory. Plans to procure BMD capabilities began 10 years later in August 2003 when the Japanese Defense Agency requested a BMD-related budget for FY2004. See: Japanese Ministry of Defense. 2010. *Japan's BMD*. As of Nov. 30, 2015: http://www.mod.go.jp/e/d_act/bmd/bmd.pdf

[34] Japanese Ministry of Defense. 2015. *Defense of Japan 2015*. As of Nov. 30, 2015: http://www.mod.go.jp/e/publ/w_paper/2015.html, Digest part 1 & p. 3.

[35]Sankaran, Jaganath & Bryan L. Fearey. 2015. *Deterring North Korea: An Examination of the East Asian Missile Defense Architecture*. CSIS – Project on Nuclear Issues (PONI) Conference, June 23-24. As of Nov. 30, 2015: http://csis.org/images/stories/poni/150702_SANKARAN.pdf

radar stations for the nation's terminal BMD layer.[36] The Maritime Self-Defense Force (JMSDF) operates four *Kongo*-class destroyers equipped with Standard Missile-3 IA interceptors, and is upgrading two *Atago*-class destroyers (to AWS baseline 9)[37] for midcourse intercept.[38] Two additional AEGIS BMD destroyers (27DDG-class, planned AWS baseline 9)[39] are being conceptualized and expected to be commissioned in 2020 and 2021 respectively.[40] The Japan Aerospace Defense Ground Environment (JADGE) pulls all theses BMD elements together into a two-tier missile defense system, by serving as the JASDF's indigenous command control, battle management, and communication system (C2BMC).[41]

The United States plays a force-multiplying role in the Japanese theater through the forward deployment of two AN/TPY-2 radars[42] (Sharirki, Aomori and Kyogamisaki, Kyoto) and AEGIS BMD-equipped hulls (US 7th Fleet, Yokosuka Naval Base, Kanagawa).[43] Additionally a PAC-3 battalion stationed at Kadena Air Force base is providing base and force protection. Overall the tactical objective of US BMD elements stationed in Japan is geared toward facilitating alliance interoperability to the extent of creating joint command structures and allowing for real-time data sharing.

Both countries have been jointly developing the Standard Missile-3 IIA interceptor since 2006. The SM-3 IIA is designed wider than the SM-3 IA, creating better intercept geometry and "more range and velocity at burnout allowing for a larger defended area."[44] In other words, instead of requiring six destroyers equipped with SM-3 IA interceptors to defend Japan, it would suffice to maintain only 2-3 platforms equipped with SM-3 IIA to

[36] Yamaguchi, Mai. 2014. *Japan's BMD Update*. Japanese Ministry of Defense, Defense Policy Bureau. As of Nov. 30, 2015: http://www.slideshare.net/RUSIEVENTS/ms-mai-yaguchi

[37] See page 37-38.

[38] Defense Industry Daily. 2015. 'Japan's Fleet BMD: Upgrades & UORs.' *Defense Industry Daily*, Nov. 10. As of Nov. 30, 2015: http://www.defenseindustrydaily.com/up-to-387m-for-japanese-naval-abm-components-0807/; US Department of Defense. 2012. '36(b)(1) Arms Sales Notification.' *Federal Register*, Volume 77, Number 246. As of Nov. 30, 2015: https://www.gpo.gov/fdsys/pkg/FR-2012-12-21/html/2012-30810.htm

[39] InsideDefense. 2015. 'State Department OKs sale of Aegis systems for new Japanese ships.' *Inside Missile Defense*, Vol. 21, No. 17, p. 9.

[40] Hardy, James. 2015. 'DSCA notification sheds light on next-gen Japanese destroyers.' *IHS Jane's Defence Weekly*, August 11. As of Nov. 30, 2015: http://www.janes.com/article/53567/dsca-notification-sheds-light-on-next-gen-japanese-destroyers; Navy Recognition. 2015. Japan 'Defense Ministry Unveiled Details of "27DD" Class Railgun & Laser armed AEGIS Destroyer.' *Navy Recognition*, July 22. As of Nov. 30, 2015: http://www.navyrecognition.com/index.php?option=com_content&task=view&id=2925

[41] Japanese Ministry of Defense. 2012. 'Japan's BMD System.' *Japan Defense Focus*, No. 31. As of Nov. 30, 2015: http://www.mod.go.jp/e/jdf/pdf/jdf_no31.pdf, p. 6.

[42] Note: The two AN/TPY-2 radars provide complete national coverage of Japan, the Korean Peninsula, and the entire Sea of Japan. They also enable higher resolution and discrimination of target missiles. See: Sankaran, Jaganath & Bryan L. Fearey. 2015. *Deterring North Korea: An Examination of the East Asian Missile Defense Architecture*. CSIS – Project on Nuclear Issues (PONI) Conference, June 23-24. As of Nov. 30, 2015: http://csis.org/images/stories/poni/150702_SANKARAN.pdf, p. 5.

[43] Sankaran, Jaganath & Bryan L. Fearey. 2015. *Deterring North Korea: An Examination of the East Asian Missile Defense Architecture*. CSIS – Project on Nuclear Issues (PONI) Conference, June 23-24. As of Nov. 30, 2015: http://csis.org/images/stories/poni/150702_SANKARAN.pdf; Ellison, Riki & Ian Williams. 2015. *Japan: Priorities for Missile Defense Development and US Partnership*. Missile Defense Advocacy Alliance, Country Brief. As of Nov. 30, 2015: http://missiledefenseadvocacy.org/wp-content/uploads/2015/04/Japan-BMD-Report.pdf, p. 3; Commander US 7th Fleet. n.d. 'US 7th Fleet Forces.' As of Nov. 30, 2015: http://www.c7f.navy.mil/forces.htm

[44] Butler, Amy. 2014. 'Raytheon Eyes Early SM-3 IIA Builds.' *Aviation Week*, March 13. As of Nov. 30, 2015: http://aviationweek.com/defense/raytheon-eyes-early-sm-3-iia-builds

cover the same area.[45] In June 2015 the SM-3 IIA conducted its first flight test and is slated to enter service in 2018.[46] Table 2 provides an overview of Japanese BMD elements.

Table 2. Japanese BMD elements

Segment	Japanese BMD	Lead Service
Midcourse	AEGIS Ballistic Missile Defense (*Kongo*-class) – (4) [Standard Missile 3 interceptor (SM-3 Block IA]	JMSDF
Midcourse*	AEGIS Ballistic Missile Defense (*Atago*-class) – (2) - *pending* [Standard Missile 3 interceptor (SM-3 Block IIA] – *pending*	JMSDF
Terminal	Patriot Advanced Capability-3 (PAC-3) – (17) [PAC-3 Interceptors (PAC-3 Baseline; PAC-3 MSE)]	JASDF
Terminal	Patriot Advanced Capability-2 (PAC-2) – (?) [PAC-2 Interceptors]	JASDF
Sensors		
SPY-1 Radar [AEGIS Radar component] – (4)		JMSDF
FPS-5 & FPS-3 Upgraded Radar [Ground-based Radar] – (4)+(7)		JASDF
Command & Control		
Japan Aerospace Defense Ground Environment (JADGE)		JASDF

Source: Japanese Ministry of Defense (2012, 6); Sankaran & Fearey (2015, 3)
* Will allow for IRBM midcourse intercept (limited ICBM intercept possible)[47]

Washington and Tokyo revised the 'Guidelines for Japan-US Defense Cooperation' in April 2015. On the issue of ballistic missile defense, both nations emphasized the need to "cooperate to expand early warning capabilities, interoperability, network coverage, and real-time information exchange and to pursue the comprehensive improvement of capabilities to respond to the threat of ballistic missiles."[48] Domestically, the Abe government pushed several policy changes through the Japanese Diet, such as the revision of Article 12 of the 'Law for the Establishment of the Defense Ministry,' to streamline MoD decision-making processes and eliminate civilian layers of control to optimize reaction times in the event of hostile missile launches.[49] The Abe government also succeeded in lifting Japan's longstanding ban on collective self-defense through the introduction of a series of security laws which were adopted by the Diet in September 2015.[50] Although Japan does not retain the BMD capabilities necessary to protect the continental United States from an ICBM attack, future deployments of SM-3 IIA missiles

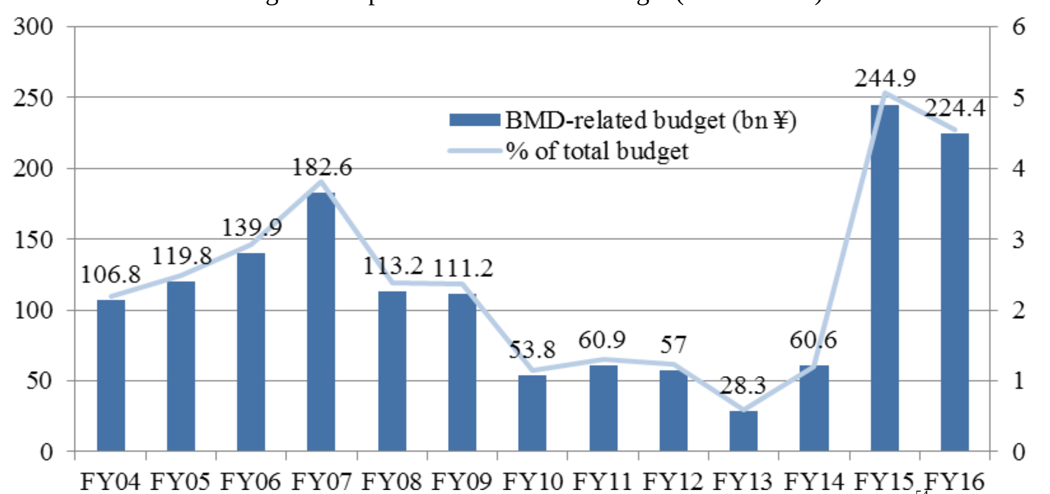
[45] Defense Industry Daily. 2015. 'Japan's Fleet BMD: Upgrades & UORs.' *Defense Industry Daily*, Nov. 10. As of Nov. 30, 2015: http://www.defenseindustrydaily.com/up-to-387m-for-japanese-naval-abm-components-0807/
[46] Wasserbly, Daniel. 2015. 'Next-generation SM-3 missile interceptor takes first flight.' *IHS Jane's Defence Weekly*, June 8. As of Nov. 2015: http://www.janes.com/article/52093/next-generation-sm-3-missile-interceptor-takes-first-flight
[47] Horn, Joe. 2010. 'Aegis Ballistic Missile Defense.' Aegis BMD Overview to the National Defense Industrial Association, July 13. As of Nov. 30, 2015: http://www.ndia.org/resources/onlineproceedings/documents/0100/0100-aegisbmdoverview-rdmlhorn.pdf, p. 6.
[48] Japanese Ministry of Defense. 2015. *The Guidelines for Japan-US Defense Cooperation*. As of Nov. 30, 2015:http://www.mod.go.jp/e/d_act/anpo/pdf/shishin_20150427e.pdf, p. 6.
[49] Miwa, Sachiko. 2015. 'Defense ministry eyes more power for SDF officers.' *Asahi Shimbun*, February 4. As of Nov. 30, 2015: http://ajw.asahi.com/article/behind_news/politics/AJ201502240049
[50] Yoshida, Reiji & Mizuho Aoki. 2015. 'Diet enacts security laws, marking Japan's departure from pacifism.' *Asahi Shimbun*, September 19. As of Nov. 30, 2015: http://www.japantimes.co.jp/news/2015/09/19/national/politics-diplomacy/diet-enacts-security-laws-marking-japans-departure-from-pacifism-2/

will enable the JMSDF to intercept IRBMs heading for Guam and Hawaii. As a result, the demand for JMSDF participation in combined theater operations with the US Navy is set to rise in tandem with Japan's adoption of simultaneous engagement capabilities (AEGIS Weapon System upgrades for air and missile defense), sensor data sharing, and improved missile interceptors.[51]

Overall, the trajectory of the US-Japan alliance is marked by "increased levels of interoperability […], driven by missile defense requirements," to create an ever closer integrated joint command relationship. [52] As a result, the DoD's 2010 BMDR praises the US-Japan partnership as "an outstanding example of the kind of cooperation the United States seeks in order to tailor a phased adaptive approach to the unique threats and capabilities in the region."[53]

Budget: Japan's MoD has requested ¥224.4 billion ($1.8 billion / 4.5 percent of the Japanese defense budget) for the BMD-related budget in FY2016. While this is ¥20 billion less than expenditures in 2015, it is also ¥160 billion more than two years ago. The large deviations in Japan's annual BMD-related spending are the result of two factors: Yen-US Dollar currency exchange rate (*procurement of US systems*) and the 1 percent of GDP defense budget cap policy (*prioritization*). Figure 1 shows the historical development of the Japanese BMD-related budget between 2004 and 2016.

Figure 2. Japanese BMD-related budget (FY04-FY16)



Source: Data compiled from the annually released Japanese MoD defense budget overview[54]

[51] Rinehart, Ian E. 2013. *Collective Self-Defense and US-Japan Security Cooperation*. East-West Center: Politics, Governance, and Security Series, No. 24. As of Nov. 30, 2015: http://www.eastwestcenter.org/sites/default/files/private/pswp024.pdf, p. 6.
[52] Berteau, David J. & Michael J. Green. 2012. *US Force Posture Strategy in the Asia Pacific Region: An Independent Assessment*. Center for Strategic & International Studies. As of Nov. 30, 2015: http://csis.org/files/publication/120814_FINAL_PACOM_optimized.pdf, p. 26.
[53] US Department of Defense. 2010. *Ballistic Missile Defense Review Report*. As of Nov. 12, 2015: http://www.defense.gov/Portals/1/features/defenseReviews/BMDR/BMDR_as_of_26JAN10_0630_for_web.pdf, p. 33.
[54] Japanese Ministry of Defense. n.d. '予算等の概要(Defense Budget Overview).' As of Nov. 30, 2015: http://www.mod.go.jp/j/yosan/yosan.html

South Korea

In a unilateral move to pave the way for the signing of the 'Joint Declaration on the Denuclearization of the Korean Peninsula,' the United States in consultation with the Roh Tae-woo administration, removed all US land- and sea-based tactical nuclear weapons from South Korea in October 1991.[55] For 15 years, subsequent South Korean administrations unsuccessfully tried to pressure North Korea to fulfill its treaty obligations, while resisting calls for missile defense procurements to counter Pyongyang's accelerating nuclear and missile program. North Korea's first nuclear test in 2006 changed Seoul's political calculus and forced the Roh Moo-hyun administration to lay the foundation for a single-layered BMD system, the so-called Korean Air and Missile Defense (KAMD).

Currently, the KAMD consists of eight PAC-2 batteries, an undisclosed number of prototypes of the Russian-Korean-build Medium-range Surface-to-Air Missile (M-SAM) system,[56] and two *Green Pine* radars (part of the US-Israel-made *Iron Dome*).[57] The South Korean Navy maintains three AEGIS cruisers equipped with SM-2 IIIA/B interceptors which are however not designed to shoot down ballistic missiles. So far Seoul has opted against procuring SM-3 interceptors, citing (1) the substantial higher costs and (2) possible controversy with Beijing due to the missile's extended range.[58] In mid-2012, the South Korean Air Force started operating the Air and Missile Defense Cell (AMD-Cell) which serves as the indigenous BMDS command-and-control center. Table 3 provides an overview of current KAMD elements.

---

[55] Rosenbaum, David E. 1991. 'US to Pull A-Bombs From South Korea.' *New York Times*, October 20. As of Nov. 30, 2015: http://www.nytimes.com/1991/10/20/world/us-to-pull-a-bombs-from-south-korea.html

[56] Perrett, Bradley. 2015. 'Korean SAM Improvement to Counter Tactical Ballistic Threats.' *Aviation Week*, Nov. 5. As of Nov. 30, 2015: http://aviationweek.com/defense/korean-sam-improvement-counter-tactical-ballistic-threats
Note: The M-SAM system was developed by Russian arms manufacturer Almaz-Antey (which also developed the Russian S-300 & S-400) with assistance from South Korea's Samsung Thales, LIG Nex1, and Doosan DST. However given that localization and industrialization are conducted in South Korea, it is officially considered an indigenous Korean missile defense system. Almaz-Antey has continued to develop a separate follow-on system for the Russian market, known as the S350E *Vityaz*. See: Malyasov, Dylan. 2015. 'Cheolmae II missile was successfully tested in South Korea is expected to mass production.' *Defence-blog.com*, July 30. As of Feb. 28, 2016: http://defence-blog.com/news/cheolmae-ii-missile-was-successfully-tested-in-south-korea-is-expected-to-mass-production.html; Aviationweek. 2015. 'S-300 Surface-To-Air Missile System.' *Aerospace Daily & Defense Report*, August 6. As of Feb. 28, 2016: http://aviationweek.com/site-files/aviationweek.com/files/uploads/2015/07/asd_08_06_2015_dossier.pdf, p. 6.

[57] *Yonhap*. 2012. 'S. Korea to deploy newly introduced radar ahead of N. Korea rocket launch.' *Yonhap News*, December 5. As of Nov. 30, 2015: http://english.yonhapnews.co.kr/national/2012/12/05/51/0301000000AEN20121205002700315F.HTML

[58] *Dong-A Ilbo*. 2012. 'Navy urged to arm Aegis destroyers with better capability.' *Dong-A Ilbo*, April 24. As of Nov. 30, 2015: http://english.donga.com/srv/service.php3?biid=2012042439578; Yonhap. 2014. 'Acquiring SM-3 missiles not an option for S. Korea: defense ministry.' *Yonhap News*, May 26. As of Nov. 30, 2015: http://english.yonhapnews.co.kr/national/2014/05/26/32/0301000000AEN20140526006400315F.html

Table 3. Korean AMD elements

Segment	Korean Air and Missile Defense (KAMD)	Lead Service
Terminal	Patriot Advanced Capability-2 (PAC-2) – (8) [PAC-2 GEM-T interceptors]	Korean Air Force
Terminal	Medium-range Surface-to-Air Missile (M-SAM) – (?) *procurement*	Korean Air Force
Terminal	Long-range Surface-to-Air Missile (L-SAM) - *pending*	Korean Air Force
Sensors		
Spy-1 Radar [aboard the KDX-III AEGIS cruisers] – (3)		Korean Navy
EL/M-2080 Green Pine Radar [forward deployed ground-based Radar] – (2)		Korean Air Force
Command & Control		
Air and Missile Defense Cell (AMD-Cell)		Korean Air Force

Source: Compiled by author

US Forces Korea (USFK) maintains its own separate BMDS on the Peninsula. The US system is comprised of PAC-3 batteries for force and base protection, and interfaces through the Theater Missile Operations-Cell (TMO-Cell) with the rest of the theater-wide US BMDS, including US forward deployed assets in Japan.[59] So far South Korea has refused to connect its AMD-Cell with the USFK TMO-Cell citing: (1) an unclear cost-benefit calculation, given that the information shared with the US will primarily be utilized to aid in the defense of Japan rather than Korea itself, and (2) fears of possible Chinese counter-reactions to Seoul joining the US-led BMDS.[60] South Korea's strategic ambiguity reached its epitome in mid-2014 when the Pentagon considered deploying a THAAD system to the Peninsula in an effort to expand the USFK footprint against North Korean ballistic missiles.[61] The THAAD debate has sparked such intense controversy in the region that it de-facto turned into a "litmus test for Seoul's alignment between Beijing and Washington."[62]

Following Pyongyang's first H-bomb test and second successful satellite launch earlier in 2016, Seoul and Washington commenced working-level talks on the possible deployment of THAAD to the Peninsula. However, as US PACOM Commander Adm. Harris noted that, "the decision to discuss it is not necessarily a decision to do it […]."[63] Beijing is vehemently objecting to any THAAD deployments in South Korea.[64] As of the end of March 2016, no alliance decision on THAAD has been made.

[59] Song, Sang-ho. 2014. 'Korea, US talk missile defense cooperation.' *Korean Herald*, March 27. As of Nov. 30, 2015: http://www.koreaherald.com/view.php?ud=20150327000977

[60] Kang, Choi & Kim Gi Bum. 2014. *Breaking the Myth of Missile Defense*. The Asan Institute for Policy Studies, Issue Brief, August 8. As of Nov. 30, 2015: http://en.asaninst.org/contents/breaking-the-myth-of-missile-defense/

[61] *Yonhap*. 2014. 'US mulls deploying MD system in S. Korea: USFK chief.' *Yonhap News*, June 3. As of Nov. 30, 2015: http://english.yonhapnews.co.kr/news/2014/06/03/86/0200000000AEN20140603002252315F.html

[62] Rinehart, Ian et al. 2015. *Ballistic Missile Defense in the Asia-Pacific Region: Cooperation and Opposition*. Congressional Research Service, April 3. As of Nov. 30, 2015: https://www.fas.org/sgp/crs/nuke/R43116.pdf, p. 11-12.

[63] Chang, Jae-soon. 2016. 'U.S. Pacific commander: THAAD talks don't necessarily mean deployment.' *Yonhap News*, Feburary 26. As of Feb. 28, 2016: http://english.yonhapnews.co.kr/national/2016/02/26/21/0301000000AEN20160226001700315F.html

[64] Ministry of National Defense of the People's Republic of China. 2016. 'Defense Ministry's regular press conference on Feb.25.' As of Feb. 28, 2016: http://eng.mod.gov.cn/DefenseNews/2016-02/25/content_4644802.htm

South Korea's current stance on the KAMD is to facilitate 'cooperation' with the US BMDS by achieving technical interoperability while avoiding operational participation in it. In other words, Seoul is planning to "use parts of the US missile defense system to protect itself more effectively from North Korean missile threats,"[65] while refraining from playing a constructive role in the wider US BMDS framework. While South Korea's position is clearly aimed at simply leveraging US assets, Seoul's decision to postpone the transfer of wartime operational control (OPCON) to mid-2020[66] ensures that the US-led Combined Forces Command (CFC) will take full control of South Korea's armed forces, including its missile defense systems, in the event of war on the Peninsula.[67]

Budget: In early 2015, the Korean MoD announced its intention to earmark KRW2.7 trillion ($2.3 billion) in FY16-FY20 to modernize the KAMD system.[68] The funds will be used in part to upgrade South Korea's PAC-2s to PAC-3 capability, procure M-SAM batteries, fund RDT&E for the L-SAM system (a long-range missile defense system similar to the THAAD), and acquire SM-6 missiles.

Taiwan

While not a US treaty ally, Washington's commitment to defend Taiwan under the Taiwan Relations Act of 1979 is an often overlooked US security challenge in the Asia-Pacific. But as Tsang notes, "the [Taiwan Relations] Act is no less credible than the mutual defense treaties the US has with its other major Asian allies, or the defense treaty with Taiwan, that it in effect replaced."[69]

When it comes to the defense of Taiwan, the primary threat emanates from the approximately 1400-1500 ballistic missiles deployed against the island across the Taiwan Strait.[70] The geographic proximity to the Chinese mainland and the absence of US military bases close to Formosa further compound the challenge for the geographic US Combatant Command.[71]

---

[65] Kang, Choi & Kim Gi Bum. 2014. *Breaking the Myth of Missile Defense*. The Asan Institute for Policy Studies, Issue Brief, August 8. As of Nov. 30, 2015: http://en.asaninst.org/contents/breaking-the-myth-of-missile-defense/

[66] Harper, Jon. 2014. 'OPCON transfer, US troop redeployment in Korea postponed indefinitely.' *Stars and Stripes*, October 23. As of Nov. 30, 2015: http://www.stripes.com/news/pacific/korea/opcon-transfer-us-troop-redeployment-in-korea-postponed-indefinitely-1.309960

[67] Sharp, Walter. 2013. *OPCON Transition in Korea*. CSIS, Korea Chair Platform, December 2. As of Nov. 30, 2015: http://csis.org/files/publication/131216_OPCON_Transition_in_Korea.pdf

[68] Caffrey, Craig. 2015. 'South Korea announces plans to increase defence spending by 7.2% from 2016-20.' *IHS Jane's Defence Weekly*, April 27. As of Nov. 30, 2015: http://www.janes.com/article/50985/south-korea-announces-plans-to-increase-defence-spending-by-7-2-from-2016-20

[69] Tsang, Steve. 2012. 'The US Military and American Commitment to Taiwan's Security.' *Asian Survey*, Vol. 52, No. 4, p. 777

[70] Lu, H.H. & Lillian Lin. 2015. 'MND reports China deploying more missiles against Taiwan.' *Focus Taiwan*, August 31. As of Nov. 30, 2015: http://focustaiwan.tw/news/acs/201508310032.aspx

[71] Heginbotham, Eric et al. 2015. *The US-China Military Scorecard – Forces, Geography, and the Evolving Balance of Power 1996-2017*. Calif., Santa Monica: RAND Corporation, RR-392-AF. As of Nov. 17, 2015: http://www.rand.org/content/dam/rand/pubs/research_reports/RR300/RR392/RAND_RR392.pdf, p. 54.

