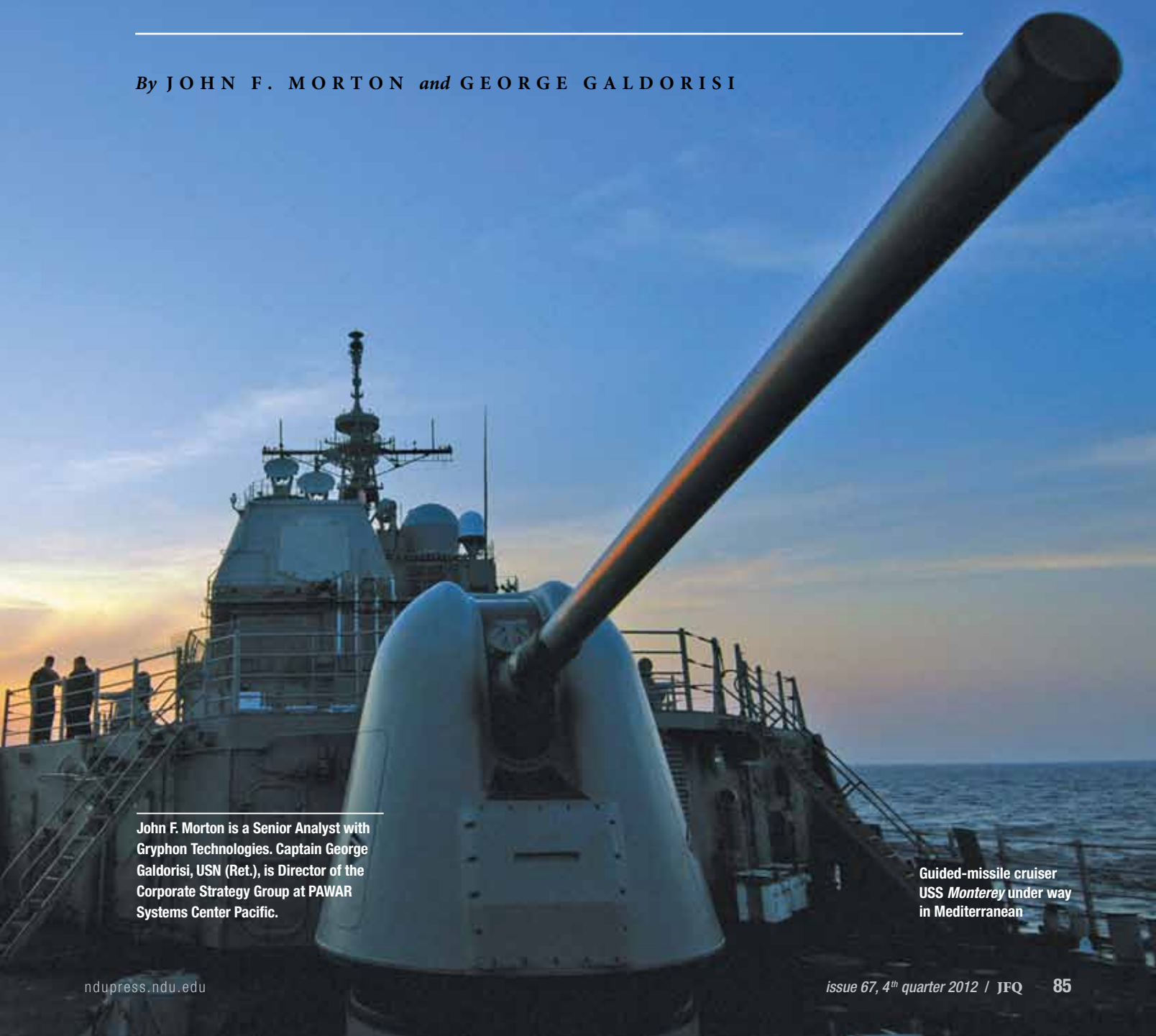
ANY SENSOR, ANY SHOOTER

Toward an Aegis BMD Global Enterprise

By JOHN F. MORTON *and* GEORGE GALDORISI



U.S. Navy (Daniel Viramontes)

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Guided-missile cruiser USS *Monterey* under way in Mediterranean

The Aegis ballistic missile defense (BMD) system aboard the USS *Ticonderoga* (CG-47) guided-missile cruisers and *Arleigh Burke* (DDG-51) guided-missile destroyers has become a primary high-end enabler for U.S., allied, and partner maritime forces as they execute the full range of operational tasks in regions where threat vectors are accelerating and proliferating. Warship-focused Aegis BMD and its foundation, the Aegis Combat System, serve as the flexible and adaptive capability to provide "regionally concentrated, credible combat power," as articulated in the national maritime strategy.[1]

Ballistic missile defense is a mission that involves all the Services, and regional BMD is a mission that increasingly supports the U.S. geographic combatant commanders. Aegis BMD is only one component of the larger national ballistic missile defense system (BMDS). This article focuses primarily on Aegis BMD, particularly current and planned roles supporting the combatant commands. Importantly, Aegis BMD is the centerpiece of the Phased Adaptive Approach (PAA), the four-stage framework for regional ballistic missile defense announced by President Barack Obama in 2009.

Proven Aegis BMD capability directly supports or will support the three operational imperatives identified in the national maritime strategy, as well as those implicitly or explicitly stated in the national security and military strategies:

- secure the United States from direct attack
- secure strategic access and retain global freedom of action
- strengthen existing and emerging alliances and partnerships and establish favorable security conditions.[2]

Aegis BMD is evolving into a global enterprise as the system migrates from the U.S. Navy to allied navies. As such, the system is becoming the interoperable "glue" that binds the United States and its regional allies and partners into a credible combat force and, by extension, into a credible deterrent. Here, too, the maritime strategy states, "Integrated maritime operations, either within formal alliance structures (such as the North Atlantic Treaty Organization [NATO]) or more informal arrangements (such as the Global Maritime Partnership initiative), send powerful messages to would-be aggressors that we will act with others to ensure collective security and prosperity."[3]

In the Middle East and Asia, the United States, its allies and partners, and naval joint and combined commanders are contending with the high-end threats posed by accelerating Iranian and North Korean ballistic missile and weapons of mass destruction development. In addition, naval commanders in the Western Pacific now must counter antiaccess/area-denial capabilities such as China's development of the Dong-Feng 21D "ship-killer" ballistic missile.

With Aegis BMD going global in the face of such regional high-end challenges, U.S. coalition partners increasingly have the option to "plug into" Aegis. The question then becomes the extent to which their naval assets—sensors and shooters—should be able to provide *and* receive BMD capability. Our maritime partners are making calculations based on their perceived national interests, threat assessments, and the inevitable budget tradeoffs that must be made in the midst of the ongoing worldwide debt crisis and concomitantly flat or declining defense budgets.

Aegis BMD builds upon the success of the Navy's Aegis Combat System

An Advancing Capability

Funded by the Missile Defense Agency (MDA) and Navy, Aegis BMD builds upon the success of the Navy's Aegis Combat System with its more than 60 years of missile research, development, and testing; real-world performance; and some $50 billion invested in technologies, systems, and ships. Aegis entered the U.S. fleet in 1983 as a blue-water air defense system to defeat massed raids of Soviet naval aviation antiship cruise missiles. In 1991, the Strategic Defense Initiative Organization, the predecessor to MDA, provided the initial funding for the first Aegis BMD capability for area-wide and theater missile defense.

Since then, regular upgrades have provided increased capabilities at every step of Aegis development—guided by its trademark "build a little, test a little, learn a lot" philosophy. The 2011 configuration of Aegis BMD, which was operationally certified in 2009, teams the Aegis 3.6.1 weapon system with the Standard Missile-3 Block 1A missile. The other two major shipboard components for Aegis BMD are the AN/SPY-1 S-band radar system and the Mk 41 vertical launching system (VLS). Phased upgrades of these components have given the Aegis BMD system the ability to counter short- to intermediate-range ballistic missile threats both in the lower and upper tiers of the atmosphere.