Taiwan maintains a single-layered terminal BMDS comprised of three upgraded PAC-2 and seven PAC-3 batteries.[72] Additionally, Taipei has developed its own missile defense system, the *Sky Bow-3*, which is a domestically-manufactured PAC-3 alternative due to the increasing difficultly and politically sensitive nature of procuring weapon systems from the United States. Washington's tip-toe stance on arming Taiwan, coupled with domestic Taiwanese politics, has also influenced the acquisition of the long-range early warning Surveillance Radar Program (SRP) and the *Syun An* command, control, communication, and computers (C4) system. To date, the island fields only one of the requested two SRPs and is in the process of integrating all its BMD components into the *Syun An* C4.[73]

Table 4. Taiwanese BMD elements

Segment	Taiwanese BMD	Lead Service
Terminal	Patriot Advanced Capability-3 (PAC-3) – (10)	Taiwanese Army
Terminal	*Sky Bow II* (Tien Kung II) – (?) *phasing out*	Taiwanese Army
Terminal	*Sky Bow III* (Tien Kung III) – *procurement*	Taiwanese Army
Sensors		
Long range early warning Surveillance Radar Program (SRP) – (1)		Taiwanese Army
PAC-2/3 Radar – (?)		Taiwanese Army
Sky Bow III Radar (Chang-Shan) – (?)		Taiwanese Army
Command & Control		
Syun An C4 system – *partial integration*		Taiwanese Army

Source: Kan (2014), Taiwanese MND (n.d., Major Weapons Systems of the ROC Armed Forces), Easton (2014)

BMD cooperation between the US and Taiwan is to a large degree shaped by domestic politics in both capitals rather than sound military strategy within the context of the US pivot to Asia. Taiwan's SRP for example is one of the most advanced radars in the world, equipped with jamming capabilities and able to track more than 1,000 targets simultaneously, including cruise- and ballistic missiles.[74] From its current position atop Mount Leshan the radar penetrates deep into Chinese airspace and also reportedly tracked North Korea's *Unha-3* rocket in late-2012.[75] Despite the strategic significance of the SRP for both US intelligence collection and early warning enhancement, there is no formal agreement on real-time data sharing between Taipei and Washington. "The main problem," as one former US government official explained, "is US policy, which self-constrains substantive cooperation."[76]

[72] Kan, Shirley A. 2014. *Taiwan: Major US Arms Sales since 1990*. Congressional Research Service, August 29. As of Nov. 30, 2015: https://www.fas.org/sgp/crs/weapons/RL30957.pdf, p. 16-17.
[73] Kan, Shirley A. 2014. *Taiwan: Major US Arms Sales since 1990*. Congressional Research Service, August 29. As of Nov. 30, 2015: https://www.fas.org/sgp/crs/weapons/RL30957.pdf, p. 19.
[74] Minnick, Wendell. 2014. 'US Might Tap Into Taiwan Early Warning Radar.' *Defense News*, May 8. As of Nov. 30, 2015: http://archive.defensenews.com/article/20140508/DEFREG03/305080026/US-Might-Tap-Into-Taiwan-Early-Warning-Radar
[75] Minnick, Wendell. 2013. 'Taiwan's BMD Radar Gives Unique Data on China.' *Defense News*, Nov. 26. As of Nov. 30, 2015: http://archive.defensenews.com/article/20131126/DEFREG03/311260013/Taiwan-s-BMD-Radar-Gives-Unique-Data-China
[76] Minnick, Wendell. 2013. 'Taiwan's BMD Radar Gives Unique Data on China.' *Defense News*, Nov. 26. As of Nov. 30, 2015: http://archive.defensenews.com/article/20131126/DEFREG03/311260013/Taiwan-s-BMD-Radar-Gives-Unique-Data-China

Taiwanese domestic politics have also significantly contributed to the lack of progress in the nation's BMDS. The acquisition of the PAC-3 for example, was blocked by the parliamentary opposition between 2001-2004, due to a failed referendum on buying additional missile systems, which then President Chen Shui-bian pushed on Election Day.[77] It took another four and six years respectively for the Taiwanese Parliament to de-freeze the allocated procurement budget and clarify whether the funds would not be better spent on an offensive long-range missile capability.[78] The Taiwanese Ministry of National Defense had to wait until late-2015 to find the necessary funds and receive the political go-ahead to test-fire its PAC-3 systems at the Army's White Sands Missile Range (New Mexico) in July 2016.[79] In fact, the significance of testing the PAC-3 on US soil, rather than in Taiwan itself, is of national and strategic importance to the US and its allies in the Asia-Pacific, because "if China could gather the PAC-3 missile's electronic signal and other flight data [it] would undermine Taiwan's national security, and could also endanger the air defense systems of Japan and the US."[80]

When it comes to BMD cooperation with Taiwan, the US has two tactical concerns: (1) the political commitment to defend the island and (2) the military capabilities to assist in Taiwan's self-defense. Compounding the problem is Taipei's inability to formulate a long-term defense strategy to comprehensively cooperate with Washington. If both capitals are unable to find common ground on BMD, Taiwan's missile defense assets will be just another weapons system to inadequately defend itself.

Budget: In August 2014, the Taiwanese MoD announced it would spend Tw$74.8 billion ($2.5 billion) over the next nine years to acquire indigenous *Sky Bow-3* systems.[81] The purchase of the *Sky Bow-3* will to become one of Taiwan's largest procurements of domestically manufactured weapon systems.

Australia

For more than 30 years, Canberra has been supporting ballistic missile early warning functions, performed remotely through the Space Based Infrared System (SBIRS) Relay Ground Station at the US-Australian Joint Defense Facility at Pine Gap.[82] Australia's

---

[77] Kan, Shirley A. 2014. *Taiwan: Major US Arms Sales since 1990*. Congressional Research Service, August 29. As of Nov. 30, 2015: https://www.fas.org/sgp/crs/weapons/RL30957.pdf, p. 17.

[78] Kan, Shirley A. 2014. *Taiwan: Major US Arms Sales since 1990*. Congressional Research Service, August 29. As of Nov. 30, 2015: https://www.fas.org/sgp/crs/weapons/RL30957.pdf, p. 16-18.

[79] Tien-pin, Lo & Jason Pan. 2015. 'Taiwan to test-fire PAC-3 missile in US.' *Taipei Times*, September 4. As of Nov. 30, 2015: http://www.taipeitimes.com/News/taiwan/archives/2015/09/04/2003626910

[80] Tien-pin, Lo & Jason Pan. 2015. 'Taiwan to test-fire PAC-3 missile in US.' *Taipei Times*, September 4. As of Nov. 30, 2015: http://www.taipeitimes.com/News/taiwan/archives/2015/09/04/2003626910

[81] AFP. 2014. 'Taiwan to spend $2.5 billion on anti-missile systems.' *Spacewar*, August 30. As of Nov. 30, 2015: http://www.spacewar.com/reports/Taiwan_to_spend_25_billion_on_anti-missile_systems_999.html

[82] Australian Department of Defence. 2013. *Minister for Defence Stephen Smith – Ministerial Statement on Full Knowledge and Concurrence*. Department of Defence Ministers, June 26. As of Nov. 30, 2015: http://www.minister.defence.gov.au/2013/06/26/minister-for-defence-stephen-smith-ministerial-statement-on-full-knowledge-and-concurrence/

early warning capabilities were for example utilized in the detection of Iraqi Scud missile launches during *Operation Desert Storm* in 1991.[83]

Currently, Australia does not retain any ballistic missile intercepting capabilities and Canberra has merely declared it will "explore opportunities to expand cooperation on ballistic missile defense, including working together to identify potential Australian contributions to ballistic missile defense in the Asia-Pacific region."[84] The DoD's 2010 BMDR notes in this context that "the United States continues to consult bilaterally with Australia regarding US BMD capabilities and plans in order to share information that would help Australia with decisions regarding BMD should the need for it be seen in the future."[85]

The construction of three *Hobart*-class AEGIS Air Warfare Destroyers (AWD) for the Australian Royal Navy is widely seen as the most suitable path for greater Australian engagement in regional BMD operations. Scheduled to enter service in 2016, 2017, and 2019 respectively, the AWD is currently set to be equipped with SM-2 IIIB missiles in accordance with a 2010 request made to the DoD's Defense Security Cooperation Agency (DSCA).[86] The Australian Parliament estimated in 2013 that the acquisition of SM-3 interceptors would not only impose significant additional costs, but will also have to compete with other defense priorities in a climate of intense budgetary pressures.[87]

Australia's recently published 2016 Defense White Paper has not clarified Canberra's stance on developing BMD capabilities and has not articulated a position on whether Australia will seek deeper defense engagements with its allies to streamline interoperability through collaborative BMD efforts.[88]

Recommendations

(1) **Increase bi- and multilateral technological cooperation**. US-Japan joint development of the Standard Missile-3 IIA interceptor is the only program in the Asia-Pacific that is purposefully utilizing bilateral industrial cooperation to strengthen allied BMD force posture. No such program exists for South Korea, which is possibly why Seoul has opted to cooperate with the Russian arms

---

[83] Brabin-Smith, Richard. 2004. 'Australia and Ballistic Missile Defence: Our Policy Choices.' *ASPI Strategic Insights, 5*. As of Nov. 30, 2015: https://www.aspi.org.au/publications/strategic-insights-5-australia-and-ballistic-missile-defence-our-policy-choices/SI_BMD.pdf, p. 3.

[84] White House. 'Fact Sheet: The United States and Australia: An Alliance for the Future.' *Office of the Press Secretary*, June 12. As of Nov. 30, 2015; https://www.whitehouse.gov/the-press-office/2014/06/12/fact-sheet-united-states-and-australia-alliance-future

[85] US Department of Defense. 2010. *Ballistic Missile Defense Review Report*. As of Nov. 12, 2015: http://www.defense.gov/Portals/1/features/defenseReviews/BMDR/BMDR_as_of_26JAN10_0630_for_web.pdf, p. 33.

[86] Air Warfare Destroyer Alliance. n.d. *Air Warfare Destroyers The Big Picture*. As of Nov. 30, 2015: http://www.ausawd.com/library/AWD%20Big%20Picture_0.pdf; US Department of Defense. 2010. 'Australia – SM-2 Block IIIB STANDARD Missiles.' *Defense Security Cooperation Agency*, October 26. As of Nov. 30, 2015: http://www.dsca.mil/major-arms-sales/australia-sm-2-block-iiib-standard-missiles

[87] Church, Nathan. 2013. 'Ballistic missile defence and Australia.' *Australian Parliamentary Library, FlagPost*, December 19. As of Nov. 30, 2015: http://www.aph.gov.au/About_Parliament/Parliamentary_Departments/Parliamentary_Library/FlagPost/2013/December/Ballistic_missile_defence_and_Australia

[88] Australian Department of Defence. 2016. *2016 Defence White Paper*. As of Feb. 28, 2016: http://www.defence.gov.au/WhitePaper/Docs/2016-Defence-White-Paper.pdf, p. 50-51 93, 96-97.

manufacturer Almaz-Antey to develop the M-SAM and L-SAM systems. Facilitating US technological cooperation with Australia could be a much-needed impetus for Canberra to play a more constructive role in BMD through increased stakeholder engagement.

(2) **Develop multipurpose platforms or open up existing ones**. One of the weaknesses of current BMD platforms is their singularity in solely defending against ballistic missile threats. Opening up existing platforms to enable the launch of a variety of interceptors to hit a variety of targets, or developing multipurpose platforms whose mission is broader than BMD, will (1) help facilitate industrial cooperation, (2) widen the audience for BMD system procurement, and (3) ease budgetary pressures in the long-term.

(3) **Operationalize allied capabilities to pivot away from a 'one-size-fits-all' BMD approach**. Currently, Washington and its allies in the Pacific are operating under a 'one-size-fits-all' approach when it comes to BMD system procurements. As a result, allied capabilities function as forward-based auxiliary forces, and are not complementing the US BMDS by closing down country specific missile defense gaps. To this end, deeper defense cooperation and coordination with Seoul and Taipei could lead to the creation of missile defense systems that are specifically adapted to the threat landscape both countries face.

(4) **Emphasize the multilayered aspect of BMD**. None of the BMD systems in the Asia-Pacific are able to defend against ballistic missiles in all phases of their flight. The KAMD and Taiwan's BMD for example are both single layered at best. While part of the problem is the singularity of BMD systems as noted in point 2, the issue predominately reflects the inability of aligning allied interests with US tactical objectives. The US PAC-3 systems in South Korea and Japan for instance are terminal defense nodes primarily deployed for US force protection, an area that could easily be covered by Seoul's PAC-2 or, given the recent policy changes, even Tokyo's PAC-3s. The DoD would be better served by forward-deploying systems that create added value for allies to ensure a truly multilayered BMDS.

(5) **Greater emphasis on an intelligence-driven BMDS force posture**. The JFCC-IMD's current approach to managing the global US BMDS force posture is primarily driven by the global Combatant Command's high demand for BMD systems. However, given the existing shortage of BMD systems and the continuous proliferation of ballistic missiles (the so-called tyranny of numbers), the JFCC-IMD should put even greater emphasis on military intelligence to optimize the US BMDS force posture globally and encourage flexible and value-added deployments regionally. This strategy would (1) lower the demand for BMD systems by raising the overall risk requirements for deployments, (2) prioritize US force protection over a theater-wide missile defense footprint, and (3) react to a specific threat, rather than maximize BMD deployments.

(6) **Emphasize temporal deployments to facilitate alliance interoperability**. BMD systems ought to be deployed to counteract a specific ballistic missile threat in accordance with intelligence-driven threat assessments. Permanent forward-

deployments, such as the THAAD to Guam, stand in stark contrast to this flexible and scalable missile defense posture. In contrast, the DoD could promote temporary THAAD deployments to Japan, South Korea, Australia, and even the Philippines to encourage alliance interoperability and optimize the Army's rapid deployment of THAAD systems across the Asia-Pacific in line with contingency demands.

(7) **Negotiate KAMD build-up and closer BMD cooperation as conditions for US THAAD deployments to the Peninsula**. The possible deployment of one or two THAAD batteries to South Korea should not come at the expense of greater US alliance defense commitments on the Peninsula. At a minimum Seoul should (1) commit to closer BMD cooperation by allowing the KAMD AMD-Cell to interface with the USFK TMO-Cell and (2) strengthen its own missile defense posture by building up a sea-based BMD system that fully leverages the potential of its growing AEGIS fleet.

(8) **Clarify the tactical role of Taiwan for US BMDS**. The DoD's 2010 Ballistic Missile Defense Review only mentions Taiwan in the context of China's growing A2/AD capabilities. While Taiwan is a sensitive political topic, closer military-to-military ties between USPACOM and the Taiwanese defense forces would create a venue to at least (1) clarify Taiwan's role in the context of US BMDS, (2) streamline Taipei's defense posture, and (3) help USPACOM devise operational plans to defend the island.

Reassurance, Stability, Deterrence, and Left- & Right-of-Launch

Apart from the tactical objectives discussed in the previous chapter, the US BMDS also encompasses a strategic dimension that stretches from (1) reassuring US allies and (2) creating regional/strategic stability, to (3) strengthening US deterrence and (4) leveraging non-kinetic left- and right-of-launch defense solutions.[89] On all four strategic fronts, the role of missile defense is evolving and has been framed in broad political terms rather than specific strategic military goals.

Reassurance

The DoD's 2010 Nuclear Posture Review (NPR) notes that "by maintaining a credible nuclear deterrent and reinforcing regional security architectures with missile defenses and other conventional military capabilities, we can reassure our non-nuclear allies and partners worldwide of our security commitments to them and confirm that they do not need nuclear weapons capabilities of their own."[90] The 2010 BMDR echoes this call by stating that missile defenses "provide reassurance that the United States will stand by those [security] commitments despite the growth in the military potential of regional adversaries."[91]

While the NPR puts forward a strong argument for the maintenance of a credible US nuclear deterrent, both documents fail to acknowledge that forward-deployed US BMDS assets are solely utilized to provide force protection or serve as force-multipliers to an existing allied BMD infrastructure. The strategic emphasis for the reassurance of allies in the Asia-Pacific therefore predominately resides with the ability of US allies to procure US BMD systems and upgrade, update, and maintain a credible national BMD force posture themselves. As a result the US strategic objective is not directly aimed at bolstering the nuclear nonproliferation regime, but is instead leveraging missile defense sales as a counter-proliferation strategy to deny non-peer adversaries missile advantages on the battlefield.

The overall challenge for the DoD is to determine the limits of its counter-proliferation strategy. Counter-proliferation has not denied North Korea the benefits of nuclear and missile testing, or the prospects of simply modernizing and expanding its

---

[89] US Department of Defense. 2010. *Ballistic Missile Defense Review Report*. As of Nov. 12, 2015: http://www.defense.gov/Portals/1/features/defenseReviews/BMDR/BMDR_as_of_26JAN10_0630_for_web.pdf, Executive Summary, p. 12; Freedberg Jr., Sydney J. 2015. 'Army explores New missile Defense options.' *Breaking Defense*, February 18. As of Nov. 30, 2015: http://breakingdefense.com/2015/02/army-explores-new-missile-defense-options/

[90] US Department of Defense. 2010. *Nuclear Posture Review Report*. As of Nov. 30, 2015: http://www.defense.gov/Portals/1/features/defenseReviews/NPR/2010_Nuclear_Posture_Review_Report.pdf, p. 7.

[91] US Department of Defense. 2010. *Ballistic Missile Defense Review Report*. As of Nov. 12, 2015: http://www.defense.gov/Portals/1/features/defenseReviews/BMDR/BMDR_as_of_26JAN10_0630_for_web.pdf, Executive Summary, p. 12.

missile arsenal.[92] Moreover, the Chinese missile threat, in the form of hypersonic cruise missiles and anti-satellite weaponry, coupled with the growing global demand for BMD, is set to occupy greater shares of allied defense budgets.

Stability

The horizontal and vertical proliferation of US BMD systems across the Asia-Pacific is adversely affecting the power projection capabilities of near-peer competitors such as Russia and China, and North Korea. But is missile defense undermining regional and strategic stability?

The concept of strategic stability still rests upon ideas developed during the Cold War. The game theoretical framework assumes that: (1) states are rational actors, (2) mutual assured destruction prevents full-scale nuclear war, and (3) nuclear escalation can be controlled.[93] Arms control regimes, such as START on the nuclear front and the ABM treaty on curtailing missile defense systems, limited and reduced the quantity of arms that ensured strategic parity amidst an imbalance of conventional forces (first offset strategy).[94]
While this concept of stability still resonates in US-Russia relations, superior US technology in the area of guided conventional munitions profoundly changed the art of modern warfare, and in effect replaced parity with US military dominance on the global stage in 1991.[95] In the end, military power became synonymous with precision, and its exercise helped significantly offset conventional numerical advantages on the battlefield (second offset strategy).[96]

The third offset strategy (which the DoD is currently devising) will host a series of new technologies by leveraging "unmanned systems and automation, extended-range and low-observable air operations, undersea warfare, and complex system engineering and integration" to counter emerging threats asymmetrically and project military power in entirely different ways than today.[97] US Deputy Secretary of Defense Robert Work explains this new strategy by highlighting that "the US has never, on the matter of

[92] Trexel, Jonathan. 2015. *Missile Defense & Deterrence*. Presentation at the 18th Annual Space and Missile Defense Symposium , August 11, Slide 13. As of Nov. 30, 2015: https://smdsymposium.org/wp-content/uploads/2015/08/T5a-Dr.-Jonathan-Trexel.pdf
[93] Kahn, Herman. 1960. *The Nature and Feasibility of War and Deterrence*. Santa Monica, California: RAND Corporation; Schelling, Thomas. 1960. *The Strategy of Conflict*. Oxford: Oxford University Press; Kahn, Herman. 1965. *On Escalation: Metaphors and Scenarios*. New York: Praeger.
[94] Martinage, Robert. 2014. *Toward a New Offset Strategy – Exploiting U.S. Long-Term Advantages to Restore U.S. Global Power Projection Capability*. Center for Strategic and Budgetary Assessments, October 27. As of Nov. 30, 2015: http://csbaonline.org/wp-content/uploads/2014/10/Offset-Strategy-Web.pdf, p. 5-13.
[95] Work, Robert. 2015. *The Third U.S. Offset Strategy and its Implications for Partners and Allies*. US Department of Defense, January 28. As of Nov. 30, 2015: http://www.defense.gov/News/Speeches/Speech-View/Article/606641/the-third-us-offset-strategy-and-its-implications-for-partners-and-allies
[96] Martinage, Robert. 2014. *Toward a New Offset Strategy – Exploiting U.S. Long-Term Advantages to Restore U.S. Global Power Projection Capability*. Center for Strategic and Budgetary Assessments, October 27. As of Nov. 30, 2015: http://csbaonline.org/wp-content/uploads/2014/10/Offset-Strategy-Web.pdf, p. 13-16.
[97] Martinage, Robert. 2014. *Toward a New Offset Strategy – Exploiting U.S. Long-Term Advantages to Restore U.S. Global Power Projection Capability*. Center for Strategic and Budgetary Assessments, October 27. As of Nov. 30, 2015: http://csbaonline.org/wp-content/uploads/2014/10/Offset-Strategy-Web.pdf, p. 1.

conventional deterrence, tried to match our conventional adversaries' tank for tank, ship for ship, airplane for airplane. It has always looked for technological offsets."[98]

Missile defense in this context is seen as flawed, because it is symmetrically engaging a threat 'missile for missile' within an environment of finite fiscal resources. The Center for Strategic and Budgetary Assessments (CSBA) notes that "barring technological breakthroughs, the competition in [missile defense and defensive space control] is currently heavily offense-dominant, and thus, ramping up expenditures in a likely futile attempt to actively defend it is a cost-imposing strategy on the United States."[99]

Finite fiscal resources coupled with persistent technical challenges have translated into a missile defense system that is primarily geared toward enabling force, allied, and limited homeland protection, in an effort to provide the space and time needed to prevent rapid escalation of crisis (escalation control).[100] But altering the parameters of stability by introducing and expanding a system that is able to 'hit a missile with a missile,' has naturally sparked concern in Moscow and Beijing, due to the possibility that missile defenses will be leveraged over time as an independent offset strategy to negate strategic stability itself.

To date, engagement with Russia and China has been reduced to a series of repetitive political statements that are aimed at emphasizing the targeted and limited nature of the US BMDS. The BMDR for example notes that "homeland missile defense capabilities are focused on regional actors such as Iran and North Korea," and that the Ground-based Midcourse Defense (GMD) does "not have the capability to cope with large scale Russian or Chinese missile attacks, and is not intended to affect the strategic balance with those countries."[101] Overall, the BMDR concludes that "the United States will continue to engage [Moscow and Beijing] on this issue to help them better understand the stabilizing benefits of missile defense."

The overall challenge for the DoD is to define the strategic and regional balance it is aiming for in the Asia-Pacific and find a feasible path to anchor it over time. So far the US trajectory is pointing toward an escalatory scenario in which (1) missile defense is expanding as fast as technology allows it, while (2) peer-competitors are modernizing and increasing their nuclear arsenals and conventional first strike capabilities.[102] In the absence of arms control regimes in the Asia-Pacific, rhetoric alone will do little to influence this growing military imbalance.

---

[98] Work, Robert. 2015. 'Closing Keynote: Managing the Age of Everything.' *DefenseOne Summit 2015*. As of Nov. 22, 2015: http://www.defenseone.com/ideas/2015/11/defense-one-summit-2015-age-everything/123168/

[99] Martinage, Robert. 2014. *Toward a New Offset Strategy – Exploiting U.S. Long-Term Advantages to Restore U.S. Global Power Projection Capability*. Center for Strategic and Budgetary Assessments, October 27. As of Nov. 30, 2015: http://csbaonline.org/wp-content/uploads/2014/10/Offset-Strategy-Web.pdf, p. 69.

[100] Creedon, Madelyn. 2012. *US Ballistic Missile Defense*. http://photos.state.gov/libraries/russia/231771/PDFs/ASD_Creedon_MD_Conference_Remarks.pdf, p. 6.