The Navy in mid-2011 had 21 Aegis BMD–capable warships: 5 cruisers and 16 destroyers. Sixteen of these BMD ships were in the Pacific supporting U.S., Japanese, and allied efforts to counter the ballistic missile threat presented by North Korea. Five were in the Atlantic to support the expanded NATO requirements vis-à-vis Iran. The commitment of the Nation and the Navy to Aegis BMD is clear, with 94 Aegis-capable ships planned for by 2024.[4]

MDA and the Navy are also developing the Aegis Ashore program, a key component that comes online in Phase II of the European PAA (EPAA), the four-phase regional PAA for the NATO area of responsibility. Initial deployments in Europe will occur later in the decade. In Phase 1 (2011 timeframe), existing sea-based Aegis missile defense ships and radars were deployed to defend against short- and medium-range ballistic missiles in Southern Europe. In Phases 2 (2015 timeframe), 3 (2018 timeframe), and 4 (2020 timeframe), Aegis SM-3 missiles will be successively upgraded to provide coverage against medium- and intermediate-range missiles. By Phase 4, the Block IIB variant of the SM-3 should have an intercept capability against some intercontinental ballistic missiles as well.[5]

In March 2011, the United States and NATO began EPAA Phase I implementation with the deployment of the Aegis cruiser USS *Monterey* (CG-61) to the Mediterranean.[6] Armed with SM-3 Block IA interceptors, the ship arrived on station with an immediate capability to track and intercept short- and medium-range missiles that comprise the Iranian ballistic missile threat to NATO territory and populations. While other Aegis BMD ships have deployed to the Mediterranean since 2009, *Monterey* was the first sustained 6-month deployment of such a ship specifically to support the EPAA.

Aegis integrated weapons system aboard USS *Hopper* launches RIM-161 SM-3 Block IA during exercise Stellar Avenger

As part of EPAA Phase II, Aegis Ashore is a relocatable, land-based Aegis BMD system that, together with the shipboard Aegis BMD, will provide the near-term deterrent framework against regional threats to Europe from short- and medium-range ballistic missiles. Aegis Ashore will reduce the Navy's need to maintain multimission Aegis BMD ships on station that would otherwise constrain their availability for other BMD and general purpose naval missions. In the NATO area, these conjoined elements of the PAA are the U.S. contribution to the NATO territorial missile defense mission and requirement adopted at the Alliance's November 2010 Lisbon Summit.[7]

In May 2011, the United States and Romania agreed on the site for the first Aegis Ashore. That site will include one land-based SPY-1 radar and a relocatable and modified Mk 41 VLS capable of housing and launching 24 SM-3 Block IB missiles.

C2BMC-enabled Aegis BMD

Both Aegis and Aegis-compatible ships plug into MDA's Command, Control, Battle Management, and Communications (C2BMC) element, which enables them to share and receive enhanced capability. Operational since 2004, C2BMC provides layered missile defense by linking regional, theater, and national commands into a single network, providing capability for battle management, planning, situational awareness, and sensor networking—the four major components for ballistic missile defense. C2BMC also links with orbital platforms such as space-based infrared satellites, which generate initial early warning data that fuse with data coming from ground-based sensors, such as the directional AN/TPY-2 X-band radar.

The C2BMC application relies on the Link 16 tactical data exchange network to ensure that sensor and shooter systems have the interoperability required for accepting and sharing target and tracking data. Link 16 is on all Aegis cruisers and destroyers and permits all elements of the national BMDS to accept and share data with other tactical platforms. U.S. allies in the U.S. Pacific Command area of responsibility, Republic of Korea, and Japan rely on Link 16 and their Aegis systems for accepting and sharing information in their missile-defense constructs. In Europe, NATO's missile defense committee is monitoring systems development to ensure interoperability there as well.

Link 16 will network the two relocatable TPY-2s planned for Europe and space-based satellites and airborne sensors with Aegis BMD ships, the Aegis Ashore system, and the air operations and C2BMC command center in Ramstein, Germany. Altogether, this network will expand the coverage area to allow missiles to engage on remotely obtained sensor data. Extending the range for intercepts will enable full-theater missile defense across Southern Europe—a major step toward the NATO territorial missile defense that was agreed upon at Lisbon. C2BMC will link the TPY-2s and the U.S. Army's Terminal High-Altitude Air Defense and Patriot batteries under the NATO missile defense framework. The system will also network with the Ground-based Midcourse Defense system that provides missile defense for North America against intercontinental ballistic missiles.