[101] US Department of Defense. 2010. *Ballistic Missile Defense Review Report*. As of Nov. 12, 2015: http://www.defense.gov/Portals/1/features/defenseReviews/BMDR/BMDR_as_of_26JAN10_0630_for_web.pdf, Executive Summary, p. 13

[102] Riqiang, Wu. 2015. 'Limit missile defense – or expand it.' *Bulletin of the Atomic Scientists,* Vol. 71(2) 9-12; Riqiang, Wu. 2014. 'No stability without limits on missile defense.' *Bulletin of the Atomic Scientists*, Roundtable, September 24.

Deterrence

The DoD's emphasis on missile defense is a silent acknowledgement that nuclear deterrence could fail and that the traditional US nuclear triad might not be the best solution for keeping non-peer adversaries at bay. To close this vulnerability gap, at the low-end of conflict, the DoD is focusing on the GMD to reinforce the US deterrence framework.

GMD is the most crucial US BMD element for the protection of the US homeland against a limited ICBM attack (whether accidental, unauthorized, or deliberate). Its value to deter and defend solely resides with the system's ability to intercept an incoming ICBM warhead midcourse in space (exoatmospheric).

Contracted for an initial $1.6 billion in 1998, the GMD, or the National Missile Defense (NMD) as it was then known, was assembled from a variety of then-available systems to enable swift deployment.[103] Under the Clinton administration, the NMD was envisioned to consist of 20 Ground-based Interceptors (GBIs) in Alaska by 2005 (Capability 1), 100 GBIs in Alaska by 2007 (expanded Capability 2), and a total of 250 GBIs spread evenly among missile sites in Alaska and North Dakota by 2011 (Capability 3).[104] The Congressional Budgetary Office estimated in April 2000 that this system would cost $48.8 billion to build and operate throughout FY2015.[105]

Fifteen years and approximately $40 billion later, the GMD consists of a mere 26 GBIs emplaced at Fort Greely (Alaska) and 4 GBIs at Vandenberg AFB (California), with the number set to increase to 44 GBIs by 2017.[106] Meanwhile the GBI's intercept flight test record is riddled with technical problems and has resulted in only nine successful intercepts in 17 attempts since 1999.[107] The existence of two different exoatmospheric kill vehicles (EKV) is symptomatic of these problems.[108] Twenty GBIs are using the Capability Enhancement 1 (CE-1) and 10 GBIs utilize the Capability Enhancement 2

[103] Boeing. 1998. 'Boeing wins $1.6 billion-dollar contract from DoD's Joint Program Office to act as Lead System Integrator for National Missile Defense Program.' *Boeing News Release*, April 30. As of Nov. 30, 2015: http://boeing.mediaroom.com/1998-04-30-Boeing-Wins-1.6-Billion-Dollar-Contract-From-DoDs-Joint-Program-Office-To-Act-As-Lead-System-Integrator-for-National-Missile-Defense-Program

[104] Congressional Budgetary Office. 2000. *Budgetary and Technical Implications of the Administration's Plan for National Missile Defense*. As of Nov. 30, 2015: https://www.cbo.gov/sites/default/files/106th-congress-1999-2000/reports/nmd.pdf, p. 8.

[105] Congressional Budgetary Office. 2000. *Budgetary and Technical Implications of the Administration's Plan for National Missile Defense*. As of Nov. 30, 2015: https://www.cbo.gov/sites/default/files/106th-congress-1999-2000/reports/nmd.pdf, p. 16.

[106] US Missile Defense Agency. 2015. *Overview - Fiscal Year 2016 Budget Estimates*. 15-MDA-8100, January 26. As of Nov. 30, 2015: http://www.mda.mil/global/documents/pdf/budgetfy16.pdf, p. 1.

[107] US Missile Defense Agency. 2015. *Ballistic Missile Defense Intercept Flight Test Record*. Fact Sheet, December 10. As of Nov. 30, 2015: http://www.mda.mil/global/documents/pdf/testrecord.pdf

Comparison: *THAAD*: 13 successful intercepts in 13 attempts (2006-2015); *SM*: 33 successful intercepts in 40 attempts (2002-2015).

[108] Note: According to Raytheon, "the EKV seeks out the target using multi-color sensors, a cutting-edge onboard computer, and a rocket motor used only for steering in space. It hones in on its target, and with pinpoint precision, destroys it using nothing more than the force of a massive collision. No traditional warhead is needed." See Raytheon. n.d. 'Kill Vehicles.' As of Nov. 30, 2015: http://www.raytheon.com/capabilities/products/ekv/

(CE-2).[109] The DoD Inspector General explains the occurrence of two EKVs by noting that "the immediate need for an initial capability drove an accelerated development process and fielded capability before EKV performance was fully characterized prior to initial fielding."[110]

Since 2007, the CE-1 has been undergoing a refurbishing and retrofitting program to "replace questionable parts identified in development testing and manufacturing" and additional problems discovered during early refurbishments.[111] The Government Accountability Office noted in 2012 that "refurbishments are planned to continue for many more years and the cost to refurbish each CE-I interceptor could range from $14 million to $24 million."[112] In July 2013 a refurbished CE-1 failed its intercept flight test because the kill vehicle was unable to separate from the booster.[113] This last test, in essence, deems 20 out of the 30 GBIs non-operational.

The CE-2 kill vehicle did not fare much better than its predecessor. It failed its first two attempts to intercept a target in January and December 2010 leading to "the need for failure reviews, additional flight tests, mitigation development efforts, and a retrofit program [which] increased the CE-II's demonstration cost by $1.745 billion.[114] In June 2014 the CE-2 finally reached its first milestone by successfully intercepting its first target.[115] However, GAO cautioned that "additional testing is necessary to demonstrate the CE-II design works as intended and for the warfighter to have a full understanding of the interceptor's capabilities and limitations."[116] According to MDA Director Vice Adm. Syring the CE-2 is scheduled to conduct its first intercept test against an ICBM range target in late 2016 (FTG-15).[117]

In response to the complications experienced in both the CE-1 and CE-2 kill vehicles, the MDA decided in 2015 to opt for a redesigned kill vehicle (RKV) and make advances into

---

[109] Union of Concerned Scientists. n.d. *The Troubled Kill Vehicle in U.S. National Missile Defenses*. As of Nov. 30, 2015: http://www.ucsusa.org/sites/default/files/legacy/assets/documents/nwgs/missile-defense-kill-vehicle.pdf

[110] US Department of Defense – Inspector General. 2014. *Exoatmospheric Kill Vehicle Quality Assurance and Reliability Assessment – Part A*. DODIG-2014-111, September 8. As of November 2015: http://www.dodig.mil/pubs/documents/DODIG-2014-111.pdf, p. 4-5.

[111] Government Accountability Office. 2012. *Missile Defense – Opportunity Exists to Strengthen Acquisition by Reducing Concurrency*. GAO-12-486, April. As of Nov. 30, 2015: http://gao.gov/assets/600/590277.pdf, p. 78.

[112] Government Accountability Office. 2012. *Missile Defense – Opportunity Exists to Strengthen Acquisition by Reducing Concurrency*. GAO-12-486, April. As of Nov. 30, 2015: http://gao.gov/assets/600/590277.pdf, p. 78.

[113] US Department of Defense - Office of the Director, Operational Test and Evaluation. 2014. *FY2014 Annual Report*. As of Nov. 30, 2015: http://www.dote.osd.mil/pub/reports/FY2013/pdf/bmds/2013gmd.pdf, p. 312.

[114] Government Accountability Office. 2015. *Missile Defense – Opportunities Exist to Reduce Acquisition Risk and Improve Reporting on System Capabilities*. GAO-15-345, May. As of Nov. 30, 2015: http://www.gao.gov/assets/680/670048.pdf, p. 63.

[115] Government Accountability Office. 2015. *Missile Defense – Opportunities Exist to Reduce Acquisition Risk and Improve Reporting on System Capabilities*. GAO-15-345, May. As of Nov. 30, 2015: http://www.gao.gov/assets/680/670048.pdf, p. 62.

[116] Government Accountability Office. 2015. *Missile Defense – Opportunities Exist to Reduce Acquisition Risk and Improve Reporting on System Capabilities*. GAO-15-345, May. As of Nov. 30, 2015: http://www.gao.gov/assets/680/670048.pdf, p. 62.

[117] Syring, James. D. 2015. *Vice Admiral J.D. Syring, USN, Director, Missile Defense Agency - Before the Senate Appropriations Committee Subcommittee on Defense*. As of Nov. 30, 2015: http://www.mda.mil/global/documents/pdf/ps_syring_031815_sacd.pdf, p. 7.

the area of multiple-object kill vehicles (MOKV).[118] The pressure to move toward an entirely new kill vehicle emanated in part from the desire to take full advantage of new sensors like the planned Long-Range Discrimination Radar (LRDR),[119] while also seeking to "improve [kill vehicle] reliability, availability, performance, and producibility."[120] However, as the Union of Concerned Scientists (UCS) pointed out "[the CE-1 and CE-2] were developed in a rush with poorly disciplined engineering and acquisition practices" while "time and again, the process for developing and procuring these kill vehicles has been driven by politically motivated time lines, rather than sound technical procedures and oversight […]."[121] GAO echoes this call by stating that the MDA "increased risk to the warfighter by prioritizing new interceptor production over fixing previously deployed interceptors and resolving known issues. In addition, MDA has decided to redesign the GMD kill vehicle prior to determining whether the effort is the most cost-effective solution."[122]

GAO's latest assessment published in February 2016 concluded that the "MDA has not proven GMD can defend the homeland,"[123] and that the agency is "relying on [a] high-risk acquisition approach to achieve [GBI] fielding goals."[124]

The challenge for the DoD is to get the GBI basics right. Currently the GMD has no credible deterrence or reliable defense value. Out of the 30 GBIs, 20 are non-operational (CE-1) and 10 might be operational but have never been flight tested against an ICBM range target (CE-2).

Left- & Right-of-Launch

Apart from kinetic missile defense systems, the DoD is set to increasingly leverage electronic- and cyber warfare capabilities in an effort to enable non-kinetic left- and

[118] Butler, Amy. 2015. 'MDA plans to build team for Redesigned Kill Vehicle.' *Aviation Week & Space Technology*, February 5. As of Nov. 30, 2015: http://aviationweek.com/defense/mda-plans-build-team-redesigned-kill-vehicle

[119] Note: According to the DoD "*current plans call for the* [LRDR] *to begin defensive operations in 2020*." See: US Department of Defense. 2015. 'Department of Defense Identifies Planned Site of Future Long Range Discrimination Radar (LRDR).' *DoD Press Operations*, May 22. As of Nov. 30, 2015: http://www.defense.gov/News/News-Releases/News-Release-View/Article/605521

[120] Freedberg, Sydney J. 2015. 'Missile Defense Strategy "Not Sustainable," Salvation lies in R&D.' *Breaking Defense*, June 18. As of Nov. 30, 2015: http://breakingdefense.com/2015/06/missile-defense-strategy-not-sustainable-salvation-lies-in-rd-brig-gen-todorov/; US Missile Defense Agency. 2015. *Overview - Fiscal Year 2016 Budget Estimates*. 15-MDA-8100, January 26. As of Nov. 30, 2015: http://www.mda.mil/global/documents/pdf/budgetfy16.pdf, p. 1.

[121] Union of Concerned Scientists. n.d. *The Troubled Kill Vehicle in U.S. National Missile Defenses*. As of Nov. 30, 2015: http://www.ucsusa.org/sites/default/files/legacy/assets/documents/nwgs/missile-defense-kill-vehicle.pdf

[122] Government Accountability Office. 2015. *Missile Defense – Opportunities Exist to Reduce Acquisition Risk and Improve Reporting on System Capabilities*. GAO-15-345, May. As of Nov. 30, 2015: http://www.gao.gov/assets/680/670048.pdf, p. GAO Highlights.

[123] Government Accountability Office. 2016. *Assessment of DOD's Reports on Status of Efforts and Options for Improving Homeland Missile Defense*. GAO-16-245R, February 17. As of Feb. 28, 2016: http://www.gao.gov/assets/680/675263.pdf, p. 6.

[124] Government Accountability Office. 2016. *Assessment of DOD's Reports on Status of Efforts and Options for Improving Homeland Missile Defense*. GAO-16-245R, February 17. As of Feb. 28, 2016: http://www.gao.gov/assets/680/675263.pdf, p. 7.

right-of-launch solutions.[125] Electronic warfare (EW) is envisioned to jam the data links between sensors, command-and-control, and the incoming missile, or spoof, disrupt, and outright fry the missile guidance and targeting systems.[126] Offensive cyber-capabilities meanwhile seek to disrupt, corrupt, or in some cases cause physical damage to a targeted system infrastructure.[127] Table 5 presents a brief overview of kinetic and non-kinetic options along the various missile defense stages.

Table 5. Deterrence to Counter-Strike

Deterrence	**Left-of-launch**	*Hostile Missile Launch*	**Right-of-launch**	**Counter Strike**
Kinetic Option • Conventional Deterrence - Offensive - Missile defense • Nuclear Deterrence *Non-Kinetic Option* • Cyber-deterrence	*Kinetic Option* • Conventional strike - Air strike - UAS strike - Cruise missile strike - Anti-satellite strike *Non-Kinetic Option* • Cyber-attack • Electronic Warfare		*Kinetic Option* • Missile defense *Non-Kinetic Option* • Cyber-attack • Electronic Warfare • Directed Energy[128]	*Kinetic Option* • Conventional Strike - Air strike - UAS strike - Cruise Missile strike • Nuclear Strike - ICBM - SLBM - B61/B83/LRSO

Source: Compiled by author

In September 2013, the DoD released its first defense white paper on electronic warfare, called the 'Electromagnetic Spectrum Strategy.' It explicitly talks about the (1) growing dependence of electromagnetic spectrum access for the DoD's air, land, sea, space, and cyberspace operations (think wireless, radar, radio, and infrared), while also highlighting (2) the aggressive fielding of electronic attacks and cyber technologies by US adversaries.[129] Despite the existence of the EW strategy, it took the DoD more than 18 months to start providing electronic warfare with the attention it received during the Cold War. As a first step, Deputy Defense Secretary Robert Work established the Electronic Warfare Programs Council in March 2015, which is tasked with devising strategic investment recommendations, and finding department-wide synergies to turn around the eroding US advantage on EW.[130]

---

[125] US Department of Defense. 2015. *Deputy Secretary of Defense Speech – McAleese/Credit Suisse Defense Programs Conference, March 17*. As of Nov. 30, 2015: http://www.defense.gov/News/Speeches/Speech-View/Article/606653/mcaleesecredit-suisse-defense-programs-conference

[126] US Army Research Laboratory. n.d. 'Electronic Warfare.' As of Nov. 30, 2015: http://www.arl.army.mil/www/default.cfm?page=2642; Freedberg Jr., Sydney J. 2015. 'Army explores new missile defense options.' *Breaking Defense*, February 18. As of Nov. 30, 2015: http://breakingdefense.com/2015/02/army-explores-new-missile-defense-options/

[127] Libicki, Martin C. 2009. *Cyberdeterrence and Cyberwar*. Santa Monica, Calif.: RAND Corporation. As of Nov. 30, 2015: http://www.rand.org/content/dam/rand/pubs/monographs/2009/RAND_MG877.pdf, p. 23, 139.

[128] See page 43.

[129] US Department of Defense. 2013. *Electromagnetic Spectrum Strategy – A Call to Action*. As of Nov. 30, 2015: http://www.defenseinnovationmarketplace.mil/resources/dodspectrumstrategy.pdf

[130] Freedberg Jr., Sydney J. 2015. 'Work Elevates Electronic Warfare, Eye on Missile Defense.' *Breaking Defense*, March 17. As of Nov. 30, 2015: http://breakingdefense.com/2015/03/raid-breaker-work-elevates-electronic-warfare-eye-on-missile-defense/

The Navy is the only service that has retained its specialized electronic warfare capabilities in the form of the EA-6B-*Prowler*/EA-18G *Growler* community.[131] In contrast, the Air Force essentially left the jamming and spoofing business in the 1990s in an effort to concentrate on stealth technology.[132] The Army meanwhile was forced to reinvest in defensive electronic capabilities and ended up buying tens of thousands of short-range Counter-Radio-Controlled IED jammers (CREW) in support of its operations in Iraq and Afghanistan.[133] As a result the ground forces are now borrowing EW assets from the Navy (primarily *Growlers*) until the defense budget allows the Army to acquire its own offensive jammers in 2023.[134]

The DoD is reportedly drafting a new directive that would recognize the electromagnetic spectrum as a separate warfare domain in line with land, sea, air, space, and cyberspace.[135] Potentially this will help offset some of the short-term EW funding gaps and compel lawmakers to not concentrate solely on cyberspace as the next military frontier.

When it comes to the cyber domain, the DoD's offensive cyber-capabilities are shrouded in secrecy. In part this is due to the nature of the tradecraft, as offensive cyber-warfare relies upon the exploitation of "specific vulnerabilities in specific [enemy] systems that can be exploited in specific ways."[136] In fact, offensive cyber-capabilities share a significant operational overlap with the intelligence community in the form of mapping enemy network infrastructure, understanding system relations, and predicting command-and-control reactions. At the same time, despite the immense intelligence necessary for the preparation of a cyber-warfare operation, the effects of such an attack are most likely not repeatable, given that vulnerabilities are fixed over time (depletion rate) or are routed around almost instantly (vulnerability fragility).[137] Consequentially, details on current offensive cyber-capabilities are too valuable to share and too classified to make their way into open source.[138]

---

[131] Freedberg Jr., Sydney J. 2012. 'Navy Bets On "Baby Steps" To Improve Electronic Warfare; F-35 Jamming Not Enough.' *Breaking Defense*, December 6. As of Nov. 30, 2015: http://breakingdefense.com/2012/12/navy-bets-on-baby-steps-to-improve-electronic-warfare-f-35-ja/

[132] Freedberg Jr., Sydney J. 2015. 'Work Elevates Electronic Warfare, Eye on Missile Defense.' *Breaking Defense*, March 17. As of Nov. 30, 2015: http://breakingdefense.com/2015/03/raid-breaker-work-elevates-electronic-warfare-eye-on-missile-defense/

[133] Freedberg Jr., Sydney. 2014. 'Army Electronic Warfare "is a Weapon" but Cyber is Sexier.' *Breaking Defense*, October 16. As of Nov. 30, 2015: http://breakingdefense.com/2014/10/army-electronic-warfare-is-a-weapon-but-cyber-is-sexier/; Gould, Joe. 2015. 'Electronic Warfare: What US Army Can Learn From Ukraine.' *DefenseNews*, August 4. As of November 2015: http://www.defensenews.com/story/defense/policy-budget/warfare/2015/08/02/us-army-ukraine-russia-electronic-warfare/30913397/

[134] Freedberg Jr., Sydney. 2015. 'Army's Electronic Warfare Cupboard Is Bare: No Jammer Until 2023.' *Breaking Defense*, July 20. As of Nov. 30, 2015: http://breakingdefense.com/2015/07/armys-electronic-warfare-cupboard-is-bare-no-jammer-until-2023/

[135] Freedberg Jr., Sydney. 2015. 'DoD CIO Says Spectrum May Become Warfighting Domain.' *Breaking Defense*, December 9. As of Nov. 30, 2015: http://breakingdefense.com/2015/12/dod-cio-says-spectrum-may-become-warfighting-domain/

[136] Libicki, Martin C. 2009. *Cyberdeterrence and Cyberwar*. Santa Monica, Calif.: RAND Corporation. As of Nov. 30, 2015: http://www.rand.org/content/dam/rand/pubs/monographs/2009/RAND_MG877.pdf, p. 154-6.

[137] Libicki, Martin C. 2009. *Cyberdeterrence and Cyberwar*. Santa Monica, Calif.: RAND Corporation. As of Nov. 30, 2015: http://www.rand.org/content/dam/rand/pubs/monographs/2009/RAND_MG877.pdf, p. 56-59.

[138] Freedberg Jr., Sydney. 2015. 'Cyber, EW Are Secret Missile Defense

To date, it is impossible to ascertain the true value of offensive cyber-capabilities and the role of cyber-deterrence on the battlefield. Time will tell whether the DoD is capable of delivering tangible operational results in cyberspace or whether resources are better spent on electronic warfare and kinetic solutions instead.

Recommendations

(1) **Incentivize procurements of US BMD systems**. Reassuring US allies in the Asia-Pacific predominantly rests upon the ability to procure and upgrade US BMD systems. The DoD in cooperation with Congress and the State Department can incentivize allied BMD system procurements and encourage timely modernization and upgrading by supplementing BMD sales to Australia, Japan, South Korea, and possibly even Taiwan.

(2) **Cap the number of missile defense systems.** Currently the expansion of the US BMDS and allied missile defense infrastructure is solely limited by the fiscal resources devoted to it. As a result, strategic and regional stability considerations take a backseat when it comes to decisions on horizontal and vertical BMD proliferation. The DoD therefore should clearly define what capabilities it actually needs (not wants!) to protect forward-based US forces and the US homeland from a limited ballistic missile strike. To this end, the OSD would be well served to either cap the number of deployed BMD systems or limit annual BMD spending in an effort to (1) streamline RTD&E, (2) promote system efficiency over numbers, and (3) concentrate deployments in line with force protection rather than arbitrary goals directed at civilian defense.

(3) **Halt GBI expansion and focus on interceptor reliability**. When it comes to the GMD's Ground-based Interceptors, quantity does not create quality. Given the current fiscal environment, the OSD should halt the planned GBI expansion and cap further GMD investments. Second, the OSD should impose the DoD's traditional 5000 series acquisition directives and Joint Staff requirement processes, as well as implement budgetary reviews under the auspices of GAO, and direct the DoD Inspector General to conduct continuous GBI performance evaluations. Third, the OSD should direct the MDA to focus on producing reliable CE-1 and CE-2 kill vehicles (2-3 successful flight-intercept tests), as a precondition for any planned introduction of a new kill-vehicle design. Fourth, subsequent GBI upgrades should be conducted in cohorts (5 GBIs), rather than implemented across the board, to (1) reduce overall upgrading costs, (2) spread the risks for the warfighter (failsafe), and (3) enable a 'best interceptor for the target' approach by maintaining an arsenal consisting of a variety of reliable GBIs.

(4) **Designate a DoD Cyber- and Electronic protection team to scrutinize BMD systems, elements, and their related components**. The objective of the DoD team would be to: (1) find and fix vulnerabilities in the US BMDS and related

---

Weapons Too Secret To Use.' *Breaking Defense,* December 4. As of Nov. 30, 2015:
http://breakingdefense.com/2015/12/cyber-ew-are-secret-missile-defense-weapons-too-secret-to-use/

components to mitigate the possibility of system critical exploitation (external security oversight), (2) create a contact point for the DoD's offensive cyber- and electronic warfare branch (cross-informational exchange), and (3) leverage warfighter feedback loops to encourage better, closer, and more focused military-industry cooperation (system development optimization).

From BMDS to IAMD

The US BMDS was initially envisioned to serve as an "evolving, integrated, and interoperable" military capability that would allow the warfighter to react to the global ballistic missile threat by intercepting "ballistic missiles in all phases of their flight, […] against all ranges of threats." [139] The fruits of this endeavor are what we witness today, a system spanning the Asia-Pacific consisting of forward-based PAC and THAAD batteries, a naval force equipped with AEGIS BMD, and a GMD system for homeland midcourse intercept.

However, despite the success of deploying the US BMDS and proving that it is indeed possible to 'hit a missile with a missile,' the DoD got only half the equation right. First, not all missiles are ballistic in nature. Cruise missiles, air-to-surface missile (ex. *Hellfire*), air-to-air missiles (ex. AMRAAM), and precision-guide ammunition for instance are not covered by the BMDS. Second, ballistic missiles come with an inherent attacker advantage due to the low-cost of decoys, non-ballistic trajectories, multiple warhead deployments (MIRVs), and hypersonic engines. As such the BMD equation on costs, numbers, speed, range, accuracy, stealth, and lethality, are firmly on the attacker's side. Third, a BMDS tailored to the needs of the geographic combatant command requires theater allies and partners to not only procure missile defense systems but also exercise the political willingness to integrate with the US BMDS in an effort to streamline command-and-control, facilitate sensor data exchange, and settle upon defined rules of engagement. Fourth, the MDA and JFCC-IMD have failed to create an interoperable system by recycling and upgrading elements that were not designed to function together in the first place. Consequentially, componentalization (ex. using a PAC radar to aim and a THAAD launcher to shoot) is not possible, because the various elements do not have a "standardized connection so everything can talk to everything else."[140] Fifth, the MDA and JFCC-IMD have also neglected the integrated part to facilitate US BMDS operationalization in concert with offensive kinetic capabilities. Meaning that "the same sensor that warns defensive systems of an incoming attack [ought] to also cue offensive systems to retaliate."[141]

To solve these shortfalls in the US BMDS and adapt the US Armed Forces to the new realities of the 'Age of Everything,' then Chairman of the Joint Chiefs of Staff Gen.

---

[139] US Department of Defense. 2009. *Directive 5134.09 – Missile Defense Agency (MDA)*. As of Nov. 8, 2015: http://www.dtic.mil/whs/directives/corres/pdf/513409p.pdf
[140] Freedberg Jr., Sydney J. 2015. 'Army Explores New Missile Defense Options.' *Breaking Defense*, February 18. As of Nov. 30, 2015: http://breakingdefense.com/2015/02/army-explores-new-missile-defense-options/
[141] Freedberg Jr., Sydney J. 2015. 'Army Explores New Missile Defense Options.' *Breaking Defense*, February 18. As of Nov. 30, 2015: http://breakingdefense.com/2015/02/army-explores-new-missile-defense-options/

Dempsey outlined a futuristic vision for an Integrated Air and Missile Defense (IAMD) system. According to Dempsey, IAMD will be a super-structure (or system-of-systems) in which "all capabilities – defensive, passive, offensive, kinetic, non-kinetic (e.g. cyber warfare, directed energy, and electronic attack) – are melded into a comprehensive joint and combined force capable of preventing an adversary from effectively employing any of its offensive air and missile weapons."[142] Within the context of IAMD, offensive counter-air is focusing on dominating air space and disrupting and defeating enemy air and missile systems.[143] Defensive counter-air meanwhile aims to counter enemy aircrafts, ballistic missiles, cruise missiles, rockets, artillery, and mortar, and unmanned aerial systems.[144] IAMD thus embodies "global strike and global missile defense beyond the theater level."[145]

Practically, the strategic pivot toward IAMD has created the operational necessity to move all counter-air systems and their related components into an open architecture which can fulfill the desired Joint Force requirements of (1) establishing extended situational awareness and (2) coherent command-and-control processes through the (3) integration of all available sensors and engagement capabilities within and across any given geographic theater. USPACOM in this regard holds a special role given that its AoR is the most heavily militarized on earth.

Japan is currently the only allied nation in the Asia-Pacific region that is about to conduct research on the possible creation of an integrated air and missile defense system. For this purpose Japan's Ministry of Defense earmarked ¥30 million in FY16 to "work out and assess architectures for integrating the SDF's air defense and missile defense systems on technical grounds, in order to explore the most effective and efficient integrated air and missile defense (IAMD) system for the future."[146]

The following three sections on the US Army, Navy, and Air Force are designed to: (1) elaborate on the ways and means the services are adapting to IAMD and (2) highlight possible avenues of alliance cooperation in the area of defensive counter-air operations, such as cruise missile defense (CMD), counter-unmanned aerial systems (CUAS), and counter-rockets, artillery, and mortar (C-RAM).

IAMD and the US Army in the Asia-Pacific

The role of the US Army in the Asia-Pacific theater is widely seen as riddled with strategic uncertainty. Mearsheimer summarizes the problem neatly by noting that "the threat environment in the Asia-Pacific region […] does not require large numbers of

---

[142] US Joint Chiefs of Staff. 2013. *Joint Integrated Air and Missile Defense: Vision 2020*. As of Nov. 21, 2015: http://www.jcs.mil/Portals/36/Documents/Publications/JointIAMDVision2020.pdf, p. 1.
[143] Air University. 2015. *Counterair Framework*. Curtis E. Lemay Center for Doctrine Development and Education, October 27. As of Nov. 30, 2015: https://doctrine.af.mil/download.jsp?filename=3-01-D08-AIR-Framework.pdf
[144] Air University. 2015. *Counterair Framework*. Curtis E. Lemay Center for Doctrine Development and Education, October 27. As of Nov. 30, 2015: https://doctrine.af.mil/download.jsp?filename=3-01-D08-AIR-Framework.pdf
[145] US Joint Chiefs of Staff. 2012. *Countering Air and Missile Threats*. Joint Publication 3-01. As of Nov. 8, 2015: http://www.dtic.mil/doctrine/new_pubs/jp3_01.pdf
[146] Japanese Ministry of Defense. 2015. *Defense Programs and Budget of Japan: Overview of FY2016 Budget Request*. As of Nov. 30, 2015: http://www.mod.go.jp/e/d_budget/pdf/271016.pdf, p. 12.

American ground forces," and the region's particular geography "appears to favor the Air Force and Navy over the Army."[147] Indeed, in the absence of another war on the Korean Peninsula or a head-on collision with Beijing over Taiwan, US ground forces are projected to play only a minor role in the Asia-Pacific, particularly if contrasted to the Army's past combat engagements in Iraq and Afghanistan.

Yet within the context of IAMD, the Army's role is pivotal to the success of swinging and integrating the Joint Force and allied capabilities within any given regional combatant theater. The DoD specifically tasks the Army with "conduct[ing] air and missile defense to support joint campaigns and assist in achieving air superiority,"[148] as well as directly engaging in Korean and Japanese theater operations.[149] In many ways the mission of the US ground forces in the Asia-Pacific is exceptional, because as Hammond highlights, "almost every other technically advanced nation retains missile defense within their air force."[150]

The Army's primary system to facilitate IAMD in the future Joint Force is the Integrated Air and Missile Defense Battle Command System (IBCS). IBCS is set to function as the Army's new brain by replacing all seven of the current command-and-control systems in service and "link[ing] radars, launchers, and human decision makers in more flexible ways than ever before."[151] Dan Verwiel, vice-president at Northrop Grumman, explained that "the ultimate long range goal is to be able to engage any target with any weapon with data that comes from any sensor."[152] To achieve this goal, IBCS is tackling three systemic challenges in its RDT&E phase:

(1) Connecting systems that were not designed to communicate which each other, such as the THAAD launcher and the *Sentinel* radar (standardization).

(2) Creating a single integrated situational awareness picture by collecting and fusing data from all available sensors (big data challenge).

(3) Transitioning to an open architecture while guaranteeing system requirements and the protection of networks from cyber- and electronic warfare (system security).

Overall the gains arising from the implementation of IBCS are expected to manifest themselves through: (1) the removal of acquisition redundancies and capability

---

[147] Mearsheimer, John. 2013. *The Rise of China and the Decline of the US Army*. Army War College, 24th Strategy Conference, April 10. As of Nov. 30, 2015: http://mearsheimer.uchicago.edu/pdfs/Future%20of%20the%20Army%20Transcript.pdf

[148] US Department of Defense. 2010. *Directive 5100.01 – Functions of the Department of Defense and its Major Components*. As of Nov. 30, 2015: http://www.dtic.mil/whs/directives/corres/pdf/510001p.pdf, p. 30.

[149] Office of Air Force Lessons Learned & 7th Air Force. 2010. *A Look at Integrated Air and Missile Defense*. Lessons Learned Report. As of Nov. 30, 2015: https://info.publicintelligence.net/USAFmissiledefense.pdf, p. 6.

[150] Hammonds, Stephen L. 2014. *MEADS: A Case Study*. Alabama, Huntsville: Defense Acquisition University. As of Nov. 15, 2015: https://acc.dau.mil/adl/en-US/708668/file/77541/ MEADS -- DAU Research Paper (Hammonds) - May 2014.pdf, p. 49.

[151] Freedberg Jr., Sydney J. 2015. 'Army Tests New Missile Defense Brain, IBCS; Navy, MDA Intrigued.' *BreakingDefense*, June 1. As of Nov. 15, 2015: http://breakingdefense.com/2015/06/army-tests-new-missile-defenses-brain-ibcs-navy-mda-intrigued/

[152] Freedberg Jr., Sydney J. 2015. 'Army Tests New Missile Defense Brain, IBCS; Navy, MDA Intrigued.' *BreakingDefense*, June 1. As of Nov. 15, 2015: http://breakingdefense.com/2015/06/army-tests-new-missile-defenses-brain-ibcs-navy-mda-intrigued/

duplications arising from closed air and missile defense systems that come with their own launcher, radar, and command and control system (better buying power), (2) allowing different components to plug-and-fight (enhanced operational flexibility), and (3) achieving greater interoperability in support of the Joint Force, while also enhancing integration with allies and partners in any given geographic theater (increased tactical interoperability). On Nov. 12, 2015, IBCS successfully used tracking data from *Sentinel* and Patriot radars, to provide command-and-control for a PAC-3 interceptor to destroy a cruise missile target.[153] IBCS is scheduled to be fielded in fiscal year 2019.[154] Table 6 briefly summarizes the Army's IAMD elements.

Table 6. US Army IAMD elements (FY16)

Air and Missile Defense (AMD) Command		
Command & Control	Air and Missile Defense Planning and Control System (AMDPCS)	*Procurement*
Command & Control	Forward Area Air Defense Command and Control (FAAD C2)	*Sustainment*
Command & Control	Integrated Air and Missile Defense Battle Command System (IBCS)	*RDT&E*
Ballistic Missile Defense (BMD)		
Interceptor	Ground-based Midcourse Defense (GMD)	*Procurement*
Interceptor	Patriot Advanced Capability-2 (PAC-2) GEM-T	*Sustainment*
Interceptor	Patriot Advanced Capability-3 (PAC-3) MSE	*Procurement*
Interceptor	Terminal High Altitude Area Defense (THAAD)	*Procurement*
Sensor	Army Navy/Transportable Radar Surveillance system (AN/TPY-2)	*Procurement*
Counter Unmanned Aerial Systems (CUAS)		
Interceptor	AN/TWQ-1 Avenger (Stinger missile system)	*Sustainment*
Interceptor	Indirect Fire Protection Capability (IFPC) Increment 2-I MML	*RDT&E*
Sensor	Sentinel Mods	*Procurement*
Cruise Missile Defense (CMD) & Counter Rockets, Artillery, and Mortar (C-RAM)		
Interceptor	Directed Energy Weapon	*RDT&E*
Interceptor	Indirect Fire Protection Capability (IFPC) Increment 2-I MML	*RDT&E*
Interceptor	Land-based Phalanx Weapon System (LPWS)	*Procurement*
Sensor	Joint Land Attack Cruise Missile Defense Elevated Netted Sensor System (JLENS)	*Procurement*
Sensor	Rocket, Artillery, Mortar (RAM) Warn	*Procurement*

Source: Howard (2015), Office of the US Army Deputy Chief of Staff (2015, 61)

CUAS, CMD, and C-RAM

The Army's emphasis on developing defenses against air-breathing threats (aircrafts, cruise missiles, and unmanned aerial systems), while expanding counter rockets, artillery, and mortar systems (C-RAM), is a major change in the ground force's RDT&E strategy and implies a broader role for the US Army in the Asia-Pacific theater.

---

[153] Northrop Grumman. 2015. 'Northrop Grumman, US Army Prove Sensors and Shooters as Network Components With Missile Defense Flight Test Intercept.' *Northrop Grumman*, News Release, Nov. 16. As of Nov. 30, 2015: http://www.globenewswire.com/newsarchive/noc/press/pages/news_releases.html?d=10156393

[154] Judson, Jen. 2015. 'DoD Officials Near Decision on Future of Patriot Missile System.' *Defense News*, Nov. 13. As of Nov. 30, 2015: http://www.defensenews.com/story/defense/land/weapons/2015/11/13/key-dod-officials-nearing-decision-on-future-of-patriot-missile-defense-system/75722406/

Traditionally the US Army has never seen the need to prioritize investments in air defense systems due to the dominance of the US Air Force. The Patriot Advanced Capability (PAC) for example, intercepted its first enemy aircraft in 2014, 30 years after the system was put into service.[155] Given this non-threat on the battlefield, it is no surprise that conditional US defense spending gradually pushed the PAC towards a terminal BMD node rather than scrapping the program altogether.[156] The Army's cancellation of the Surface Launched Advanced Medium-Range Air-to-Air Missile (SLAMRAAM) in 2011 (after spending around $3 billion and a decade on RDT&E)[157] and the US exit from the Medium Extended Air Defense System (MEADS) in 2013 (after spending $2.5 billion)[158] are synonymous for the lack of air defense prioritization within the US ground forces.

This lack of focus has meant that the Army's current cost-exchange ratio to defend against air and missile threats is situated on two opposite extremes. Currently, hostile air targets can either be engaged with the inexpensive but low-range *Stinger* missile ($44,000 per unit)[159] or Lockheed Martin's highly capable but very expensive PAC-3 Missile Segment Enhancement (MSE) ($5.1 million per unit).[160]

Two operational paths have emerged to close the cost-intercept exchange gap. The first is the utilization of air-to-air missiles in ground-based defense systems. At the forefront of this challenge is the National Advanced Surface-to-Air Missile System (NASAMS) which can launch AMRAAMs, ESSMs, and the AIM-9X *Sidewinder* traditionally used by the Air Force and Navy fighter planes.[161] Today, NASAMS is in service in several NATO allies and is the premier ground-based defense system for Washington DC.[162] It has not been deployed to the Asia-Pacific. The second is an upgrade of PAC-2 missiles to

---

[155] Opall-Rome, Barbara. 2014. Israel Air Force Hones Patriot Batteries for UAV Defense. *DefenseNews*, Nov. 16. As of Nov. 15, 2015: http://www.defensenews.com/article/20141116/DEFREG04/311160018/Israel-Air-Force-Hones-Patriot-Batteries-UAV-Defense

[156] Hildreth for example explains that: "Global media reporting, including live camera coverage throughout Desert Storm, portrayed Patriot's performance against Iraqi missiles as a technological marvel. […] When the war was nearly over, President Bush extolled Patriot's near-perfect effectiveness in a nationally televised speech to employees of the Raytheon Missile Plant. After the war, policymakers throughout the Government continued to assess Patriot as a highly effective missile defense system. This support helped justify budget requests for additional improvements to the Patriot system, funding increases in the Strategic Defense Initiative (SDI), and plans to proceed with a limited strategic missile defense of the United States." See: Hildreth, Steven A. 1992. *Evaluation of US Army Assessment of Patriot Antitactical Missile Effectiveness in the War against Iraq*. Congressional Research Service, report prepared for the House Government Operations Subcommittee on Legislation and National Security. As of Nov. 30, 2015: http://fas.org/spp/starwars/congress/1992_h/h920407h.htm

[157] Dunnigan, James. 2011. 'SLAMRAAM dies from loneliness.' *Strategypage.com*, February 5. As of Nov. 30, 2015: https://www.strategypage.com/dls/articles/SLAMRAAM-Dies-From-Loneliness-2-5-2011.asp

[158] Hammonds, Stephen L. 2014. *MEADS: A Case Study*. Alabama, Huntsville: Defense Acquisition University. As of Nov. 15, 2015: https://acc.dau.mil/adl/en-US/708668/file/77541/ MEADS -- DAU Research Paper (Hammonds) - May 2014.pdf, p. 6.

[159] Deagal. n.d. 'FIM-92 Stinger-RMP.' As of Nov. 15, 2015: http://www.deagel.com/Surface-to-Air-Missiles/FIM-92-Stinger-RMP_a001145002.aspx

[160] US Department of Defense. 2015. *Fiscal Year (FY) 2016 President's Budget Submission - Army*. Justification Book of Missile Procurement. As of Nov. 15, 2015: http://asafm.army.mil/Documents/OfficeDocuments/Budget/budgetmaterials/fy16/pforms/missiles.pdf, p. 5.

[161] Raytheon. n.d. 'In the Air and on the Ground.' As of Nov. 30, 2015: http://www.raytheon.com/news/feature/air_and_ground.html

[162] Raytheon. n.d. National Advanced Surface-to-Air Missile System (NASAMS). As of Nov. 30, 2015: http://www.raytheon.com/capabilities/rtnwcm/groups/public/documents/content/nasams_pdf.pdf

Raytheon's Guidance Enhanced Missile (GEM) version (~$500,000 per unit upgrade)[163] and the introduction of the PAC-3 Cost Reduction Initiative (CRI) missile design.[164]

While 'opening up' the PAC system to accommodate other missile variants is an important step toward a multipurpose defense platform and a healthier cost-intercept exchange ratio, the PAC-3 still lacks operational flexibility due to the absence of 360-degree situational awareness (radar and launcher) and an open architecture for instant plug-and-fight.

In many ways, the Army's PAC-3 program is exhibiting all the traits and problems connected to the phenomenon of vendor lock-in.[165] Hammond, for example, notes that MEADS, a multinational next-generation PAC-3 replacement system equipped with a 360-degree radar and open architecture for plug-and-fight,[166] was in part cancelled by the OSD due to the in desire to protect US technology, persistent organizational conflicts-of-interests within the Lower Tier Project Office, and a lack of support for MEADS within both the Army and the Program Executive Office.[167] Hammond concludes that the cancellation of MEADS was a process that started not long after the program was formed and resulted in a "death by a thousand cuts."[168]

In the end, however, Raytheon was forced to adapt to the competition and replicate the strengths of the MEADS system by putting forward a new Global Patriot Solution that will house a 360-degree GaN based AESA radar (adapted AMDR radar), an open architecture command-and-control system, and a new launcher that is capable of firing multiple missile types.[169]

A promising candidate to help the Army provide cost-effective C-RAM, CMD, and CUAS in the not-so-distant future is the Indirect Fire Protection Capability (IFPC). As far as details go, IFPC is set up as a modular system, leveraging "(1) existing mission command and control (C2), (2) existing sensors networked via the C2, (3) existing

---

[163] US House of Representatives. 2013. *National Defense Authorization Act for Fiscal Year 2014 – Report of the Committee on Armed Services*. 113th Congress, Report 113-102. As of Nov. 15, 2015: http://www.gpo.gov/fdsys/pkg/CRPT-113hrpt102/pdf/CRPT-113hrpt102.pdf, p. 21.
Note: $500.000 are the costs connected to the upgrade, not the procurement of the missile itself.

[164] Lockheed Martin. 2011. 'Lockheed Martin Conducts Successful PAC-3 Missile Test at White Sands Missile Range.' *Lockheedmartin.com*, Nov. 1. As of Nov. 30, 2015: http://www.lockheedmartin.com/us/news/press-releases/2011/november/LMConductsSuccessfulPac-3.html

[165] Vendor lock-in "describes the situation in which customers depend on a single manufacturer or supplier for some product (i.e., a good or service), and cannot shift to another vendor without incurring substantial costs or inconvenience." See: Wydler, Virginia L. 2014. *Gaining Leverage over Vendor Lock to Improve Acquisition Performance and Cost Efficiencies*. The MITRE Corporation, Technical Papers. As of Nov. 2015: http://www.mitre.org/sites/default/files/publications/gaining-leverage-over-vendor-lock-14-1262.pdf, p. 3.

[166] MEADS. n.d. 'About MEADS .' As of Nov. 30, 2015: http://meads-amd.com/about-meads/

[167] Hammonds, Stephen L. 2014. *MEADS: A Case Study*. Alabama, Huntsville: Defense Acquisition University. As of Nov. 15, 2015: https://acc.dau.mil/adl/en-US/708668/file/77541/ MEADS -- DAU Research Paper (Hammonds) - May 2014.pdf, p. 49.

[168] Hammonds, Stephen L. 2014. *MEADS: A Case Study*. Alabama, Huntsville: Defense Acquisition University. As of Nov. 15, 2015: https://acc.dau.mil/adl/en-US/708668/file/77541/ MEADS -- DAU Research Paper (Hammonds) - May 2014.pdf, p. 49.

[169] Raytheon. n.d. 'Global Patriot Solutions.' As of Nov. 30, 2015: http://www.raytheon.com/capabilities/products/patriot/

interceptor(s) and (4) a new Multi-Mission Launcher (MML)."[170] The system is envisioned to be fully integrated into the Army's IBCS and is set to accommodate IAMD's open architecture capability to target threats with any sensor, the best shooter, and the optimal interceptor. So far, IFPC is on budget and schedule, and slated for procurement in 2019 with a block-1 CMD and CUAS configuration.[171] C-RAM is planned for the block-2 upgrade and projected to be procured by the Army in 2021.[172]

To provide the necessary extended radar coverage against low- and fast-flying cruise missiles, the Army has also procured the Joint Land Attack Cruise Missile Defense Elevated Netted Sensor System (JLENS). The current program consists of two tethered aerostats (or blimps), that float ~10,000 feet above ground to provide 360-degree 'over-the horizon' radar coverage on the US East Coast.[173] According to Raytheon, one aerostat can roughly cover an area the size of Texas. JLENS also serves as the Joint Air Warfare Sensor and is interoperable with the Navy's IAMD (NIFC-CA).[174] In late October 2015 an aerostat broke loose from its mooring station in Baltimore knocking down power lines and causing several large power outages.[175] The Pentagon announced that it was indefinitely suspending the JLENS program one week later.[176] While this mishap was not the first that has jolted the program in the past, [177] the DoD allowed JLENS to fly again in mid-February 2016. A four-month long investigation concluded that "a combination of design, human error and procedural issues" led to the blimp's escape.[178]

Japan

Tokyo has developed its own indigenous CMD system, the Chu-SAM(KAI), to "fill the gap between the indigenous Tan-SAM[179] and the US Patriot"[180] currently in service with

[170] Hamilton, John A. 2015. 'New air defense system under development being tested at White Sands Missile Range.' *Army.mil*, May 22. As of Nov. 30, 2015: http://www.army.mil/article/149083/New_air_defense_system_under_development_being_tested_at_White_Sands_Missile_Range/

[171] Hamilton, John A. 2015. 'New air defense system under development being tested at White Sands Missile Range.' *Army.mil*, May 22. As of Nov. 30, 2015: http://www.army.mil/article/149083/New_air_defense_system_under_development_being_tested_at_White_Sands_Missile_Range/; Dayley, Brant. 2015. *Next Generation Missile Defense*. Presentation at the 2015 Space & Missile Defense Symposium. As of Nov. 15, 2015: https://smdsymposium.org/wp-content/uploads/2014/04/T5e-NexGen-Panel-Col-Dayley.pdf

[172] Office of the US Army Deputy Chief of Staff. 2015. *Army Equipment Program in support of the President's Budget 2016*. As of Nov. 15, 2015: http://www.g8.army.mil/pdf/Army_Equipment_Program2016.pdf, p. 61.

[173] Raytheon. n.d. 'JLENS.' As of Nov. 30, 2015: http://www.raytheon.com/capabilities/products/jlens/

[174] See page 39.

[175] Judson, Jen. 2015. 'After Blimp Broke Free and Crashed, JLENS Program Hangs by a Thread.' *Defense News*, October 30. As of Nov. 30, 2015: http://www.defensenews.com/story/defense/2015/10/30/jlens-hangs-by-thread/74873058/

[176] WBALT-TV. 2015. 'Pentagon to suspend JLENS blimp program.' *WBAL-TV*, Nov. 4. As of Nov. 30, 2015: http://www.wbaltv.com/news/pentagon-to-suspend-jlens-blimp-program/36255066

[177] Willman, David. 'How a $2.7 billion air-defense system became a 'zombie' program.' *Los Angeles Times*, September 24. As of Nov. 30, 2015: http://graphics.latimes.com/missile-defense-jlens/

[178] Judson, Jen. 2016. 'After Blimp's Wild Ride, JLENS Program Will Fly Again.' *Defense News*, February 11. As of Feb. 28, 2016: http://www.defensenews.com/story/breaking-news/2016/02/11/runaway-blimp-jlens-program-fly-again-norad/80241204/

[179] Note**:** The Tan-SAM is the Japanese equivalent to the US *Avenger* system (Stinger missile). Both were developed to replace Raytheon's MIM-23 *HAWK*.

[180] Weaponssystems.net. n.d. 'Chu-SAM.' As of Nov. 30, 2015: http://weaponsystems.net/weaponsystem/EE04%20-%20Chu-SAM.html

Japan's Ground Self-Defense Force (JGSDF). During the summer of 2015, the Chu-SAM(KAI) was successfully flight tested against supersonic cruise missiles and anti-surface missile threats at the US Army's White Sands Missile Range (WSMR) in New Mexico.[181] While WSMR offered the JGSDF the unique large size and controlled airspace "needed to satisfy the requirements of the Chu-SAM(KAI),"[182] the absence of any bilateral CMD development cooperation between both countries was a lost opportunity in terms of cost-reduction and IAMD facilitation within the context of the US-Japan alliance. As a result, the Chu-SAM(KAI) is now an inherently complex system, coming with its own launcher, radar, and command-and-control vehicle.[183]

South Korea

Seoul maintains a variety of systems for CUAS and anti-aircraft defense, such as the French-Korean K-SAM (short-range anti-air system), the indigenous KP-SAM (manpad), and the M-SAM.[184] The PAC-2 is augmenting medium-range air defenses.[185] C-RAM has also been high on the agenda of the South Korean Ministry of Defense, but given the Peninsula's mountainous terrain, the overwhelming size of the North Korean artillery force, and budgetary constraints at home, Seoul has opted against acquiring C-RAM capabilities to protect key government and military facilities.[186]

Taiwan

Taipei is utilizing the indigenous *Sky-Bow* (Tien Kung II & III) and the *Patriot* (PAC-2 & PAC-3) for CMD and CUAS. Additionally, Taiwan's counter-air arsenal consists of predominately aging US-made weapon systems, such as *HAWK* missile batteries and the mobile *Avenger* system (*Stinger* missiles).[187] In 2014, Taiwan's National Assembly approved $2.5 billion (FY15-FY23) to replace the *HAWK* system with the *Sky Bow-3*.[188] Strategically, Taiwan has no need for C-RAM capabilities.