C2BMC enables a missile defense framework that leverages "any sensor, any shooter, at any phase of missile flight in any region, against any size and type of attack."[8] C2BMC and Link 16 enable TPY-2 radars to provide sensor data to shipboard SM-3 interceptors to allow an Aegis BMD ship to cue its sensors. With the addition of the launch-on-remote (LoR) capability, Aegis BMD ships will be able use this data to launch their interceptors. And these interceptors—no longer constrained by the range of the Aegis radar to detect an incoming missile—can be launched sooner and fly farther.

Existing Aegis BMD–equipped ships already embody the LoR capability, as demonstrated by the 25th Aegis BMD flight test FTM-15 on April 15, 2011. This was the first LoR test of the system against an intermediate-range "separating target"—a warhead separating from its booster missile. FTM-15 featured the Aegis BMD system installed in the guided-missile destroyer USS *O'Kane* (DDG-77) firing a Standard Missile-3 Block IA missile in response to remote sensor data provided by a forward-based TPY-2 radar. This pitted for the first time an in-service SM-3 Block 1A missile against an intermediate-range (1,800–3,400 miles) modified Trident I/C-4 ballistic missile target called the LV-2. This test was well beyond the expected capability of the current version of Aegis BMD, Version 3.6.1, which was developed to counter only short- and medium-range ballistic missiles. The LV-2 had flown in two previous BMD live-fire tests but was not hit until FTM-15.

The flight test thus used technologies and systems that are at sea and in service *today*. There were no changes to *O'Kane*'s BMD suite for the test. Thus, FTM-15 proved an intercept capability against a PAA Phase III intermediate-range ballistic missile (IRBM) threat using a current, though enhanced, PAA Phase I Aegis BMD architecture. Under the PAA, LoR is to have full operational capability during Phase II. MDA had planned for LoR capability to come online in 2015 with the next spiral upgrades to the Aegis 4.0.1 system software and SM-3 IB. The successful FTM-15 intercept demonstrates that the SM-3 IA, supported by a forward sensor and C2BMC architecture, can process forward cueing already, thus giving *Monterey* and other Aegis BMD ships on Phase I deployments an initial LoR capability to intercept an IRBM.[9]

The latest Aegis BMD flight test, FTM-16, occurred September 1, 2011. The

primary goal was to engage a separating ballistic missile target with the Aegis BMD 4.0.1 Weapon System and the SM-3 Block IB missile, the block upgrade to the SM-3 Block IA.[10] The shooter, the guided-missile cruiser USS *Lake Erie* (CG-70), had on board the 4.0.1's upgraded Aegis BMD signal processor along with a two-color infrared sensor in the SM-3 IB seeker. FTM-16 was the first flight test of the Block IB. Unfortunately, the test yielded no intercept despite *Lake Erie* having successfully detected and tracked the target and guided the SM-3. Although the test result was disappointing, FTM-16 highlighted the difficulties and complexities of the ballistic defense mission. In accord with the Aegis philosophy, the Navy and MDA will glean important information from FTM-16, incorporate it, and continue to advance Aegis BMD capabilities.

FTM-16's secondary objective was to test the capability of the FTM-16 participants, which along with *Lake Erie* included the Space and Naval Warfare Command and the Space Tracking and Surveillance System, to exchange Link 16 tracks and simulated engagement status messages. FTM-16 thus served as the second test of the LoR concept for linking an Aegis ship to remote sensor data to increase the coverage area. Certification of BMD 4.0.1 and the Block IB was scheduled for early 2012, after which the system would be ready to be used and supported by the operational forces, thus providing another initial LoR capability.

The next step after LoR is the engage-on-remote (EoR) capability, where the interceptor uses tracking data from remote off-board sensors to destroy a missile threat. EoR, scheduled for PAA Phase III deployment, advances LoR by providing an organic track to the interceptor late in its flight. To the extent that LoR and EoR can provide enhanced capability to the Block IA, IB, and IIA interceptors, these missiles—supported by a C2BMC-netted sensor framework—have the potential to provide territorial and even homeland missile defense in some circumstances.