---

[181] Hamilton, John A. 2015. 'Japanese Test Engages Supersonic Target on WSMR.' *Army.mil*, November 5. As of Nov. 30, 2015: http://www.army.mil/article/158283/Japanese_Test_Engages_Supersonic_Target_on_WSMR/

[182] Hamilton, John A. 2015. 'Japanese Test Engages Supersonic Target on WSMR.' *Army.mil*, November 5. As of Nov. 30, 2015: http://www.army.mil/article/158283/Japanese_Test_Engages_Supersonic_Target_on_WSMR/

[183] Japanese Ministry of Defense. n.d. 'Department of Guided Weapon Systems Development – Improved Type 03 Medium-range Surface-to-Air Missile (Chu-SAM(KAI)).' *Technical Research & Development Institute*. As of Nov. 30, 2015: http://www.mod.go.jp/trdi/en/research/gijutu_yudo_en.html; Weaponssystems.net. n.d. 'Chu-SAM.' As of Nov. 30, 2015: http://weaponsystems.net/weaponsystem/EE04%20-%20Chu-SAM.html

[184] Kim, Sarah. 2015. 'Korean-made missiles to replace aging Hawks.' *Korea Joongang Daily*, July 31. As of Nov. 30, 2015: http://koreajoongangdaily.joins.com/news/article/article.aspx?aid=3007277

[185] Montague, Karen. 2014. *A Review of South Korean Missile Defense Programs*. George C. Marshall Institute, Policy Outlook. As of Nov. 30, 2015: http://marshall.org/wp-content/uploads/2014/03/South-Korean-BMD-Mar-14.pdf, p. 4.

[186] Song, Sang-Ho. 2015. 'N.K. rocket threats escalate.' *Korea Herald*, July 26. As of Nov. 30, 2015: www.koreaherald.com/view.php?ud=20150726000314

[187] Easton, Ian. 2014. *Able Archers – Taiwan Defense Strategy in an Age of Precision Strike*. Project 2049 Institute. As of Nov. 30, 2015: http://www.project2049.net/documents/Easton_Able_Archers_Taiwan_Defense_Strategy.pdf, p. 35-36.

[188] AFP. 2014. 'Taiwan Develops New Missiles To Counter China's Threat.' *Defense News*, December 2. As of Nov. 30, 2015: http://archive.defensenews.com/article/20141202/DEFREG03/312020037/Taiwan-Develops-New-Missiles-Counter-China-s-Threat

Australia

Canberra introduced a C-RAM sense and warning capability in late 2010 in an effort to provide 360-degree force protection to the Australian Defence Force (ADF) operating in Afghanistan.[189] The system currently consists of three SAAB *Giraffe* agile multi-beam radars, lightweight counter-mortar radars, command-and-control and warning equipment, as well as *Giraffe* training simulators.[190] C-RAM sense and warn is not designed to intercept incoming projectiles but is utilized to detect, warn, and thus enable personnel to seek shelter or hit the ground, increasing the chances of survival.[191] In term of ground-based air defenses (GBAD), the ADF only maintains the very-short range SAAB RBS-70 manpad, which according to an ADF spokesperson "lacks the sensors, range and performance to protect against the likely threats of today's helicopters, UAVs, stand-off aerial weapons, cruise missiles and rockets, artillery, mortars."[192]

In June 2015, the Australian government approved $325 million (US $235 million) for "Project Land 17 Phase 7B." The funds will be used to (1) enhance or replace the nation's outdated GBAD, and (2) to "sustain C-RAM Sense and Warn capability for use in future operations."[193] Currently, the ADF does not retain any up-to-date CMD, CUAS, or C-RAM intercepting systems.

Recommendations

(1) **Open up existing platforms**. To increase interoperability and facilitate allied system procurements, the DoD ought to encourage industrial partners to open their defense platforms to enable launching a variety of surface-to-air missiles, including the South Korean M-SAM, the Taiwanese *Sky Bow*-3, and the Japanese Chu-SAM(KAI). This policy aims to: (1) stimulate defense industrial cooperation, (2) close country specific missile gaps, and (3) move existing platforms toward a modular design in an effort to level the playing field for domestic and allied suppliers.

---

[189] Australian Department of Defence. 2011. 'C-RAM in Afghanistan.' *Defence News*, March 11. As of Nov. 30, 2015: http://www.defence.gov.au/defencenews/stories/2011/mar/0311.htm

[190] Army-Technology. 2015. 'Australia approves funds for sustainment of C-RAM capability.' *Army-technology.com*, July 1. As of Nov. 30, 2015: http://www.army-technology.com/news/newsaustralia-approves-funds-for-sustainment-of-c-ram-capability-4613134

[191] Australian Department of Defence. 2011. 'C-RAM in Afghanistan.' *Defence News*, March 11. As of Nov. 30, 2015: http://www.defence.gov.au/defencenews/stories/2011/mar/0311.htm

[192] Pittaway, Nigel. 2014. 'Australia To Renew Ground-based Air Defense Capability.' *Defense News*, July 27. As of Nov. 30, 2015: http://archive.defensenews.com/article/20140727/DEFREG03/307270016/Australia-Renew-Ground-based-Air-Defense-Capability

[193] Australian Department of Defence. 2015. 'Minister for Defence – Counter Rocket, Artillery and Mortar System for the ADF.' *Department of Defence Ministers*, June 26. As of Nov. 30, 2015: http://www.minister.defence.gov.au/2015/06/26/minister-for-defence-counter-rocket-artillery-and-mortar-system-for-the-adf-26-june-2015/; Pittaway, Nigel. 2014. 'Australia To Renew Ground-based Air Defense Capability.' *Defense News*, July 27. As of Nov. 30, 2015: http://archive.defensenews.com/article/20140727/DEFREG03/307270016/Australia-Renew-Ground-based-Air-Defense-Capability
Note: According to Jane's, Project Land 19 Phase 7B absorbed the existing Phase 7A 'Sense and Warn' (C-RAM). See: Sydney, Julian Kerr. 2015. 'Australia releases RfI for next-generation air-defence system.' *IHS Jane's Defence Industry*, June 28. As of Nov. 30, 2015: http://www.janes.com/article/52618/australia-releases-rfi-for-next-generation-air-defence-system

(2) **Get open architecture right**. Since 1994, the DoD has been working on implementing an open architecture system (OAS)[194] with rather limited success, as highlighted by the difficulties to integrate components into the IBCS. For IAMD to function properly, the Pentagon needs to constantly track and persistently ensure that open architecture requirements are implemented throughout systems development and reconfiguration processes. The DoD also has to make substantial efforts to spread OAS expertise so that it is abundant and readily available.

(3) **Engage allies and partners on IAMD**. Japan is the only allied nation that is about to conduct preliminary research into the creation of an integrated air and missile defense system. Due to the 'novelty' of open architecture in the armed forces, the DoD should reach out to allies and partners to explain, coordinate, and possibly outline standardization steps that they could take to adapt to, or benefit from, the US move toward IAMD.

(4) **Actively promote cooperation on CMD, CUAS, and C-RAM**. The development of the Japanese Chu-SAM(KAI) and the US-made IFPS is evidence of the lack of joint development programs within the US alliance framework. The DoD should investigate why cooperation did not take place and what opportunities exist to facilitate cooperation with other treaty allies on CMD, CUAS, and C-RAM. Particularly in regards to Canberra's 'Project Land 17 Phase 7B,' the opportunity for enhanced defense cooperation with the ADF exists. Seoul might also be interested in the IFPS given its modular setup and multi-mission launcher, which might prove to be a better alternative than the K- and M-SAM, and it not having any C-RAM capabilities at all.

(5) **Export the JLENS.** Despite the recent 'mishap' of the JLENS system, the blimp solution is a cost-effective option to provide over-the horizon radar coverage. Particularly in the Asia-Pacific, the JLENS could be harnessed to support the South Korean Navy, as an inexpensive CMD radar system.

[194] Office of the Deputy Secretary of Defense – Systems Engineering. n.d. 'Initiatives – Open Systems Architecture (OSA).' As of Nov. 30, 2015: http://www.acq.osd.mil/se/initiatives/init_osa.html

IAMD and the US Navy in the Asia-Pacific

In contrast to the Army, the US Navy has a clearly defined mission role in the Asia-Pacific, stretching from (1) safeguarding the freedom of the seas and (2) deterring conflict and coercion to (3) promoting adherence to international law and standards.[195] To fulfill these mission objectives at a time when the USPACOM AoR is experiencing rapid military modernization coupled with persistent maritime and territorial disputes, the DoD has been continuously "strengthening US military capabilities in the maritime domain," and helped "building the maritime capacity of our allies and partners" in line with the US pivot to Asia.[196]

In the context of IAMD and anti-air warfare (as the Navy calls it), the surface branch is predominately relying upon the AEGIS weapon system (AWS) aboard the *Arleigh Burke*-class guided missile destroyers (DDG) and the *Ticonderoga*-class guided missile cruisers (CG). The AWS comes in various baselines (software and hardware updates).[197] The most recent AWS version is baseline 9, which consists of four different configurations:[198]

- *Baseline 9A*: Air Defense Cruisers (CG 59-64) / no BMD
- *Baseline 9C*: IAMD (DDG 51-112) / Air Defense + BMD
- *Baseline 9D*: IAMD (newly constructed DDG 113 and follow-ons) / Air Defense + BMD
- *Baseline 9E*: Aegis Ashore / BMD only

The baseline 9C and 9D include a (1) "multi-mission signal processor for anti-air warfare and ballistic missile defense in support of IAMD," (2) the Cooperative Engagement Capability (CEC) for real-time sensor netting, and (3) the AEGIS BMD version 5.0.[199]

In addition to the AWS configurations, the *Arleigh Burke*-class has also transitioned through three different ship design variants, so-called Flight versions.[200]

- *Flight I*: Original *Arleigh Burke*-class design

[195] US Department of Defense. 2015. *Asia-Pacific Maritime Security Strategy*. As of Nov. 30, 2015: http://www.defense.gov/Portals/1/Documents/pubs/NDAA%20A-P_Maritime_SecuritY_Strategy-08142015-1300-FINALFORMAT.PDF, p. 1.

[196] US Department of Defense. 2015. *Asia-Pacific Maritime Security Strategy*. As of Nov. 30, 2015: http://www.defense.gov/Portals/1/Documents/pubs/NDAA%20A-P_Maritime_SecuritY_Strategy-08142015-1300-FINALFORMAT.PDF, p. 19; Campbell, Kurt and Brian Andrews. 2013. *Explaining the US Pivot to Asia*. Chatham House. As of Nov. 30, 2015: https://www.chathamhouse.org/sites/files/chathamhouse/public/Research/Americas/0813pp_pivottoasia.pdf

[197] Note: Apart from baseline configurations, in-service ships also receive periodic software updates (so called Advanced Capability Builds (ACB)) and hardware upgrades (Technology Insertions (TI)), whose placement might vary due to budget availability, technological maturity, and maintenance time constraints.

[198] DeLuca, Paul et al. 2013. *Assessing Aegis Program Transition to an Open Architecture Model.* Santa Monica, Calif.: RAND Corporation. As of Nov. 30, 2015: http://www.rand.org/content/dam/rand/pubs/research_reports/RR100/RR161/RAND_RR161.pdf, p. 8-9.

[199] US Department of the Navy. 2015. 'DDG 51 Modernization Program Meets Key Milestones.' *Public affairs*, February 27. As of Nov. 30, 2015: http://www.navy.mil/submit/display.asp?story_id=85018

[200] US Department of the Navy. n.d. 'Aegis Weapon System.' *Navy.mil*, Fact Sheet. http://www.navy.mil/navydata/fact_display.asp?cid=2100&tid=200&ct=2; IHS Jane's. n.d. 'Beneath the skin: US Navy DDG 51 Flight III guided missile destroyer.' *IHS Jane's Defence Weekly*. As of Nov. 30, 2015: http://www.janes360.com/images/assets/731/51731/US_Navy_DDG_51_Flight_III_guided_missile_destroyer.pdf

- *Flight II*: Improved SPY-1 radar, additional active electronic countermeasures and communications
- *Flight IIA*: Added helicopter hangar
- *Flight III*: SPY-1 replaced by Air Missile Defense Radar (AMDR)

Flight III is the latest *Arleigh Burke* ship design and conceptualized to accommodate the new Air Missile Defense Radar (AMDR).[201] According to Raytheon the AMDR (designated AN/SPY-6) is over 30 times more sensitive than the current SPY-1, and can see a target of half the size at almost four times the range.[202] The Navy is planning to procure 22 Flight III destroyers over the next 30 years at an estimated cost of $56 billion.[203]

In addition to developing the Flight III, the Pentagon also briefly restarted the acquisition of Flight IIA ships to account for the construction delays and limited procurement numbers of the DG1000 *Zumwalt*-class destroyer.[204] Three of the new Flight IIAs (DDG 113-115) are equipped with baseline 9D and are already in service in the Pacific Fleet.[205] The Navy is planning to acquire one more Flight IIA in FY16 (DDG 116).[206]

Apart from building new destroyers, the Navy is modernizing all DDGs and CGs in an effort to "maintain their mission and cost effectiveness out to the end of their projected service lives."[207] The current pace of modernization is set to 1-2 DDGs annually.[208] However, due to defense budget and time constraints only earlier Flight I and II DDGs will receive the baseline 9C upgrade, leaving some ships with only hull, mechanical, and electrical (HM&E) systems repairs.[209] The Navy's FY15 30-year plan projects the total

---

[201] Note: For a in-depth discussion on the Flight III, including design readiness, cost, technical and schedule risks, as well as growth margin issues see: O'Rourke, Ronald. 2015. *Navy DDG-51 and DDG-1000 Destroyer Programs: Background and Issues for Congress*. Congressional Research Service, RL32109. As of Nov. 30, 2015: https://www.fas.org/sgp/crs/weapons/RL32109.pdf.

[202] Raytheon. n.d. 'Air and Missile Defense Radar (AMDR).' As of Nov. 30, 2015: http://www.raytheon.com/capabilities/products/amdr/

[203] InsideDefense. 2015. 'DDG-51 Flight III Fleet, including new radar, estimated to cost $56B.' *Inside Missile Defense*, Vol. 21, No. 16, p. 3.

[204] Eckstein, Megan. 2015. 'Ingalls Shipbuilding Launches First Ship Since Destroyer Program Restart.' *USNI News*, March 30. As of Nov. 30, 2015: http://news.usni.org/2015/03/30/ingalls-shipbuilding-launches-first-ship-since-destroyer-program-restart

Note: All three of the planned DDG-1000 *Zumwalt*-class destroyers will be home-porting with the Pacific fleet. See: US Department of Defense. 2015. *Asia-Pacific Maritime Security Strategy*. As of Nov. 30, 2015: http://www.defense.gov/Portals/1/Documents/pubs/NDAA%20A-P_Maritime_SecuritY_Strategy-08142015-1300-FINALFORMAT.PDF, p. 20.

[205] US Navy - Personnel Command. n.d. ' New Ships.' As of Nov. 30, 2015: http://www.public.navy.mil/bupers-npc/enlisted/detailing/seaspecial/NewShips/Pages/default.aspx

[206] O'Rourke, Ronald. 2015. *Navy Aegis Ballistic Missile Defense (BMD) Program: Background and Issues for Congress*. As of Nov. 30, 2015: https://www.fas.org/sgp/crs/weapons/RL33745.pdf, p. 2.

[207] O'Rourke, Ronald. 2015. *Navy DDG-51 and DDG-1000 Destroyer Programs: Background and Issues for Congress*. Congressional Research Service, RL32109. As of Nov. 30, 2015: https://www.fas.org/sgp/crs/weapons/RL32109.pdf, p. 3.

[208] DeLuca, Paul et al. 2013. *Assessing Aegis Program Transition to an Open Architecture Model*. Santa Monica, Calif.: RAND Corporation. As of Nov. 30, 2015: http://www.rand.org/content/dam/rand/pubs/research_reports/RR100/RR161/RAND_RR161.pdf, p. 15.

[209] LaGrone, Sam. 2015. 'Navy Again Reduces Scope of Destroyer Modernization, 5 Ships Won't Receive Any Ballistic Missile Defense Upgrades.' *USNI News*, March 3. As of Nov. 30, 2015: http://news.usni.org/2015/03/03/navy-again-reduces-scope-of-destroyer-modernization-5-ships-wont-receive-any-ballistic-missile-defense-upgrades

number of AEGIS cruisers and destroyers to settle between 80 and 97 with the majority of ships upgraded to baseline 9.[210]

Cruise Missile Defense (CMD)

The emergence of sophisticated anti-ship cruise missiles (ASCMs), and in particular the evolution of hypersonic ASCMs, has forced the US Navy to seek new technical solutions that go well beyond 'on-sight engagements,' based on SM-2s, Evolved *Sea Sparrow* Missiles and the *Phalanx* close-in weapon system, to protect its fleet.[211] GAO for example noted back in 2000 that "although the Navy has made some progress in improving surface ship self-defense capabilities, most ships continue to have only limited capabilities against cruise missile threats."[212]

The solution the Navy has come up with is an 'over-the-horizon' (OTH) IAMD engagement capability known as the Navy Integrated Fire Control-Counter Air (NIFC-CA) system-of-systems.[213] NIFC-CA primarily leverages the Cooperative Engagement Capability (CEC), which facilitates real-time sensor networking (extending sensor range) and target data sharing (networked fire control) between various platforms. The CEC is currently (1) included in the AWS baseline 9 version,[214] (2) installed on the carrier-launched E-2 *Hawkeye* early warning aircraft, and (3) integrated in the Army's land-based JLENS system.[215] To intercept and kill incoming ASCMs, the surface branch relies upon the new Standard Missile 6 (SM-6), which in contrast to its predecessor, the SM-2, has greater range and is equipped with an active radar seeker that can "acquire and track the target itself once it has flown to within radar range of the incoming cruise missile."[216] Table 7 briefly summarizes the current NIFC-CA elements.

---

[210] O'Rourke, Ronald. 2015. *Navy Aegis Ballistic Missile Defense (BMD) Program: Background and Issues for Congress*. As of Nov. 30, 2015: https://www.fas.org/sgp/crs/weapons/RL33745.pdf, p. 2.

[211] Government Accountability Office. 2010. *Defense Acquisitions: Comprehensive Strategy Needed to Improve Ship Cruise Missile Defense*. As of Nov. 30, 2015: http://www.gao.gov/assets/230/229270.pdf, p. 34-40.

[212] Government Accountability Office. 2010. *Defense Acquisitions: Comprehensive Strategy Needed to Improve Ship Cruise Missile Defense*. As of Nov. 30, 2015: http://www.gao.gov/assets/230/229270.pdf, p. 8.

[213] Kilby, Jim. 2014. 'Surface Warfare: Lynchpin of Naval Integrated Air/Missile Defense.' *Center for International Maritime Security*, April 4. As of Nov. 30, 2015: http://cimsec.org/surface-warfare-lynchpin-naval-integrated-airmissile-defense/10748

[214] Note: The Baseline 9C & 9D upgrade includes Lockheed Martin's Multi-Mission Signal Processor (MMSP) which allows "*operators to dynamically allocate radar resources in response to specific threats* (essentially switching between BMD and Anti-Air Warfare)." See: Kilby, Jim. 2014. 'Surface Warfare: Lynchpin of Naval Integrated Air/Missile Defense.' *Center for International Maritime Security*, April 4. As of Nov. 30, 2015: http://cimsec.org/surface-warfare-lynchpin-naval-integrated-airmissile-defense/10748

[215] US Department of the Navy. n.d. 'CEC - Cooperative Engagement Capability.' *Navy.mil*, Fact Sheet. As of Nov. 30, 2015: http://www.navy.mil/navydata/fact_display.asp?cid=2100&tid=325&ct=2; McConnell, Jeffrey H. 2013. *Naval Integrated Fire Control–Counter Air Capability- Based System of Systems Engineering*. As of Nov. 30, 2015: http://www.acq.osd.mil/se/webinars/2013_11_14-SOSECIE-McConnell-brief.pdf

[216] Schwartz. Paul N. 2015. *U.S. Navy Deploying New Measures to Counter Russian Cruise Missile Threat*. Center for Strategic and International Studies, Russian Defense and High Technology Project. As of Nov. 30, 2015: http://csis.org/files/publication/150311_russian_cruise_missiles.pdf, p. 5.

Table 7. US Navy IAMD for CMD[217]

Navy Integrated Fire Control-Counter Air (NIFC-CA)			
Cooperative Engagement Capability (CEC)			**Interceptor**
E-2D Hawkeye (Surveillance Aircraft)	**JLENS** (US Army Aerostat)	**AEGIS** (AWS Baseline 9)	**Standard Missile 6** (SM-6)
• Airborne CEC relay • Enhanced Airborne Early Warning • Air Warfare battle management roles and functionality • Electronically scanned array radar • 360 surveillance	• Airborne CEC relay • Fire control provider • Joint Air Warfare Sensor & Overland Cruise Missile Defense • 360 surveillance	• Fire control provider • Adapts new SM-6 capabilities and performance • Enhanced OTH functionality • Enhanced defended asset controls	• Integrated active seeker • Ship-controlled fly-out and midcourse • Independent OTH endgame/intercept • Improved high altitude capability • Endgame data feedback

Source: McConnell (2013, 4)

To date the SM-6 has reached several important milestones. In mid-June 2014 it destroyed “a cruise missile target at near the missile’s maximum range,” proving that the SM-6 can successfully intercept an over-the horizon target.[218] And in late July 2015, the SM-6 Dual I destroyed two different types of cruise missiles and intercepted a short-range ballistic missile in its terminal phase, making it “the only missile now out there that has […] dual-mission capability.”[219]

Japan

With Tokyo currently upgrading its two *Atago*-class destroyers to AWS baseline 9 and the State Department’s approval for the sale of four E-2D *Hawkeyes* to Japan, the adoption of NIFC-CA seems to be only a matter of time.[220] Japanese Defense Minister Nakatani Gen suggested as much when he singled out NIFC-CA in a Q&A session during his visit to Pearl Harbor in November 2015.[221]

Indeed, NIFC-CA’s adoption would squarely fall in line with Tokyo’s re-interpretation of collective self-defense and underline Japanese efforts to tighten integration with US theater forces in the area of defensive mission support. However, despite Japan’s recent constitutional changes, it is not entirely clear whether OTH engagements fall within the definition of an ‘imminent critical threat’ scenario that would permit the JMSDF to actively fire an interceptor in defense of a US asset.

[217] Note: According to a December 2015 report by InsideDefense, the Navy is in the early stages of networking F-35 radar data into NIFC-CA. The F-35 will not be utilized as a defensive counter-air asset, but will be integrated in the Navy’s kill chain to project offensive power. As such the F-35 was excluded from this study. See: Doubleday, Justin. 2015. ‘Navy looping Joint Strike Fighter into integrated anti-air warfare system.’ *Inside Missile Defense*, December 9.
[218] PRNewswire. 2014. SM-6 destroys longest range cruise missile target to date.’ *Missilethreat.com*, July 15. As of Nov. 30, 2015: http://missilethreat.com/sm-6-destroys-longest-range-cruise-missile-target-to-date/
[219] Freedberg Jr. Sydney J. 2015. ‘SM-6 Can Now Kill Both Cruise AND Ballistic Missiles.’ *Breaking Defense*, August 4. As of Nov. 30, 2015: http://breakingdefense.com/2015/08/sm-6-can-now-kill-both-cruise-and-ballistic-missiles/
[220] Malenic, Marina. 2015. ‘US approves E-2D sale to Japan.’ *IHS Jane’s Defence Weekly*, June 2. As of Nov. 30, 2015: http://www.janes.com/article/51957/us-approves-e-2d-sale-to-japan
[221] Japanese Ministry of Defense. 2015. ‘Extra Press Conference by the Defense Minister Nakatani.’ *MoD Press Conference*, Nov. 24. As of Nov. 30, 2015: http://www.mod.go.jp/e/pressconf/2015/11/151124a.html

South Korea

Seoul has not yet made any advances on NIFC-CA, but is set to procure SM-6 interceptors in 2016, as a means to extend the missile range beyond its current SM-2 IIIA/B arsenal. JLENS might be an attractive solution for South Korea as well to enable 360-degree OTH radar coverage in an effort to shield its expanding AEGIS fleet from North Korean ASCM deployments.[222] The JLENS/SM-6 combination was successfully flight tested by the US Army and Navy at the White Sands Missile Range (New Mexico) in September 2012.[223]

If Seoul were to go one step further and procure the SM-6 Dual I, while also upgrading its destroyers to AWS baseline 9 (to enable switching between anti-air warfare and BMD missions), it could add the long awaited sea-based terminal BMD layer to the KAMD without undermining its strategic ambiguity vis-à-vis Washington and Beijing.

Recommendations

(1) **Utilize JLENS for trilateral cooperation**. Deploying JLENS to the Asia-Pacific might be the practical way to kick off trilateral military cooperation between the US, Japan, and South Korea. To accommodate each party, the system could be (1) placed under US command, (2) co-financed by Seoul and Tokyo, and (3) installed on Tsushima Island. The symbolic meaning, geographic location, and equal radar coverage might square the circle for cross-alliance cooperation in the maritime domain amidst persistent historic animosity and mistrust between the two US allies.

(2) **Press Seoul on SM-6 Dual I acquisition**. With Seoul set to acquire the SM-6 interceptor, Washington should press South Korea to build up a sea-based terminal BMD to develop the full potential of its AEGIS platforms and strengthen the alliance deterrence posture.

(3) **Press Australia on SM-6 acquisition**. According to a 2010 DSCA request, Canberra is planning to equip its upcoming *Hobart*-class destroyer with SM-2 IIIB interceptors (see BMDS section). It might be suitable to revisit this sale and, in the absence of any Australian BMD capability, highlight the CMD contribution Canberra could make within the alliance framework.

(4) **Clearly assess and communicate JMSDF rules of engagements.** Given Tokyo's security reforms, the DoD should comprehensively assess the various practical scenarios under which the JMSDF is able to assist and defend US assets. The new JMSDF rules of engagement will also have to be communicated effectively to the warfighter to clearly mark the new opportunities and continuing restraints that the new laws create for alliance interoperability and US defense posturing.

---

[222] Pearson, James. 2015. 'North Korea test-fires new anti-ship cruise missile.' *Reuters*, February 5. As of Nov. 30, 2015: http://www.reuters.com/article/northkorea-missile-idUSL4N0VH02620150207

[223] Richardson, Doug. 2012. 'JLENS guides SM-6 against a cruise missile target.' *IHS Jane's Missiles & Rockets*, September 26.

(5) **Emphasize cross-domain networks**. NIFC-CA is the perfect example of an IAMD capability that connects air, land, and sea platforms to extend defensive naval counter-air operations. The Army should adopt the same cross-domain approach and interface with the Navy to ensure jointness and extended battlespace coverage to accommodate the particular geography of the Asia-Pacific.

(6) **Outsourcing components over centralized platforms**. The evolution of the *Arleigh Burke*-class destroyer is representative of the centralized approach the Navy has been taking to pack more equipment onto naval platforms. The Flight III is being built to accommodate the new AMDR. The Navy should reverse its desire to centralize components and instead leverage networks to decentralize sensors, fire controls, and even payloads onto smaller, cheaper, and more agile UAS and naval platforms. As such, the surface branch could increasingly rely upon a swarm of small mobile radars to expand situational awareness, external fire controls, and even outsource interceptors and offensive missiles to provide a first-encounter capability that would significantly shorten defense reaction times and naturally converge with OTH engagement capabilities.

IAMD and the US Air Force in the Asia-Pacific

In contrast to the Army and Navy, the Air Force is not so much restrained by geographic features, but by the location of its air bases and the reach of its power-projection capabilities. While the US Air Force is the nation's principle air and space force, the aviation service does not maintain any "organic ground-based defenses against aircraft[s]; armed remotely piloted vehicle[s]; or cruise-missile[s], ballistic-missile[s], rocket, artillery, or mortar attack[s]." [224] The reason for this apparent mismatch is that ground-based air defense, even for Air Force bases, is an Army responsibility. As a result, Air Force programs like the Network Centric Airborne Defense Element (NCADE) and the Air Launched Hit-to-Kill (ALHK) that were conceptualized to intercept ballistic missiles,[225] were in the end adopted by the Army to fire air-to-air missiles from ground-based systems rather than fighter aircraft.[226] Consequentially, the Air Force is focusing on passive air defenses, such as hardened aircraft shelters, aircraft decoys, and on-base and across-bases dispersal tactics, to mitigate damage to its fighter and bomber force rather than protecting its air field infrastructure.

The Air Force has also been making head-way in airborne non-kinetic capabilities, such as directed energy (lasers) and electromagnetic pulse technology (electronic warfare). While the development of airborne lasers (ABL) still poses a number of significant technical hurdles, including (1) jitter from the aircraft platform, (2) atmospheric conditions, (3) beam control, and (4) cool-off times after firing,[227] electromagnetic pulse technology has developed more smoothly. In late 2012 for example, Boeing and the US Air Force Research Laboratory successfully flight tested the Counter-electronics High-powered Microwave Advanced Missile Project (CHAMP), which "emitted bursts of high-powered energy, effectively knocking out the target's data and electronic subsystems." [228] Or as Boeing calls it: "Lights Out!" However, due to several program delays, CHAMP is slated to achieve an initial operational capability in 2016 with possible

---

[224] Vick, Alan J. 2015. *Air Base Attacks and Defensive Counters – Historical Lessons and Future Challenges*. Santa Monica, Calif.: RAND Corporation. As of Nov. 30, 2015: http://www.rand.org/content/dam/rand/pubs/research_reports/RR900/RR968/RAND_RR968.pdf, p. 39.

[225] See for example: Corbett, Mike & Paul Zachan. 2010. 'The Role of Airpower in Active Missile Defense.' *Air & Space Power Journal*, Summer. As of Nov. 30, 2015: http://www.airpower.maxwell.af.mil/airchronicles/apj/apj10/sum10/2010-2%20Summer%20English%20ASPJ.pdf, p. 57-71.; Corbett, Mike & Paul Zachan. 2011. 'The United States Should Develop a Missile Defense System That Builds Confidence.' *Air & Space Power Journal*, Fall. As of Nov. 30, 2015: http://www.airpower.maxwell.af.mil/airchronicles/apj/2011/2011-3/2011_3_08_corbett_zarchan.pdf

[226] LaGrone, Sam. 2009. 'Fighters eyed for ballistic missile defense.' *Air Force Times*, June 16. As of Nov. 30, 2015: http://archive.airforcetimes.com/article/20090616/NEWS/906160350/Fighters-eyed-ballistic-missile-defense;

Note: Air-to-air missiles have been incorporated into the Army's Indirect Fire Protection Capability (IFPC) and the National Advanced Surface-to-Air Missile System (NASAMS). See: Raytheon. 2015. 'Raytheon air-to-air missile scores direct hit from U.S. Army ground launcher.' *PRNewswire*, August 26. As of Nov. 30, 2015: http://www.prnewswire.com/news-releases/raytheon-air-to-air-missile-scores-direct-hit-from-us-army-ground-launcher-300133091.html; Raytheon. 2015. 'Raytheon completes lab testing on AMRAAM-ER, NASAMS integration.' *PRNewswire*, June 10. As of Nov. 30, 2015: http://raytheon.mediaroom.com/2015-06-10-Raytheon-completes-lab-testing-on-AMRAAM-ER-NASAMS-integration

[227] InsideDefense. 2015. 'Air Force Science Board Takes Fast Track On Laser Study.' *Inside Missile Defense*, October 13.

[228] Boeing. 2012. 'CHAMP – Lights Out.' *Boeing.com*, October 22. As of Nov. 30, 2015: http://www.boeing.com/features/2012/10/bds-champ-10-22-12.page

further plans to integrate with UAVs and across the US air-launched cruise missile arsenal.[229]

When it comes to IAMD, the Air Force is the lead service to create and maintain a robust array of cyber, intelligence, surveillance, and reconnaissance capabilities. To this extent the USAF has (1) established space situational awareness agreements with eight countries, including Japan, Korea and Australia,[230] (2) is modernizing the Global Positioning System (GPS),[231] and (3) is supporting the integration of the MDA's Command and Control, Battle Management and Communications (C2BMC) system into the appropriate USAF Air and Space Operation Centers (AOC).[232] Apart from these tasks, the Air Force is primarily engaged in developing and communicating IAMD doctrine, training, planning, and jointness for counter-air operations.[233] Overall however, one has to conclude that, given the overwhelming firepower of the US Air Force and its allied air wings in the Asia-Pacific, the aviation service is still comfortably operating under the assumption that the best defense remains a good offense.[234]

Recommendations

(1) **Determine the appropriate level of protection for all Air Force bases in the Asia-Pacific**. Given the expanding range of ballistic and cruise missile, the DoD should re-evaluate the specific threat environment each Air Force base in the Pacific is facing, draw up cost-benefit analyses, and deploy systems to achieve appropriate counter-air defense capabilities. Since an increase in the number of defensive counter-air assets will be difficult, if not impossible, to achieve in the current fiscal environment, strengthening rapid runway repair systems and finding a healthy mix between passive and active defenses might be the best cost-effective way to ensure AFB resilience.

(2) **Generate combat capability even if Air Force bases come under attack**. The Air Force needs to think about how to generate combat capabilities and the force readiness necessary to achieve air superiority in the Asia-Pacific even when its main airfield hubs are attacked by cruise and ballistic missiles. Closer

[229] Peniston, Bradley. 2014. 'Air Force expects to test counter-electronics missile in 2016.' *Air Force Times*, September 16. As of Nov. 30, 2015: http://archive.airforcetimes.com/article/20140916/NEWS04/309160056/Air-Force-expects-test-counter-electronics-missile-2016; Giangreco, Leigh. 2015. 'Air Force awards High Power Electromagnetics contract to Raytheon.' *Inside Defense*, Daily News, December 31.

[230] Giangreco, Leigh. 2015. 'Air Force expanding space, cyber and ISR work among coalition partners.' *Inside Missile Defense*, November 25.

[231] GPS.gov. n.d. 'GPS Modernization.' As of Nov. 30, 2015: http://www.gps.gov/systems/gps/modernization/

[232] Donley, Michael B. & Norton A. Schwartz. 2010. *Integrating Air and Missile Defense – Incorporating Ballistic Missile Defense within the Counterair Framework*. The Secretary of the Air Force, Chief of Staff USAF, June. Note: The Air Force relies on the 631 AOC for all IAMD in-theater operations in the Pacific; except for Korean theater operations which are conducted by the Combined Air Operations Center at Osan (South Korea). See: Dorner, Kenneth R. et al. 2015. 'Back to the Future – Integrated Air and Missile Defense in the Pacific.' *Air & Space Power Journal*, January-February. As of Nov. 30, 2015: http://www.airpower.maxwell.af.mil/digital/pdf/articles/2015-Jan-Feb/V-Dorner_Hartman_Teague.pdf, p. 68.

[233] Pacific Air Forces. 2014. 'PACAF established Pacific IAMD Center. *Pacific Air Forces*, Nov. 14. As of Nov. 30, 2015: http://www.pacaf.af.mil/News/ArticleDisplay/tabid/377/Article/591097/pacaf-establishes-pacific-iamd-center.aspx; Office of Air Force Lessons Learned & 7th Air Force. 2010. *A Look at Integrated Air and Missile Defense*. Lessons Learned Report. As of Nov. 30, 2015: https://info.publicintelligence.net/USAFmissiledefense.pdf. p. 1-2.

[234] Dorner, Kenneth R. et al. 2015. 'Back to the Future – Integrated Air and Missile Defense in the Pacific.' *Air & Space Power Journal*, January-February. As of Nov. 30, 2015: http://www.airpower.maxwell.af.mil/digital/pdf/articles/2015-Jan-Feb/V-Dorner_Hartman_Teague.pdf, p. 73.

coordination with the Army and the Navy's aviation wing will be essential to better protect Air Force bases in Japan and South Korea, and quickly engage hostile forces that are threatening US air superiority buildup.

(3) **Focus on Electronic Warfare.** While cyber and lasers are buzzwords within the DoD, the Air Force should concentrate on developing and deploying electronic warfare capabilities that are tackling threats in a more direct, holistic, and practical way. CHAMP was an impressive start, but the program needs to become operational; otherwise it will remain an idea the warfighter is unable to utilize on the battlefield.

(4) **Develop military alternatives for space-based assets and clarify alliance responses in the event of hostile anti-satellite weapons use.** While very few nations have developed the capability to destroy space-based assets, the increasing reliance on military satellites for communication, navigation, intelligence, surveillance, and reconnaissance purposes, is creating a growing defense vulnerability that might translate into a first-strike advantage. The DoD would do well to (1) probe the possibility of using commercial satellites for military purposes and (2) determine and clarify alliance responses in the event of hostile anti-satellite weapons usage.

Final Thoughts

The United States needs to think about BMD and IAMD in a strategic context. What does Washington want to achieve now and in the foreseeable future in the Asia-Pacific? How far is the DoD able to push BMDS and IAMD in terms of increasing alliance cohesion, expanding defensive counter-air systems, and solidifying conventional deterrence? But also, to what extent is the US politically willing to escalate and fight certain wars in the Asia-Pacific?

The US BMDS for example can be harnessed and refined to win a prospective missile salvo competition, but it does not present a tangible solution to curtail nuclear proliferation, nor is it a substitute for offensive nuclear and conventional capabilities. In the end what counts is not the amount of missiles that can be intercepted in the sky, but the number of enemy launching platforms that will be destroyed during the exchange. However, to fight such a war successfully, missile defense needs to be integrated and automated within the IAMD framework to minimize reaction times and maximize its strategic value. In essence, only if the US BMDS is inherently connected to a retaliatory capability (the so-called kill-chain) can it survive and tactically contribute to curb a hostile missile salvo beyond its initial phase.

This intersection between offensive and defensive capabilities is best harnessed by utilizing defensive elements in offensive operations and vice-versa. The current trajectory of IAMD defensive counter-air systems is creating the groundwork for this capability to emerge, but IAMD also needs to move in a direction in which the BMDS dictum of 'multilayered, multilateral, and multipurpose' is the new normal rather than an exceptional occurrence.

Conclusion

Within the area of defensive counter-air operations, the push toward IAMD is steadily progressing. All three services are applying different approaches to implement the changes needed to realize an interoperable, networked, open architecture system that can plug-and-fight, streamline command-and-control processes, and extend situational awareness. The Army is focusing on IBCS, the Navy has put forward NIFC-CA, and the Air Force is relying on an offensive posture in the absence of ground-based air defenses.

When it comes to missile defense specifically, getting priorities right is essential. BMD assets are nice to have if they work as desired, but they need to be utilized in a tactical and strategic context and cannot be proliferated horizontally in the same manner as offensive systems, given finite resources and the BMD's symmetric approach to defense.

(1) **What are the strategic and tactical objectives of the US BMDS in the Asia-Pacific?** Chapter one identified the tactical objectives of the US BMDS by highlighting the role of forward-based US assets in the area of force protection, alliance interoperability, creating joint command structures, and facilitating real-time data sharing. Chapter two touched upon the strategic objectives of the US BMDS which are currently grounded in (1) a counter-proliferation strategy to reassure allies, (2) an attempt to redefine the strategic balance in the Asia-Pacific, (3) an overall desire to strengthen US deterrence against non-peer competitors, and (4) an attempt to leverage non-kinetic left- and right-of-launch defense solutions.

(2) **How does BMDS fit into the IAMD 2020 vision?** BMDS fits neatly into the IAMD 2020 vision and to some extent necessitates it. BMDS without IAMD would be an incomplete defensive counter-air system whose assets will be vulnerable to a variety of non-ballistic missile threats. The main challenge for the US BMDS is to transition away from the singularity of its counter-ballistic missile mission and pivot toward a multilayered, multilateral, and multipurpose system in line with the IAMD vision.

(3) **What role can regional US allies play in the context of IAMD?** IAMD is still in its infancy and has not yet transcended into a broader push to achieve greater alliance interoperability. The main problem in this regard is that IAMD goes hand in hand with updating and upgrading existing defensive assets, acquiring new ones, and scrapping redundancies. Allies have to make the RDT&E and procurement investments necessary to reap the long-term benefits from IAMD. Additionally, they need to exercise the political willingness to integrate their systems with US assets and allow for cross-alliance plug-and-fight and data-sharing capabilities. The shortfalls in the BMDS context have shown that IAMD will not come about naturally, and that some allies will be more valuable than others. Cooperation with Japan on IAMD seems to be the most promising, while South Korea's strategic ambiguity and Australia's unique threat environment significantly limit alliance cohesion and IAMD growth prospects.

(4) **How will IAMD influence the strategic balance in the Asia-Pacific?** It is not clear how IAMD will influence the strategic balance in the Asia-Pacific, given the uncertainty surrounding the spread of IAMD and the DoD's desire to balance in the first place. The third offset strategy will to a large degree define the utility of IAMD on the battlefield due to its emphasis on automation, extended-range, and complex system engineering and integration.

APPENDIX A

Abbreviations

A2/AD	Anti-Access/Anti-Denial
ABL	Airborne Laser
ABM	Anti-Ballistic Missile
ACB	Advanced Capability Build
ADF	Australian Defence Force
AESA	Active Electronically Scanned Array
AFB	Air Force Base
ALHK	Air-Launched Hit-to-Kill
AMD	Air and Missile Defense
AMDR	Air and Missile Defense Radar
AMRAAM	Advanced Medium-Range Air-to-Air Missile
AN/TPY-2	Army Navy/Transportable Radar Surveillance system
AOC	Air and Space Operation Centers
AOR	Area of Responsibility
ASCM	Anti-Ship Cruise Missile
AWD	Air-Warfare Destroyer
AWS	AEGIS Weapon System
BMD	Ballistic Missile Defense
BMDO	Ballistic Missile Defense Organization
BMDR	Ballistic Missile Defense Review
BMDS	Ballistic Missile Defense System
C2	Command and Control
C2BMC	Command, Control, Battle Management and Communications
C4	Command, Control, Communication, and Computers
CE	Capability Enhancement
CEC	Cooperative Engagement Capability
CFC	Combined Forces Command
CHAMP	Counter-electronics High-powered Microwave Advanced Missile Project
CMD	Cruise Missile Defense
C-RAM	Counter-Rocket, Artillery, and Mortar
CREW	Counter-Radio controlled improvised explosive device Electronic Warfare
CRI	Cost-Reduction Initiative
CUAS	Counter-Unmanned Aerial System
CSBA	Center for Strategic and Budgetary Assessments
DoD	US Department of Defense
DPRK	Democratic People's Republic of Korea (North Korea)
DSCA	Defense Security Cooperation Agency
EKV	Exoatmospheric Kill Vehicle
EW	Electronic Warfare
GaN	Gallium Nitride
GAO	Government Accountability Office
GBAD	Ground-Based Air Defenses
GBI	Ground-based Interceptor
GEM	Guidance Enhanced Missile
GMD	Ground-based Midcourse Defense
GPS	Global Positioning System

HM&E	Hull, Mechanical and Electrical
IAMD	Integrated Air and Missile Defense
IBCS	Integrated Air and Missile Defense Battle Command System
ICBM	Intercontinental Ballistic Missile
IFPC	Indirect Fire Protection Capability
IRBM	Intermediate-Range Ballistic Missile
JADGE	Japan Aerospace Defense Ground Environment
JASDF	Japanese Air Defense Force
JCIDS	Joint Capabilities Integration Development System
JFCC-IMD	Joint Functional Component Command for Integrated Missile Defense
JGSDF	Japanese Ground Defense Force
JLENS	Joint Land Attack Cruise Missile Defense Elevated Netted Sensor System
JMSDF	Japanese Maritime Defense Force
JROC	Joint Requirements Oversight Council
KAMD	Korean Air and Missile Defense
LRSO	Long-Range Standoff weapon (nuclear tipped cruise missile)
LRDR	Long Range Discriminating Radar
MD	Missile Defense
MDA	Missile Defense Agency
MEADS	Medium Extended Air Defense System
MIRV	Multiple Independent targetable Re-entry Vehicle
MML	Multi-Mission Launcher
MMSP	Multi-Mission Signal Processor
MoD	Ministry of Defense
MOKV	Multiple Object Kill Vehicle
MSE	Missile Segment Enhancement
NCADE	Network Centric Airborne Defense Element
NIFC-CA	Navy Integrated Fire Control-Counter Air
NMD	National Missile Defense
NPR	Nuclear Posture Review
OAS	Open Architecture System
OPCON	Operational Control
OSD	Office of the Secretary of Defense
OTH	Over-the Horizon
PAC	Patriot Advanced Capability
Q&A	Question & Answer
RDT&E	Research, Development, Testing & Evaluation
RKV	Redesigned Kill Vehicle
SAM	Surface-to-Air Missile
SBIRS	Space Based Infrared System
SBX	Sea Based X-Band Radar
SDF	Self-Defense Force
SDIO	Strategic Defense Initiative Organization
SLAMRAAM	Surface Launched Advanced Medium-Range Air-to-Air Missile
SLBM	Submarine Launched Ballistic Missile
SM	Standard Missile
SRP	Surveillance Radar Program
START	Strategic Arms Reduction Treaty
STSS	Space Tracking and Surveillance System
THAAD	Terminal High Altitude Area Defense
TI	Technology Insertion

TMMR	Technology Maturation and Risk Reduction
TMO	Theater Missile Operations
UAV	Unmanned Aerial Vehicle
UCS	Union of Concerned Scientists
UEWR	Upgraded Early Warning Radars
US	United States
USAF	United States Air Force
USFK	United States Forces in Korea
USNORTHCOM	United States Northern Command
USPACOM	United States Pacific Command
USSTRATCOM	United States Strategic Command
WSMR	White Sands Missile Range

APPENDIX B

References

AFP. 2014. 'Taiwan Develops New Missiles To Counter China's Threat.' *Defense News*, December 2. As of Nov. 30, 2015: http://archive.defensenews.com/article/20141202/DEFREG03/312020037/Taiwan-Develops-New-Missiles-Counter-China-s-Threat

AFP. 2014. 'Taiwan to spend $2.5 billion on anti-missile systems.' *Spacewar*, August 30. As of Nov. 30, 2015: http://www.spacewar.com/reports/Taiwan_to_spend_25_billion_on_anti-missile_systems_999.html

Air University. 2015. *Counterair Framework*. Curtis E. Lemay Center for Doctrine Development and Education, October 27. As of Nov. 30, 2015: https://doctrine.af.mil/download.jsp?filename=3-01-D08-AIR-Framework.pdf

Air Warfare Destroyer Alliance. n.d. *Air Warfare Destroyers The Big Picture*. As of Nov. 30, 2015: http://www.ausawd.com/library/AWD%20Big%20Picture_0.pdf

Arms Control Association. 2015. '*Arms Control and Proliferation Profile: North Korea*.' Fact Sheets & Briefs, Update October 2015. As of Nov. 17, 2015: https://www.armscontrol.org/factsheets/northkoreaprofile

Army-Technology. 2015. 'Australia approves funds for sustainment of C-RAM capability.' *Army-technology.com*, July 1. As of Nov. 30, 2015: http://www.army-technology.com/news/newsaustralia-approves-funds-for-sustainment-of-c-ram-capability-4613134

Australian Department of Defence. 2011. 'C-RAM in Afghanistan.' *Defence News*, March 11. As of Nov. 30, 2015: http://www.defence.gov.au/defencenews/stories/2011/mar/0311.htm

Australian Department of Defence. 2013. *Minister for Defence Stephen Smith – Ministerial Statement on Full Knowledge and Concurrence*. Department of Defence Ministers, June 26. As of Nov. 30, 2015: http://www.minister.defence.gov.au/2013/06/26/minister-for-defence-stephen-smith-ministerial-statement-on-full-knowledge-and-concurrence/

Australian Department of Defence. 2015. 'Minister for Defence – Counter Rocket, Artillery and Mortar System for the ADF.' *Department of Defence Ministers*, June 26. As of Nov. 30, 2015: http://www.minister.defence.gov.au/2015/06/26/minister-for-defence-counter-rocket-artillery-and-mortar-system-for-the-adf-26-june-2015/

Australian Department of Defence. 2016. *2016 Defence White Paper*. As of Feb. 28, 2016: http://www.defence.gov.au/WhitePaper/Docs/2016-Defence-White-Paper.pdf

Aviationweek. 2015. 'S-300 Surface-To-Air Missile System.' *Aerospace Daily & Defense Report*, August 6. As of Feb. 28, 2016: http://aviationweek.com/site-files/aviationweek.com/files/uploads/2015/07/asd_08_06_2015_dossier.pdf, p. 6.