The addition of LoR capability enables Aegis BMD shooters to launch interceptors earlier in the target missile's trajectory. The goal is to enable a shooter to launch off a track of a forward-based sensor in the system. Ultimately, EoR will enable the shooter to complete the intercept. LoR thus facilitates layered defense, a critical capability for the intercept of longer range and fast-flying missiles. When launch-on-remote and engage-on-remote become operational, the Aegis system can reach farther into the joint and combined arenas. The enhanced network integration of Aegis BMD and MDA's BMDS legitimizes the concept of "any sensor, any shooter" and thus extends the battlespace as well as the area defended.

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Linking Aegis BMD and Regional Framework Capabilities via C2BMC

Similar to MDA and the Navy's approach with Aegis and Aegis BMD, NATO has built its theater ballistic missile command and control system upon its air defense capability—calling the system Active Layered Theater Ballistic Missile Defense (ALTBMD). NATO is now expanding ALTBMD to meet its territorial missile defense requirement, which was announced at Lisbon.[11] Alliance members are not building and deploying systems in isolation. Instead, they are providing opportunities for regional and global partners to participate in an integrated, networked territorial missile defense effort that leverages prior investments and investment decisions. Under the expanded ALTBMD framework, the European Allies will operate systems for lower layer, terminal defense for theater-deployed forces. Leveraging its contribution, the U.S. Aegis BMD will operate upper layer (high-altitude) missile defense systems.

Aegis BMD and the MDA's C2BMC element have been fully involved in ALTBMD testing. In December 2010, Aegis BMD participated in the ALTBMD integration test bed at the NATO Consultation, Command and Control Agency facilities in The Hague, providing sensor support to initial lower tier ALTBMD efforts. Aegis BMD is completing lower tier activities as it prepares for the upper tier ALTBMD efforts yet to be planned. A month after beginning its EPAA Phase I deployment in spring 2011, *Monterey* made a port visit to Antwerp, Belgium, where it participated in initial testing of links between Aegis BMD and ALTBMD. In August, NATO conducted the first operational test of the links across ALTBMD, C2BMC, and Aegis BMD to validate ALTBMD's ability to track a target missile. This test was the first time that ALTBMD and Aegis were formally linked and proved their command, control, and communications compatibility. Follow-on efforts will aim to make those links permanent, with a second test scheduled to occur prior to ALTBMD initial operational capability in 2012.[12]

Aegis BMD Global Enterprise

Aegis open architecture provided by the Aegis BMD 5.0 system software upgrade will make it easier for allies and partners to integrate new weapons systems and sensors into the Aegis system—and C2BMC. Aegis BMD officials have been working with foreign shipyards on innovative approaches for reconfiguring Aegis to fit on several classes of foreign ships. Worldwide, seven shipyards have installed Aegis and the SPY-1 radar aboard seven different ship classes. In mid-2011, more than 20 percent of the global Aegis fleet was non-American. Five allies had their navies actively participating in Aegis—Japan, Korea, Spain, Australia, and Norway.

This global effort started in the 1980s with a foreign military sales (FMS) relationship with Japan. The Japanese Maritime Self-Defense Force (JMSDF) was the first foreign navy to construct Aegis warships. The JMSDF currently operates four *Kongo*-class destroyers. The lead ship of the class was commissioned in 1993. In 2000, the JMSDF won approval for two improved units, known as the *Atago* class. The lead ship of that class was commissioned in 2007.

Sharing the U.S. interest in building ballistic missile defenses in light of an increasing regional threat, Japan also decided in 2003 to upgrade its *Kongo*-class destroyers with an Aegis BMD capability. U.S. FMS packages subsequently went to upgrade all four ships with this capability, along with

inclusion of SM-3 Block IA missiles. Japan eventually decided to upgrade its *Atago*-class ships with Aegis BMD as well. That upgrade enables the JMSDF to meet the tenets of its New Defense Program Guidelines, which call for a total of six Aegis BMD–equipped ships to defend the country from missile threats in conjunction with U.S. Navy warships.[13]