Berteau, David J. & Michael J. Green. 2012. *US Force Posture Strategy in the Asia Pacific Region: An Independent Assessment*. Center for Strategic & International Studies. As of Nov. 30, 2015: http://csis.org/files/publication/120814_FINAL_PACOM_optimized.pdf

Boeing. 1998. 'Boeing wins $1.6 billion-dollar contract from DoD's Joint Program Office to act as Lead System Integrator for National Missile Defense Program.' *Boeing News Release*, April 30. As of Nov. 30, 2015: http://boeing.mediaroom.com/1998-04-30-Boeing-Wins-1.6-Billion-Dollar-Contract-From-DoDs-Joint-Program-Office-To-Act-As-Lead-System-Integrator-for-National-Missile-Defense-Program

Boeing. 2012. 'CHAMP – Lights Out.' *Boeing.com*, October 22. As of Nov. 30, 2015: http://www.boeing.com/features/2012/10/bds-champ-10-22-12.page

Brabin-Smith, Richard. 2004. 'Australia and Ballistic Missile Defence: Our Policy Choices.' *ASPI Strategic Insights, 5*. As of Nov. 30, 2015: https://www.aspi.org.au/publications/strategic-insights-5-australia-and-ballistic-missile-defence-our-policy-choices/SI_BMD.pdf

Butler, Amy. 2014. 'Raytheon Eyes Early SM-3 IIA Builds.' *Aviation Week*, March 13. As of Nov. 30, 2015: http://aviationweek.com/defense/raytheon-eyes-early-sm-3-iia-builds

Butler, Amy. 2015. 'MDA plans to build team for Redesigned Kill Vehicle.' *Aviation Week & Space Technology*, February. 5. As of Nov. 30, 2015: http://aviationweek.com/defense/mda-plans-build-team-redesigned-kill-vehicle

Caffrey, Craig. 2015. 'South Korea announces plans to increase defence spending by 7.2% from 2016-20.' *IHS Jane's Defence Weekly*, April 27. As of Nov. 30, 2015: http://www.janes.com/article/50985/south-korea-announces-plans-to-increase-defence-spending-by-7-2-from-2016-20

Campbell, Kurt and Brian Andrews. 2013. *Explaining the US Pivot to Asia*. Chatham House. As of Nov. 30, 2015: https://www.chathamhouse.org/sites/files/chathamhouse/public/Research/Americas/0813pp_pivottoasia.pdf

Carter, Ashton B. 2015. 'Maintaining the Edge in the Age of Everything.' *DefenseOne*, Nov. 2, 2015. As of Nov. 17: http://www.defenseone.com/ideas/2015/11/maintaining-edge-age-everything/123313/

Chang, Jae-soon. 2016. 'U.S. Pacific commander: THAAD talks don't necessarily mean deployment.' *Yonhap News*, Feburary 26. As of Feb. 28, 2016: http://english.yonhapnews.co.kr/national/2016/02/26/21/0301000000AEN20160226001700315F.html

Church, Nathan. 2013. 'Ballistic missile defence and Australia.' *Australian Parliamentary Library, FlagPost*, December 19. As of Nov. 30, 2015: http://www.aph.gov.au/About_Parliament/Parliamentary_Departments/Parliamentary_Library/FlagPost/2013/December/Ballistic_missile_defence_and_Australia

Clements, Richard. 2013. 'Pentagon deploys anti-ballistic missile defense system to Guam while North Korea announces nuclear attack on US.' *The Aviationist*, April 3. As of Nov. 30, 2015: http://theaviationist.com/2013/04/03/thaad-north-korea/

Commander US 7th Fleet. n.d. 'US 7th Fleet Forces.' As of Nov. 30, 2015: http://www.c7f.navy.mil/forces.htm

Congressional Budgetary Office. 2000. *Budgetary and Technical Implications of the Administration's Plan for National Missile Defense*. As of Nov. 30, 2015: https://www.cbo.gov/sites/default/files/106th-congress-1999-2000/reports/nmd.pdf

Corbett, Mike & Paul Zachan. 2010. 'The Role of Airpower in Active Missile Defense.' *Air & Space Power Journal*, Summer. As of Nov. 30, 2015: http://www.airpower.maxwell.af.mil/airchronicles/apj/apj10/sum10/2010-2%20Summer%20English%20ASPJ.pdf

Corbett, Mike & Paul Zachan. 2011. 'The United States Should Develop a Missile Defense System That Builds Confidence.' *Air & Space Power Journal*, Fall. As of Nov. 30, 2015: http://www.airpower.maxwell.af.mil/airchronicles/apj/2011/2011-3/2011_3_08_corbett_zarchan.pdf

Creedon, Madelyn. 2012. *US Ballistic Missile Defense*. http://photos.state.gov/libraries/russia/231771/PDFs/ASD_Creedon_MD_Conference_Remarks.pdf

Cronk, Terry Moon. 2015. 'Work Applauds Defense Funding Agreement.' *US Department of Defense News*, November 3. As of Nov. 17, 2015: http://www.defense.gov/News-Article-View/Article/627554/work-applauds-defense-funding-agreement

Dayley, Brant. 2015. *Next Generation Missile Defense*. Presentation at the 2015 Space & Missile Defense Symposium. As of Nov. 15, 2015: https://smdsymposium.org/wp-content/uploads/2014/04/T5e-NexGen-Panel-Col-Dayley.pdf

Deagal. n.d. ‘FIM-92 Stinger-RMP.’ As of Nov. 15, 2015: http://www.deagel.com/Surface-to-Air-Missiles/FIM-92-Stinger-RMP_a001145002.aspx

Defense Industry Daily. 2015. ‘Japan’s Fleet BMD: Upgrades & UORs.’ *Defense Industry Daily*, Nov. 10. As of Nov. 30, 2015: http://www.defenseindustrydaily.com/up-to-387m-for-japanese-naval-abm-components-0807/

Defense Industry Daily. 2015. ‘Missile Defense: Next Steps for the USA’s GMD.’ *Defense Industry Daily*, June 1. As of Nov. 30, 2015: http://www.defenseindustrydaily.com/3979m-next-step-or-last-step-for-gmd-05229/

DeLuca, Paul et al. 2013. *Assessing Aegis Program Transition to an Open Architecture Model*. Santa Monica, Calif.: RAND Corporation. As of Nov. 30, 2015: http://www.rand.org/content/dam/rand/pubs/research_reports/RR100/RR161/RAND_RR161.pdf

Dong-A Ilbo. 2012. ‘Navy urged to arm Aegis destroyers with better capability.’ *Dong-A Ilbo,* April 24. As of Nov. 30, 2015: http://english.donga.com/srv/service.php3?biid=2012042439578

Donley, Michael B. & Norton A. Schwartz. 2010. *Integrating Air and Missile Defense – Incorporating Ballistic Missile Defense within the Counterair Framework*. The Secretary of the Air Force, Chief of Staff USAF, June.

Dorner, Kenneth R. et al. 2015. ‘Back to the Future – Integrated Air and Missile Defense in the Pacific.’ *Air & Space Power Journal*, January-February. As of Nov. 30, 2015: http://www.airpower.maxwell.af.mil/digital/pdf/articles/2015-Jan-Feb/V-Dorner_Hartman_Teague.pdf

Doubleday, Justin. 2015. ‘Navy looping Joint Strike Fighter into integrated anti-air warfare system.’ *Inside Missile Defense*, December 9.

Dunnigan, James. 2011. ‘SLAMRAAM dies from loneliness.’ *Strategypage.com*, February 5. As of Nov. 30, 2015: https://www.strategypage.com/dls/articles/SLAMRAAM-Dies-From-Loneliness-2-5-2011.asp

Easton, Ian. 2014. *Able Archers – Taiwan Defense Strategy in an Age of Precision Strike*. Project 2049 Institute. As of Nov. 30, 2015: http://www.project2049.net/documents/Easton_Able_Archers_Taiwan_Defense_Strategy.pdf

Eckstein, Megan. 2015. ‘Ingalls Shipbuilding Launches First Ship Since Destroyer Program Restart.’ *USNI News*, March 30. As of Nov. 30, 2015: http://news.usni.org/2015/03/30/ingalls-shipbuilding-launches-first-ship-since-destroyer-program-restart

Ellison, Riki & Ian Williams. 2015. *Japan: Priorities for Missile Defense Development and US Partnership*. Missile Defense Advocacy Alliance, Country Brief. As of Nov. 30, 2015: http://missiledefenseadvocacy.org/wp-content/uploads/2015/04/Japan-BMD-Report.pdf

Freedberg Jr., Sydney J. 2012. ‘Navy Bets On “Baby Steps” To Improve Electronic Warfare; F-35 Jamming Not Enough.’ *Breaking Defense*, December 6. As of Nov. 30, 2015: http://breakingdefense.com/2012/12/navy-bets-on-baby-steps-to-improve-electronic-warfare-f-35-ja/

Freedberg Jr., Sydney. 2014. ‘Army Electronic Warfare “is a Weapon” but Cyber is Sexier.’ *Breaking Defense*, October 16. As of Nov. 30, 2015: http://breakingdefense.com/2014/10/army-electronic-warfare-is-a-weapon-but-cyber-is-sexier/

Freedberg Jr., Sydney J. 2015. ‘Army explores New missile Defense options.’ *Breaking Defense*, February 18. As of Nov. 30, 2015: http://breakingdefense.com/2015/02/army-explores-new-missile-defense-options/

Freedberg Jr., Sydney J. 2015. ‘Army Tests New Missile Defense Brain, IBCS; Navy, MDA Intrigued.’ *BreakingDefense*, June 1. As of Nov. 15, 2015: http://breakingdefense.com/2015/06/army-tests-new-missile-defenses-brain-ibcs-navy-mda-intrigued/

Freedberg Jr., Sydney. 2015. ‘Army’s Electronic Warfare Cupboard Is Bare: No Jammer Until 2023.’ *Breaking Defense*, July 20. As of Nov. 30, 2015: http://breakingdefense.com/2015/07/armys-electronic-warfare-cupboard-is-bare-no-jammer-until-2023/

Freedberg Jr., Sydney. 2015. 'Cyber, EW Are Secret Missile Defense Weapons Too Secret To Use.' *Breaking Defense*, December 4. As of Nov. 30, 2015: http://breakingdefense.com/2015/12/cyber-ew-are-secret-missile-defense-weapons-too-secret-to-use/

Freedberg Jr., Sydney. 2015. 'DoD CIO Says Spectrum May Become Warfighting Domain.' *Breaking Defense*, December 9. As of Nov. 30, 2015: http://breakingdefense.com/2015/12/dod-cio-says-spectrum-may-become-warfighting-domain/

Freedberg, Sydney J. 2015. 'Missile Defense Strategy "Not Sustainable," Salvation lies in R&D.' *Breaking Defense*, June 18. As of Nov. 30, 2015: http://breakingdefense.com/2015/06/missile-defense-strategy-not-sustainable-salvation-lies-in-rd-brig-gen-todorov/

Freedberg Jr. Sydney J. 2015. 'SM-6 Can Now Kill Both Cruise AND Ballistic Missiles.' *Breaking Defense*, August 4. As of Nov. 30, 2015: http://breakingdefense.com/2015/08/sm-6-can-now-kill-both-cruise-and-ballistic-missiles/

Freedberg Jr., Sydney J. 2015. 'Work Elevates Electronic Warfare, Eye on Missile Defense.' *Breaking Defense*, March 17. As of Nov. 30, 2015: http://breakingdefense.com/2015/03/raid-breaker-work-elevates-electronic-warfare-eye-on-missile-defense/

Giangreco, Leigh. 2015. 'Air Force awards High Power Electromagnetics contract to Raytheon.' *Inside Defense*, Daily News, December 31.

Giangreco, Leigh. 2015. 'Air Force expanding space, cyber and ISR work among coalition partners.' *Inside Missile Defense*, November 25.

Gould, Joe. 2015. 'Electronic Warfare: What US Army Can Learn From Ukraine.' *DefenseNews*, August 4. As of November 2015: http://www.defensenews.com/story/defense/policy-budget/warfare/2015/08/02/us-army-ukraine-russia-electronic-warfare/30913397/

Government Accountability Office. 2010. *Defense Acquisitions: Comprehensive Strategy Needed to Improve Ship Cruise Missile Defense*. As of Nov. 30, 2015: http://www.gao.gov/assets/230/229270.pdf

Government Accountability Office. 2011. *Ballistic Missile Defense: Actions Needed to Improve Training Integration and Increase Transparency of Training Resources*. GAO-11-625, July. As of Nov. 30, 2015: http://www.gao.gov/assets/330/321144.pdf

Government Accountability Office. 2012. *Missile Defense – Opportunity Exists to Strengthen Acquisition by Reducing Concurrency*. GAO-12-486, April. As of Nov. 30, 2015: http://gao.gov/assets/600/590277.pdf

Government Accountability Office. 2015. *Missile Defense – Opportunities Exist to Reduce Acquisition Risk and Improve Reporting on System Capabilities*. GAO-15-345, May. As of Nov. 30, 2015: http://www.gao.gov/assets/680/670048.pdf

Government Accountability Office. 2016. *Assessment of DOD's Reports on Status of Efforts and Options for Improving Homeland Missile Defense*. GAO-16-245R, February 17. As of Feb. 28, 2016: http://www.gao.gov/assets/680/675263.pdf

GPS.gov. n.d. 'GPS Modernization.' As of Nov. 30, 2015: http://www.gps.gov/systems/gps/modernization/

Hamilton, John A. 2015. 'Japanese Test Engages Supersonic Target on WSMR.' *Army.mil*, November 5. As of Nov. 30, 2015: http://www.army.mil/article/158283/Japanese_Test_Engages_Supersonic_Target_on_WSMR/

Hamilton, John A. 2015. 'New air defense system under development being tested at White Sands Missile Range.' *Army.mil*, May 22. As of Nov. 30, 2015: http://www.army.mil/article/149083/New_air_defense_system_under_development_being_tested_at_White_Sands_Missile_Range/

Hammonds, Stephen L. 2014. *MEADS: A Case Study*. Alabama, Huntsville: Defense Acquisition University. As of Nov. 15, 2015: https://acc.dau.mil/adl/en-US/708668/file/77541/ MEADS -- DAU Research Paper (Hammonds) - May 2014.pdf

Hardy, James. 2015. 'DSCA notification sheds light on next-gen Japanese destroyers.' *IHS Jane's Defence Weekly*, August 11. As of Nov. 30, 2015: http://www.janes.com/article/53567/dsca-notification-sheds-light-on-next-gen-japanese-destroyers

Harper, Jon. 2014. 'OPCON transfer, US troop redeployment in Korea postponed indefinitely.' *Stars and Stripes*, October 23. As of Nov. 30, 2015: http://www.stripes.com/news/pacific/korea/opcon-transfer-us-troop-redeployment-in-korea-postponed-indefinitely-1.309960

Harrell, Casey. 2011. 'Senior commander visits 35th ADA Brigade for UFG.' *Army.mil*, August 30. As of Nov. 30, 2015: http://www.army.mil/article/64504

Heginbotham, Eric et al. 2015. *The US-China Military Scorecard – Forces, Geography, and the Evolving Balance of Power 1996-2017*. Calif., Santa Monica: RAND Corporation, RR-392-AF. As of Nov. 17, 2015: http://www.rand.org/content/dam/rand/pubs/research_reports/RR300/RR392/RAND_RR392.pdf

Hildreth, Steven A. 1992. *Evaluation of US Army Assessment of Patriot Antitactical Missile Effectiveness in the War against Iraq*. Congressional Research Service, report prepared for the House Government Operations Subcommittee on Legislation and National Security. As of Nov. 30, 2015: http://fas.org/spp/starwars/congress/1992_h/h920407h.htm

Horn, Joe. 2010. 'Aegis Ballistic Missile Defense.' Aegis BMD Overview to the National Defense Industrial Association, July 13. As of Nov. 30, 2015: http://www.ndia.org/resources/onlineproceedings/documents/0100/0100-aegisbmdoverview-rdmlhorn.pdf

Howard, Terrence. 2015. *PEO Missiles and Space*. CMDS Overview to Space and Missile Defense Working Group, January 28. As of Nov. 30, 2015: http://ndiatvc.org/images/downloads/SMDWG_Jan_15/cmds_overview_to_2015_meeting_of_the_ndia_smd_wg.pdf

IHS Jane's. 2015. 'Patriot PAC-3.' *Land Warfare Platforms: Artillery & Air Defence*, May 19.

IHS Jane's. n.d. 'Beneath the skin: US Navy DDG 51 Flight III guided missile destroyer.' *IHS Jane's Defence Weekly*. As of Nov. 30, 2015: http://www.janes360.com/images/assets/731/51731/US_Navy_DDG_51_Flight_III_guided_missile_destroyer.pdf

InsideDefense. 2015. 'Air Force Science Board Takes Fast Track On Laser Study.' *Inside Missile Defense*, October 13.

InsideDefense. 2015. 'DDG-51 Flight III Fleet, including new radar, estimated to cost $56B.' *Inside Missile Defense*, Vol. 21, No. 16.

InsideDefense. 2015. 'State Department OKs sale of Aegis systems for new Japanese ships.' *Inside Missile Defense*, Vol. 21, No. 17.

Japanese Ministry of Defense. n.d. '予算等の概要(Defense Budget Overview).' As of Nov. 30, 2015: http://www.mod.go.jp/j/yosan/yosan.html

Japanese Ministry of Defense. n.d. 'Department of Guided Weapon Systems Development – Improved Type 03 Medium-range Surface-to-Air Missile (Chu-SAM(KAI)).' *Technical Research & Development Institute*. As of Nov. 30, 2015: http://www.mod.go.jp/trdi/en/research/gijutu_yudo_en.html

Japanese Ministry of Defense. 2010. *Japan's BMD*. As of Nov. 30, 2015: http://www.mod.go.jp/e/d_act/bmd/bmd.pdf

Japanese Ministry of Defense. 2012. 'Japan's BMD System.' *Japan Defense Focus*, No. 31. As of Nov. 30, 2015: http://www.mod.go.jp/e/jdf/pdf/jdf_no31.pdf

Japanese Ministry of Defense. 2015. *Defense of Japan 2015*. As of Nov. 30, 2015: http://www.mod.go.jp/e/publ/w_paper/2015.html

Japanese Ministry of Defense. 2015. *Defense Programs and Budget of Japan: Overview of FY2016 Budget Request*. As of Nov. 30, 2015: http://www.mod.go.jp/e/d_budget/pdf/271016.pdf

Japanese Ministry of Defense. 2015. 'Extra Press Conference by the Defense Minister Nakatani.' *MoD Press Conference*, November 24. As of Nov. 30, 2015: http://www.mod.go.jp/e/pressconf/2015/11/151124a.html

Japanese Ministry of Defense. 2015. *The Guidelines for Japan-US Defense Cooperation*. As of Nov. 30, 2015:http://www.mod.go.jp/e/d_act/anpo/pdf/shishin_20150427e.pdf

Joint Chiefs of Staff. 2013. *Joint Integrated Air and Missile Defense: Vision 2020*. As of Nov. 21, 2015: http://www.jcs.mil/Portals/36/Documents/Publications/JointIAMDVision2020.pdf

Judson, Jen. 2015. 'DoD Officials Near Decision on Future of Patriot Missile System.' *Defense News*, November 13. As of Nov. 30, 2015: http://www.defensenews.com/story/defense/land/weapons/2015/11/13/key-dod-officials-nearing-decision-on-future-of-patriot-missile-defense-system/75722406/

Judson, Jen. 2016. 'After Blimp's Wild Ride, JLENS Program Will Fly Again.' *Defense News*, February 11. As of Feb. 28, 2016: http://www.defensenews.com/story/breaking-news/2016/02/11/runaway-blimp-jlens-program-fly-again-norad/80241204/

Kahn, Herman. 1960. *The Nature and Feasibility of War and Deterrence*. Santa Monica, California: RAND Corporation.

Kahn, Herman. 1965. *On Escalation: Metaphors and Scenarios*. New York: Praeger

Kan, Shirley A. 2014. *Taiwan: Major US Arms Sales since 1990*. Congressional Research Service, August 29. As of Nov. 30, 2015: https://www.fas.org/sgp/crs/weapons/RL30957.pdf

Kang, Choi & Kim Gi Bum. 2014. *Breaking the Myth of Missile Defense*. The Asan Institute for Policy Studies, Issue Brief, August 8. As of Nov. 30, 2015: http://en.asaninst.org/contents/breaking-the-myth-of-missile-defense/

Kilby, Jim. 2014. 'Surface Warfare: Lynchpin of Naval Integrated Air/Missile Defense.' *Center for International Maritime Security*, April 4. As of Nov. 30, 2015: http://cimsec.org/surface-warfare-lynchpin-naval-integrated-airmissile-defense/10748

Kim, Sarah. 2015. 'Korean-made missiles to replace aging Hawks.' *Korea Joongang Daily*, July 31. As of Nov. 30, 2015: http://koreajoongangdaily.joins.com/news/article/article.aspx?aid=3007277

Kunsan Air Base. 2013. 'Alpha Battery, 2nd Battalion, 1st Air Defense Artillery.' *Kunsan.af.mil*, April 23. As of Nov. 30, 2015: http://www.kunsan.af.mil/AboutUs/FactSheets/tabid/1943/Article/412719/alpha-battery-2nd-battalion-1st-air-defense-artillery.aspx

LaGrone, Sam. 2009. 'Fighters eyed for ballistic missile defense.' *Air Force Times*, June 16. As of Nov. 30, 2015: http://archive.airforcetimes.com/article/20090616/NEWS/906160350/Fighters-eyed-ballistic-missile-defense;

LaGrone, Sam. 2015. 'Navy Again Reduces Scope of Destroyer Modernization, 5 Ships Won't Receive Any Ballistic Missile Defense Upgrades.' *USNI News*, March 3. As of Nov. 30, 2015: http://news.usni.org/2015/03/03/navy-again-reduces-scope-of-destroyer-modernization-5-ships-wont-receive-any-ballistic-missile-defense-upgrades

Libicki, Martin C. 2009. *Cyberdeterrence and Cyberwar*. Santa Monica, Calif.: RAND Corporation. As of Nov. 30, 2015: http://www.rand.org/content/dam/rand/pubs/monographs/2009/RAND_MG877.pdf

Lockheed Martin. 2011. 'Lockheed Martin Conducts Successful PAC-3 Missile Test at White Sands Missile Range.' *Lockheedmartin.com*, November 1. As of Nov. 30, 2015: http://www.lockheedmartin.com/us/news/press-releases/2011/november/LMConductsSuccessfulPac-3.html

Lu, H.H. & Lillian Lin. 2015. 'MND reports China deploying more missiles against Taiwan.' *Focus Taiwan*, August 31. As of Nov. 30, 2015: http://focustaiwan.tw/news/acs/201508310032.aspx

Malenic, Marina. 2015. 'US approves E-2D sale to Japan.' *IHS Jane's Defence Weekly*, June 2. As of Nov. 30, 2015: http://www.janes.com/article/51957/us-approves-e-2d-sale-to-japan

Malyasov, Dylan. 2015. 'Cheolmae II missile was successfully tested in South Korea is expected to mass production.' *Defence-blog.com*, July 30. As of Feb. 28, 2016: http://defence-blog.com/news/cheolmae-ii-missile-was-successfully-tested-in-south-korea-is-expected-to-mass-production.html

Martinage, Robert. 2014. *Toward a New Offset Strategy – Exploiting U.S. Long-Term Advantages to Restore U.S. Global Power Projection Capability*. Center for Strategic and Budgetary Assessments, October 27. As of Nov. 30, 2015: http://csbaonline.org/wp-content/uploads/2014/10/Offset-Strategy-Web.pdf

McCarthy, Christopher J. 2010. *Anti-Access/Area Denial: The Evolution of Modern Warfare*. US Naval War College: Luce.nt. As of Nov. 17, 2015: https://www.usnwc.edu/Lucent/OpenPdf.aspx?id=95

McConnell, Jeffrey H. 2013. *Naval Integrated Fire Control–Counter Air Capability- Based System of Systems Engineering*. As of Nov. 30, 2015: http://www.acq.osd.mil/se/webinars/2013_11_14-SOSECIE-McConnell-brief.pdf

MEADS. n.d. 'About MEADS .' As of Nov. 30, 2015: http://meads-amd.com/about-meads/

Mearsheimer, John. 2013. *The Rise of China and the Decline of the US Army*. Army War College, 24th Strategy Conference, April 10. As of Nov. 30, 2015: http://mearsheimer.uchicago.edu/pdfs/Future%20of%20the%20Army%20Transcript.pdf

Menzies, Kimberly. 2015. '94th AAMDC THAAD Battery in Guam transfers authority to its sister unit.' *Army.mil*, March 5. As of Nov. 30, 2015: http://www.army.mil/article/143951/94th_AAMDC_THAAD_Battery_in_Guam_transfers_authority_to_its_sister_unit/?from=RSS

Ministry of National Defense of the People's Republic of China. 2016. 'Defense Ministry's regular press conference on Feb.25.' As of Feb. 28, 2016: http://eng.mod.gov.cn/DefenseNews/2016-02/25/content_4644802.htm

Minnick, Wendell. 2013. 'Taiwan's BMD Radar Gives Unique Data on China.' *Defense News*, November 26. As of Nov. 30, 2015: http://archive.defensenews.com/article/20131126/DEFREG03/311260013/Taiwan-s-BMD-Radar-Gives-Unique-Data-China

Minnick, Wendell. 2014. 'US Might Tap Into Taiwan Early Warning Radar.' *Defense News*, May 8. As of Nov. 30, 2015: http://archive.defensenews.com/article/20140508/DEFREG03/305080026/US-Might-Tap-Into-Taiwan-Early-Warning-Radar

Miwa, Sachiko. 2015. 'Defense ministry eyes more power for SDF officers.' *Asahi Shimbun*, February 4. As of Nov. 30, 2015: http://ajw.asahi.com/article/behind_news/politics/AJ201502240049

Montague, Karen. 2014. *A Review of South Korean Missile Defense Programs*. George C. Marshall Institute, Policy Outlook. As of Nov. 30, 2015: http://marshall.org/wp-content/uploads/2014/03/South-Korean-BMD-Mar-14.pdf

Navy Recognition. 2015. Japan 'Defense Ministry Unveiled Details of "27DD" Class Railgun & Laser armed AEGIS Destroyer.' *Navy Recognition*, July 22. As of Nov. 30, 2015: http://www.navyrecognition.com/index.php?option=com_content&task=view&id=2925

Northrop Grumman. 2015. ‘Northrop Grumman, US Army Prove Sensors and Shooters as Network Components With Missile Defense Flight Test Intercept.’ *Northrop Grumman*, News Release, Nov. 16. As of Nov. 30, 2015: http://www.globenewswire.com/newsarchive/noc/press/pages/news_releases.html?d=10156393

O’Connor, Sean. 2015. ’China’s ICBM modernization alters threat profile.’ *IHS Jane’s Intelligence Review*.