Aegis BMD has worked closely with Japan since 1999 to design and develop advanced components for the SM-3 missile. The United States and Japan signed a memorandum of agreement in 1999 to cooperate in the development of the SM-3 Block IIA, with Japan contributing both funding and know-how. The Japanese technical contribution included activities in the areas of the kinetic kill vehicle, second-stage propulsion, and the missile's nose cone. In 2010, the Japanese government relaxed its decades-long arms embargo to allow for the U.S. export of the SM-3 Block IIA to other countries such as U.S. European Allies.[14]

South Korea has announced plans to build six 5,600-ton KDX-IIIA Aegis-equipped destroyers beginning in 2019 that will join its three *Sejon-Daewan* KDX-III destroyers scheduled for service by 2012. High-level discussions have taken place to provide South Korea an Aegis BMD capability on its KDX-III class ships. In 2011, South Korea declared that it was establishing a defensive system to combat air-breathing (aircraft and cruise missile) and ballistic missile threats from North Korea. Scheduled to be in place by 2015, the Korean Air and Missile Defense System will be built around the capabilities inherent in its Aegis-equipped destroyers and its modified Patriot Advanced Capability-3 ground-based interceptors.

In Europe, Aegis has been included in a commercial relationship with Spain that has extended to an enterprise among the Spanish, Australians, and Norwegians.[15] The Spanish navy has been operating four Aegis-equipped *Alvaro de Bazan* (F100) air defense frigates built by the Navantia shipyard in Ferrol, Spain. A fifth F100 was under construction in mid-2011. Navantia has partnered with the Australian government to construct three Royal Australian Navy *Hobart*-class air defense destroyers at the ASC Shipbuilding facility in South Australia. The Australian Ministry of Defence wants to use Aegis to link other maritime assets into an integrated architecture while stipulating that the system must have the capability of adding BMD in the future. In 2004, Australia signed a memorandum of understanding with the United States that provides for a 25-year framework for missile defense cooperation. Navantia also has a commercial enterprise with Norway that put the Aegis system aboard their Royal Norwegian Navy *Fridtjof Nansen F310*–class frigates. In 2011, Norway received the last of five frigates of the class that is a somewhat less capable but still potent version of Spain's F100.

Although their navies have no Aegis warships, other NATO Allies, specifically the United Kingdom, the Netherlands, Denmark, and Germany, have destroyers and frigates with combat systems that can contribute to a broader, Aegis-centered naval BMD architecture. In 2003, the British signed a memorandum of understanding with the United States that led to a follow-on 2006 joint study on a potential Type 45 guided-missile destroyer BMD capability. The Netherlands and the United States have been assessing the potential of Dutch naval combat systems for a BMD capability with SM-3 missiles that could be integrated onto ships equipped with a SMART-L surveillance radar and the Advanced Phased Array Radar (APAR). The German navy also operates three frigates fitted with SMART-L/APAR and the VLS missile launcher. Additionally, Germany has assigned a BMD liaison officer to the Aegis BMD staff to further German understanding of BMD-related issues. This summer, NATO pursued ideas for cooperative SM-3 procurement for use on German and Dutch frigates. In turn, these ships would further explore how they could provide sensor support to the long-range sensor network under the EPAA.[16] Finally, Denmark has plans to construct comparably equipped patrol frigates, suggesting another avenue for migrating the BMD capability to NATO navies.

Aegis BMD's flight test program has engaged allied participation both in missile tracking and interceptor launches. The JMSDF has progressed furthest in this regard, closely integrating its activities with its American counterparts. The destroyer *Kirishima* was the first foreign warship to participate in a U.S. Aegis BMD flight test in the June 2006 FTM-10. In December 2007, the *Kongo* became the first ship of an allied navy to successfully engage a ballistic missile target during the JMSDF's first flight test mission, designated Japan JFTM-1. Between 2007 and 2010, four separate JMSDF ships launched SM-3 missiles at medium-range, separating-warhead targets.[17] These tests, involving JMSDF guided-missile destroyers, demonstrated the promise of a broad-based coalition enterprise linking several navies' Aegis capabilities to address shared operational requirements. Japan's involvement has

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Standing watch aboard guided missile cruiser USS *Monterey*, Black Sea

potential for the Aegis BMD, given Aegis procurements that presage potential partnering opportunities for mutual self-defense and greatly enhanced interoperability.