Odierno, Raymond T. & Jonathan W. Greenert. 2014. *Memorandum for Secretary of Defense - Subject: Adjusting the Ballistic Missile Defense Strategy*. As of Nov. 21, 2015: http://news.usni.org/2015/03/19/document-army-navy-memo-on-need-for-ballistic-missile-defense-strategy

Office of Air Force Lessons Learned & 7th Air Force. 2010. *A Look at Integrated Air and Missile Defense*. Lessons Learned Report. As of Nov. 30, 2015: https://info.publicintelligence.net/USAFmissiledefense.pdf

Office of the Deputy Secretary of Defense – Systems Engineering. n.d. ‘Initiatives – Open Systems Architecture (OSA).’ As of Nov. 30, 2015: http://www.acq.osd.mil/se/initiatives/init_osa.html

Office of the US Army Deputy Chief of Staff. 2015. *Army Equipment Program in support of the President’s Budget 2016*. As of Nov. 15, 2015: http://www.g8.army.mil/pdf/Army_Equipment_Program2016.pdf

Opall-Rome, Barbara. 2014. Israel Air Force Hones Patriot Batteries for UAV Defense. *DefenseNews*, Nov. 16. As of Nov. 15, 2015: http://www.defensenews.com/article/20141116/DEFREG04/311160018/Israel-Air-Force-Hones-Patriot-Batteries-UAV-Defense

O'Rourke, Ronald. 2015. *Navy Aegis Ballistic Missile Defense (BMD) Program: Background and Issues for Congress.* As of Nov. 30, 2015: https://www.fas.org/sgp/crs/weapons/RL33745.pdf

O'Rourke, Ronald. 2015. *Navy DDG-51 and DDG-1000 Destroyer Programs: Background and Issues for Congress*. Congressional Research Service, RL32109. As of Nov. 30, 2015: https://www.fas.org/sgp/crs/weapons/RL32109.pdf

Pacific Air Forces. 2014. ‘PACAF established Pacific IAMD Center. *Pacific Air Forces*, November 14. As of Nov. 30, 2015: http://www.pacaf.af.mil/News/ArticleDisplay/tabid/377/Article/591097/pacaf-establishes-pacific-iamd-center.aspx

Pearson, James. 2015. ‘North Korea test-fires new anti-ship cruise missile.’ *Reuters*, February 5. As of Nov. 30, 2015: http://www.reuters.com/article/northkorea-missile-idUSL4N0VH02620150207

Peniston, Bradley. 2014. ‘Air Force expects to test counter-electronics missile in 2016.’ *Air Force Times*, September 16. As of Nov. 30, 2015: http://archive.airforcetimes.com/article/20140916/NEWS04/309160056/Air-Force-expects-test-counter-electronics-missile-2016

Perrett, Bradley. 2015. ‘Korean SAM Improvement to Counter Tactical Ballistic Threats.’ *Aviation Week*, November 5. As of Nov. 30, 2015: http://aviationweek.com/defense/korean-sam-improvement-counter-tactical-ballistic-threats

Pittaway, Nigel. 2014. ‘Australia To Renew Ground-based Air Defense Capability.’ *Defense News*, July 27. As of Nov. 30, 2015: http://archive.defensenews.com/article/20140727/DEFREG03/307270016/Australia-Renew-Ground-based-Air-Defense-Capability

PRNewswire. 2014. SM-6 destroys longest range cruise missile target to date.’ *Missilethreat.com*, July 15. As of Nov. 30, 2015: http://missilethreat.com/sm-6-destroys-longest-range-cruise-missile-target-to-date/

Raytheon. 2015. ‘Raytheon air-to-air missile scores direct hit from U.S. Army ground launcher.’ *PRNewswire*, August 26. As of Nov. 30, 2015: http://www.prnewswire.com/news-releases/raytheon-air-to-air-missile-scores-direct-hit-from-us-army-ground-launcher-300133091.html

Raytheon. 2015. ‘Raytheon completes lab testing on AMRAAM-ER, NASAMS integration.’ *PRNewswire*, June 10. As of Nov. 30, 2015: http://raytheon.mediaroom.com/2015-06-10-Raytheon-completes-lab-testing-on-AMRAAM-ER-NASAMS-integration

Raytheon. n.d. ‘Air and Missile Defense Radar (AMDR).’ As of Nov. 30, 2015: http://www.raytheon.com/capabilities/products/amdr/

Raytheon. n.d. ‘Army Navy/Transportable Radar Surveillance (AN/TPY-2) – Countering the growing ballistic missile threat.’ As of Nov. 12, 2015: http://www.raytheon.com/capabilities/products/antpy2/

Raytheon. n.d. ‘Global Patriot Solutions.’ As of Nov. 30, 2015: http://www.raytheon.com/capabilities/products/patriot/

Raytheon. n.d. ‘Kill Vehicles.’ As of Nov. 30, 2015: http://www.raytheon.com/capabilities/products/ekv/

Reif, Kingston. 2015. ‘Missile defense cost rise amid concerns.’ *Arms Control Today*, April. As of Nov. 20, 2015: https://www.armscontrol.org/ACT/2015_04/News/Missile-Defense-Cost-Rises-Amid-Concerns

Richardson, Doug. 2012. ‘JLENS guides SM-6 against a cruise missile target.’ *IHS Jane’s Missiles & Rockets*, September 26.

Rinehart, Ian E. 2013. *Collective Self-Defense and US-Japan Security Cooperation*. East-West Center: Politics, Governance, and Security Series, No. 24. As of Nov. 30, 2015: http://www.eastwestcenter.org/sites/default/files/private/pswp024.pdf

Rinehart, Ian et al. 2015. *Ballistic Missile Defense in the Asia-Pacific Region: Cooperation and Opposition*. Congressional Research Service, April 3. As of Nov. 30, 2015: https://www.fas.org/sgp/crs/nuke/R43116.pdf

Riqiang, Wu. 2014. ‘No stability without limits on missile defense.’ *Bulletin of the Atomic Scientists*, Roundtable, September 24.

Riqiang, Wu. 2015. ‘Limit missile defense – or expand it.’ *Bulletin of the Atomic Scientists*, Vol. 71(2) 9-12.

Rosenbaum, David E. 1991. ‘US to Pull A-Bombs From South Korea.’ *New York Times*, October 20. As of Nov. 30, 2015: http://www.nytimes.com/1991/10/20/world/us-to-pull-a-bombs-from-south-korea.html

Rusten, Lynn R. 2010. *U.S. Withdrawal from the Antiballistic Missile Treaty*. National Defense University: Center for the Study of Weapons of Mass Destruction. As of Nov. 14, 2015: http://ndupress.ndu.edu/Portals/68/Documents/casestudies/CSWMD_CaseStudy-2.pdf

Sang-ho, Song. 2014. ‘Korea, US talk missile defense cooperation.’ *Korean Herald*, March 27. As of Nov. 30, 2015: http://www.koreaherald.com/view.php?ud=20150327000977

Sankaran, Jaganath & Bryan L. Fearey. 2015. *Deterring North Korea: An Examination of the East Asian Missile Defense Architecture*. CSIS – Project on Nuclear Issues (PONI) Conference, June 23-24. As of Nov. 30, 2015: http://csis.org/images/stories/poni/150702_SANKARAN.pdf

Schwartz. Paul N. 2015. *U.S. Navy Deploying New Measures to Counter Russian Cruise Missile Threat*. Center for Strategic and International Studies, Russian Defense and High Technology Project. As of Nov. 30, 2015: http://csis.org/files/publication/150311_russian_cruise_missiles.pdf

Shahal, Andrea. 2015. ‘Pentagon plans hard look at missile defense programs.’ *Reuters*, March 17. As of Nov. 20, 2015: http://www.reuters.com/article/2015/03/18/us-usa-military-missiledefense-idUSKBN0ME0AD20150318

Sharp, Walter. 2013. *OPCON Transition in Korea*. CSIS, Korea Chair Platform, December 2. As of Nov. 30, 2015: http://csis.org/files/publication/131216_OPCON_Transition_in_Korea.pdf

Schelling, Thomas. 1960. *The Strategy of Conflict*. Oxford: Oxford University Press

Song, Sang-ho. 2014. ‘Korea, US talk missile defense cooperation.’ *Korean Herald*, March 27. As of Nov. 30, 2015: http://www.koreaherald.com/view.php?ud=20150327000977

Song, Sang-Ho. 2015. ‘N.K. rocket threats escalate.’ *Korea Herald*, July 26. As of Nov. 30, 2015: www.koreaherald.com/view.php?ud=20150726000314

South Korean Ministry of Defense. *2014 Defense White Paper*. As of Nov. 30, 2015: http://www.mnd.go.kr/user/mnd_eng/upload/pblictn/PBLICTNEBOOK_201506161152304650.pdf

Sydney, Julian Kerr. 2015. ‘Australia releases RfI for next-generation air-defence system.’ *IHS Jane’s Defence Industry*, June 28. As of Nov. 30, 2015: http://www.janes.com/article/52618/australia-releases-rfi-for-next-generation-air-defence-system

Syring, James. D. 2015. *Vice Admiral J.D. Syring, USN, Director, Missile Defense Agency - Before the Senate Appropriations Committee Subcommittee on Defense*. As of Nov. 30, 2015: http://www.mda.mil/global/documents/pdf/ps_syring_031815_sacd.pdf

Taiwanese Ministry of National Defense. n.d. ‘Major Weapon Systems of the ROC Armed Forces.’ As of Nov. 30, 2015: https://www.mnd.gov.tw/english/Publish.aspx?cnid=504

Thornton, Marsha. 2015. *MDA Acquisition Overview*. Missile Defense Agency, August 13. As of Nov. 30, 2015: http://www.mda.mil/global/documents/pdf/osbp_15conf_Thornton_Overview1.pdf

Tien-pin, Lo & Jason Pan. 2015. ‘Taiwan to test-fire PAC-3 missile in US.’ *Taipei Times*, September 4. As of Nov. 30, 2015: http://www.taipeitimes.com/News/taiwan/archives/2015/09/04/2003626910

Trexel, Jonathan. 2015. *Missile Defense & Deterrence*. Presentation at the 18th Annual Space and Missile Defense Symposium , August 11, Slide 13. As of Nov. 30, 2015: https://smdsymposium.org/wp-content/uploads/2015/08/T5a-Dr.-Jonathan-Trexel.pdf

Tsang, Steve. 2012. ‘The US Military and American Commitment to Taiwan’s Security.’ *Asian Survey*, Vol. 52, No. 4.

Union of Concerned Scientists. n.d. *The Troubled Kill Vehicle in U.S. National Missile Defenses*. As of Nov. 30, 2015: http://www.ucsusa.org/sites/default/files/legacy/assets/documents/nwgs/missile-defense-kill-vehicle.pdf

US Army Research Laboratory. n.d. ‘Electronic Warfare.’ As of Nov. 30, 2015: http://www.arl.army.mil/www/default.cfm?page=2642

US Congress. 1999. *National Missile Defense Act of 1999*. Public Law 106-38, 106th Congress. As of Nov. 12, 2015: https://www.congress.gov/106/plaws/publ38/PLAW-106publ38.pdf

US Department of Defense. 2009. *Directive 5134.09 – Missile Defense Agency (MDA)*. As of Nov. 12, 2015: http://www.dtic.mil/whs/directives/corres/pdf/513409p.pdf

US Department of Defense. 2010. ‘Australia – SM-2 Block IIIB STANDARD Missiles.’ *Defense Security Cooperation Agency*, October 26. As of Nov. 30, 2015: http://www.dsca.mil/major-arms-sales/australia-sm-2-block-iiib-standard-missiles

US Department of Defense. 2010. *Ballistic Missile Defense Review Report*. As of Nov. 12, 2015: http://www.defense.gov/Portals/1/features/defenseReviews/BMDR/BMDR_as_of_26JAN10_0630_for_web.pdf

US Department of Defense. 2010. *Directive 5100.01 – Functions of the Department of Defense and its Major Components*. As of Nov. 30, 2015: http://www.dtic.mil/whs/directives/corres/pdf/510001p.pdf

US Department of Defense. 2010. *Nuclear Posture Review Report*. As of Nov. 30, 2015: http://www.defense.gov/Portals/1/features/defenseReviews/NPR/2010_Nuclear_Posture_Review_Report.pdf

US Department of Defense. 2012. ‘36(b)(1) Arms Sales Notification.’ *Federal Register*, Volume 77, Number 246. As of Nov. 30, 2015: https://www.gpo.gov/fdsys/pkg/FR-2012-12-21/html/2012-30810.htm

US Department of Defense. 2013. *Electromagnetic Spectrum Strategy – A Call to Action*. As of Nov. 30, 2015: http://www.defenseinnovationmarketplace.mil/resources/dodspectrumstrategy.pdf

US Department of Defense. 2014. *Quadrennial Defense Review 2014*. As of Nov. 17, 2015: http://www.defense.gov/Portals/1/features/defenseReviews/QDR/2014_Quadrennial_Defense_Review.pdf

US Department of Defense – Inspector General. 2014. *Exoatmospheric Kill Vehicle Quality Assurance and Reliability Assessment – Part A*. DODIG-2014-111, September 8. As of November 2015: http://www.dodig.mil/pubs/documents/DODIG-2014-111.pdf

US Department of Defense - Office of the Director, Operational Test and Evaluation. 2014. *FY2014 Annual Report*. As of Nov. 30, 2015: http://www.dote.osd.mil/pub/reports/FY2013/pdf/bmds/2013gmd.pdf

US Department of Defense. 2015. *Annual Report to Congress – Military and Security Developments Involving the People's Republic of China 2015*. As of Nov. 17, 2015: http://www.defense.gov/pubs/2015_China_Military_Power_Report.pdf

US Department of Defense. 2015. *Asia-Pacific Maritime Security Strategy*. As of Nov. 30, 2015: http://www.defense.gov/Portals/1/Documents/pubs/NDAA%20A-P_Maritime_SecuritY_Strategy-08142015-1300-FINALFORMAT.PDF

US Department of Defense. 2015. 'Department of Defense Identifies Planned Site of Future Long Range Discrimination Radar (LRDR).' *DoD Press Operations*, May 22. As of Nov. 30, 2015: http://www.defense.gov/News/News-Releases/News-Release-View/Article/605521

US Department of Defense. 2015. *Deputy Secretary of Defense Speech – McAleese/Credit Suisse Defense Programs Conference, March 17*. As of Nov. 30, 2015: http://www.defense.gov/News/Speeches/Speech-View/Article/606653/mcaleesecredit-suisse-defense-programs-conference

US Department of Defense. 2015. *Fiscal Year (FY) 2016 President's Budget Submission - Army*. Justification Book of Missile Procurement. As of Nov. 15, 2015: http://asafm.army.mil/Documents/OfficeDocuments/Budget/budgetmaterials/fy16/pforms/missiles.pdf

US Department of Defense. 2015. *Fiscal Year (FY) 2016 President's Budget Submission – Missile Defense Agency, Defense Wide Justification Book Volume 2a of 2*. As of Nov. 30, 2015: http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2016/budget_justification/pdfs/03_RDT_and_E/MDA_RDTE_MasterJustificationBook_Missile_Defense_Agency_PB_2016_1.pdf

US Department of the Navy. n.d. 'CEC - Cooperative Engagement Capability.' *Navy.mil*, Fact Sheet. As of Nov. 30, 2015: http://www.navy.mil/navydata/fact_display.asp?cid=2100&tid=325&ct=2

US Department of the Navy. 2015. 'DDG 51 Modernization Program Meets Key Milestones.' *Public affairs*, February 27. As of Nov. 30, 2015: http://www.navy.mil/submit/display.asp?story_id=85018

US Department of the Navy. n.d. 'Aegis Weapon System.' *Navy.mil*, Fact Sheet. http://www.navy.mil/navydata/fact_display.asp?cid=2100&tid=200&ct=2

US House of Representatives. 2013. *National Defense Authorization Act for Fiscal Year 2014 – Report of the Committee on Armed Services*. 113th Congress, Report 113-102. As of Nov. 15, 2015: http://www.gpo.gov/fdsys/pkg/CRPT-113hrpt102/pdf/CRPT-113hrpt102.pdf

US Joint Chiefs of Staff. 2012. *Countering Air and Missile Threats*. Joint Publication 3-01. As of Nov. 8, 2015: http://www.dtic.mil/doctrine/new_pubs/jp3_01.pdf

US Joint Chiefs of Staff. 2013. *Joint Integrated Air and Missile Defense: Vision 2020*. As of Nov. 21, 2015: http://www.jcs.mil/Portals/36/Documents/Publications/JointIAMDVision2020.pdf

US Missile Defense Agency. n.d. 'A system of elements.' As of Nov. 30, 2015: http://www.mda.mil/system/elements.html

US Missile Defense Agency. n.d. 'Budget information.' As of Nov. 30, 2015: http://www.mda.mil/news/budget_information.html

US Missile Defense Agency. n.d. 'System.' As of Nov. 30, 2015: http://www.mda.mil/system/system.html

US Missile Defense Agency. n.d. 'THAAD.' As of Nov. 30, 2015: http://www.mda.mil/system/thaad.html

US Missile Defense Agency. n.d. 'The Threat – Technology Transfer.' As of Nov. 12, 2015: http://www.mda.mil/system/threat.html

US Missile Defense Agency. 2015. *Ballistic Missile Defense Intercept Flight Test Record*. Fact Sheet, December 10. As of Nov. 30, 2015: http://www.mda.mil/global/documents/pdf/testrecord.pdf

US Missile Defense Agency. 2015. *Overview - Fiscal Year 2016 Budget Estimates*. 15-MDA-8100, January 26. As of Nov. 30, 2015: http://www.mda.mil/global/documents/pdf/budgetfy16.pdf

US Navy - Personnel Command. n.d. ' New Ships.' As of Nov. 30, 2015: http://www.public.navy.mil/bupers-npc/enlisted/detailing/seaspecial/NewShips/Pages/default.aspx

Vick, Alan J. 2015. *Air Base Attacks and Defensive Counters – Historical Lessons and Future Challenges*. Santa Monica, Calif.: RAND Corporation. As of Nov. 30, 2015: http://www.rand.org/content/dam/rand/pubs/research_reports/RR900/RR968/RAND_RR968.pdf

Wasserbly, Daniel. 2015. 'Next-generation SM-3 missile interceptor takes first flight.' *IHS Jane's Defence Weekly*, June 8. As of November 2015: http://www.janes.com/article/52093/next-generation-sm-3-missile-interceptor-takes-first-flight

Weaponssystems.net. n.d. 'Chu-SAM.' As of Nov. 30, 2015: http://weaponsystems.net/weaponsystem/EE04%20-%20Chu-SAM.html

Welch, Larry & David Briggs. 2008. *Study on the Mission, Roles, and Structure of the Missile Defense Agency (MDA)*. Institute for Defense Analyses, IDA Paper P-4374.

White House. 'Fact Sheet: The United States and Australia: An Alliance for the Future.' *Office of the Press Secretary*, June 12. As of Nov. 30, 2015; https://www.whitehouse.gov/the-press-office/2014/06/12/fact-sheet-united-states-and-australia-alliance-future

Work, Bob. 2015. 'Closing Keynote: Managing the Age of Everything.' *DefenseOne Summit 2015*. As of Nov. 22, 2015: http://www.defenseone.com/ideas/2015/11/defense-one-summit-2015-age-everything/123168/

Wydler, Virginia L. 2014. *Gaining Leverage over Vendor Lock to Improve Acquisition Performance and Cost Efficiencies*. The MITRE Corporation, Technical Papers. As of November 2015: http://www.mitre.org/sites/default/files/publications/gaining-leverage-over-vendor-lock-14-1262.pdf

Yamaguchi, Mai. 2014. *Japan's BMD Update*. Japanese Ministry of Defense, Defense Policy Bureau. As of Nov. 30, 2015: http://www.slideshare.net/RUSIEVENTS/ms-mai-yaguchi

Yonhap. 2012. 'S. Korea to deploy newly introduced radar ahead of N. Korea rocket launch.' *Yonhap News*, December 5. As of Nov. 30, 2015: http://english.yonhapnews.co.kr/national/2012/12/05/51/0301000000AEN20121205002700315F.HTML

Yonhap. 2014. 'Acquiring SM-3 missiles not an option for S. Korea: defense ministry.' *Yonhap News*, May 26. As of Nov. 30, 2015: http://english.yonhapnews.co.kr/national/2014/05/26/32/0301000000AEN20140526006400315F.html

Yonhap. 2014. 'US mulls deploying MD system in S. Korea: USFK chief.' *Yonhap News*, June 3. As of Nov. 30, 2015: http://english.yonhapnews.co.kr/news/2014/06/03/86/0200000000AEN20140603002252315F.html

Yoshida, Reiji & Mizuho Aoki. 2015. 'Diet enacts security laws, marking Japan's departure from pacifism.' *Asahi Shimbun*, September 19. As of Nov. 30, 2015: http://www.japantimes.co.jp/news/2015/09/19/national/politics-diplomacy/diet-enacts-security-laws-marking-japans-departure-from-pacifism-2/

APPENDIX C

About the Author

Stefan Soesanto (DEU) was a research assistant at RAND Europe Brussels office, and has served in the European Parliament as a GPF trainee in the Group of the Progressive Alliance of Socialists and Democrats (S&D). Prior to his pivot back to Europe, Stefan was a research intern at the Asan Institute for Policy Studies while concurrently working as a remote analyst for the Hudson Institute. He holds an MA from Yonsei University (Korea) with a focus on security policies, international law, and humanitarian aid, and a BA from the Ruhr-University (Germany) in political science and Japanese. Among others, his writings have been published in the *NATO Review*, the *Straits Times*, the *South China Morning Post*, the *Diplomat*, the *JoongAng Ilbo*, and the *Hill*.