Aegis BMD will continue to pursue spiral upgrades to advance capabilities—both afloat and ashore

The Netherlands' LCF *Tromp* (F 803) was the first European FTM participant. The ship's modified SMART-L/APAR tracked the ballistic missile target during the December 2006 FTM-11. The Spanish navy's *Mendez Nunez* (F 104), outfitted with BMD software, tracked a ballistic missile target in the June 2007 FTM-12.

The Course Ahead

"The Joint Chiefs of Staff are coming to realize that the Navy's approach to improving Aegis command and control has applicability to the broader BMD system," notes former Deputy Chief of Naval Operations for Naval Warfare Vice Admiral J.D. Williams, who made possible the introduction of a BMD capability into Aegis in the early 1990s. "The Navy, for its part," he continues, "recognizes that its Aegis BMD system needs access to off-board sensor data generated by systems that are outside its control through the improved command and control structure."[18]

The United States and its allies and partners have Aegis and Aegis-compatible assets that offer a variety of in-service and projected capabilities to support and enhance regional ballistic missile defense. As the 2010 *Ballistic Missile Defense Review* put it:

Other allies already own or are working with the United States to acquire specific capabilities, such as naval vessels equipped with the Aegis defensive system that could be adapted to include a missile defense capability. . . . A primary U.S. emphasis is on ensuring appropriate burden sharing. The Administration recognizes that allies do not view the specifics of the missile threat in the same way, and do not have equal resources to apply to this problem, but there is general recognition of a growing threat and the need to take steps now to address both existing threats and emerging ones.[19]

Aegis BMD will continue to pursue spiral upgrades to advance capabilities—both afloat and ashore. LoR and EoR are two emerging Aegis capabilities that are leveraging MDA's C2BMC to expand the Aegis BMD battlespace and improve integration with allied and partner BMD efforts. Command and control interoperability is key to enabling allied and partner navies—with their Aegis and Aegis-compatible ships—to plug their sensors and shooters into this Aegis BMD capability to yield effective, robust, and overlapping regional defense. Command and control interoperability makes for cost-effective burdensharing, especially in this era of declining defense budgets.

In the end, the truly global Aegis BMD enterprise is about networking and leveraging assets—existing or potential—to create the necessary allied and partner synergies for a resilient missile defense framework that is any sensor, any shooter. **JFQ**

NOTES

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[3] Ibid., 6.

[4] See Clarence Robinson, "A Sea Change in Ballistic Missile Defense," in *The Year in Defense: Spring 2010 Naval Edition* (Tampa, FL: Faircount Media, 2010). Robinson quotes Rear Admiral Frank Pandolfe, then-director of the Surface Warfare Division (N86), Office of the Chief of Naval Operations: "Over time we will have a much larger and more capable BMD force, with all 62 destroyers already built or under construction as BMD-capable units." See also, "Navy Aims for 94 BMD-Capable Ships by 2024, Lays Out Plans to Congress," *Inside the Navy*, June 20, 2011.

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[11] NATO.

[12] Amy Butler, "NATO Eyes IOC for BMD Shield Next Spring," *Aviation Week & Space Technology*, August 17, 2011, available at <www.aviationweek.com/Article.aspx?id=/article-xml/asd_08_17_2011_p01-01-360132.xml>.

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[15] MDA, *At Sea*, 25.

[16] Butler, "NATO."

[17] MDA, *At Sea*, 25.

[18] J.D. Williams, *Improving Aegis Ballistic Missile Defense Command and Control*, Heritage Special Report SR-89 (Washington, DC: The Heritage Foundation, May 2, 2011), 11, available at <http://thf_media.s3.amazonaws.com/2011/pdf/sr0089.pdf>.

[19] MDA, *At Sea*, 32. The success of Aegis BMD afloat and the promise of Aegis Ashore have also garnered interest from a wide range of nontraditional partners such as India. See Amy Kazmin and Farhan Bokhari, "New Delhi Weighs Up U.S. Missile Shield," *The Financial Times*, January 8, 2009, available at <www.ft.com/intl/cms/s/0/1331a926-dce4-11dd-a2a9-000077b07658.html#axzz1t5WCBvtg>.