Naval War College Review

Volume 50
Number 2 *Spring*

Article 3

1997

Ballistic Missile Defense from the Sea—The Commander's Perspective

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The Commander's Perspective

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THEATER BALLISTIC MISSILE DEFENSE PERFORMED by warships—a mission already touted for future joint and combined task forces—is rich in inherent and unavoidable complexities. Moreover, as present and future commanders envision this mission and prepare the Navy to meet its challenges, they should recognize that while TBMD almost necessarily will have strategic implications, it will also be a supporting and enabling function, carried out so that other military operations may occur.

The conundrum posed by conflicting missions that must be executed with limited means affects every decision of the joint force maritime component commander (JFMCC) when confronting the theater ballistic missile (TBM) and weapons of mass destruction (WMD) challenges. Conducting operations in the face of the TBM-WMD threat will require that the JFMCC make hard choices in a timely, forthright manner. Whenever possible, they must be in accordance with joint TBMD doctrine, to help ensure a smooth transition of the TBMD fight from protection of strategically significant areas to flexible maneuver when an offensive campaign begins to move inland from the littoral. How might naval forces defend key areas at the beginning of a crisis, and what challenges will they face in supporting a transition to offensive operations?

Very likely, such a transition will have been made possible only by a successful TBMD battle waged by the maritime component, "holding open the door" for

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This article is an extract and adaptation of a much fuller and more detailed study produced at the Naval War College as an Advanced Research Project. That paper, which won the College's 1996 J. William Middendorf II Award for Student Research, will be published at full length in the Naval War College Press "Newport Papers" series.

follow-on TBMD forces deploying into the theater. This capability cannot be considered in isolation, for it exists to enable other operations to be undertaken despite a known or presumed high-order threat.

As the TBM threat continues to evolve, joint TBMD capability must progress beyond the present, very limited baseline. In the military world, as in the natural world, overspecialization is an invitation to catastrophe. A robust response to an evolving threat requires diverse capabilities. During the crucial early days of a regional contingency, the TBMD active defense capabilities most likely to be picked from that diverse palette will be naval.[1]

Naval TBMD to 2005

"The Navy TBMD system shall [comprise] two tiers, [a structure] which provides for an area (lower tier) defense and theater wide (upper tier) defense. The Naval TBMD system shall provide capability against the full range of TBM threats for protection of joint forces, sea and air lines of communications, command and control facilities, vital political and military assets, supporting infrastructure, and population centers."[2] If current initiatives remain funded, this layered-defense approach to naval TBMD should have achieved significant capability by 2005. "Navy area defense" (NAD) will be provided by the SM2 Block IVA interceptor, while " Navy theater-wide (NTW) defense " will likely depend on an SM2 variant that carries an infrared-homing lightweight exoatmospheric projectile (LEAP). Sensor capability will be built around the Aegis-organic SPY radar, currently at sea on the USS *Ticonderoga* (CG 47) and USS *Arleigh Burke* (DDG 51) classes of combatants. Because of the highly automated, highly integrated, self-contained nature of modern warships, much of the projected framework is already in place. Early warning from satellite and other remote sensors ("offboard cueing") will enhance the effectiveness of sea-based systems.

NAD: the "Lower Tier." The SM2 Block IVA area defense (lower tier) interceptor represents the latest stage in the remarkable evolution of the Navy's Standard Missile. Navy area defense is one of the Ballistic Missile Defense Organization's "core" TBMD systems, and thus it has a great deal of developmental and bureaucratic momentum.

The Block IVA missile itself is a boosted, high-mach, long-range, solid-fuel interceptor with "dual mode" (infrared and semi-active radiofrequency) homing and a blast-fragmentation warhead specifically enhanced for the TBMD role. The combination of precise guidance (which increases the chance of a direct "skin-to-skin" hit or very near miss) with a powerful explosive warhead makes this interceptor extremely potent.[3] Because it is proximity-fuzed, it does not suffer the major drawback of kinetic-energy hit-to-kill systems—an all-or-nothing gamble on flawless guidance and homing.

Like the proposed next-generation Patriot PAC-3 missile, the SM2 Block IVA will be multimission-capable, lethal against cruise missiles and manned aircraft in addition to TBMs. However, as shown during the exercise ROVING SANDS 95, its "defended footprint" will be far larger than that of PAC-3, thereby allowing in some geographic situations a rudimentary layered defense using only lower tier systems, if Patriot is in place.[4] Additionally, it should be noted that NAD will be the sole naval active defense system capable of engaging low-apogee, short-range TBMs, because the theater-wide LEAP ("upper tier") interceptor functions only outside the atmosphere, above seventy kilometers.

We must beware of oversimplification. The concept of a "defended footprint," in effect an NAD enclave, represents a complex geometry that is dependent on many factors, including TBM range and terminal velocity, reentry-vehicle radar cross-section, and the spatial relationship between the Aegis ship and what it is defending. Furthermore, in a littoral environment, Navy area defense systems will have to provide greater coverage than equivalent ground-based systems, because of the prospect of a shoal-water "buffer" between the ship and whatever it must protect. Area defense systems generally benefit from collocation with the assets they are defending, yet it may often be difficult for an NAD ship to patrol constantly in close proximity to a capital city, major population center, or key logistics terminal. Until ground-based systems are emplaced in theater, NAD ships will need all the reach they can get if they are to provide protection—"hold open the door"—for arriving reinforcements.

Well forward, defending an amphibious objective area against short-range TBM threats, that inland NAD "reach" is considerable. But in the majority of scenarios, the most likely initial task of a naval TBMD capability—defending political, population, or logistics centers far from the main military engagement—not only takes multimission ships and tethers them to single targets, it also markedly shrinks the footprint area and engagement altitude of their defended envelopes, against just those hostile systems (long-range TBMs) most likely to be employed with WMD warheads, all of which tends to negate the value of close-in point defense. This long-range, politically targeted, WMD-capable threat postulated for 2005 requires another layer of protection to complement the versatile, capable, but limited scope of Navy area defense.

NTW: the "Upper Tier." That seagoing upper tier capability is Navy Theater-Wide defense. Interception of theater ballistic missiles outside the atmosphere using theater-wide active defense systems is fundamentally different from the more intuitive "goalkeeping" defense accomplished by lower tier systems. As with combat air patrol aircraft, the area defended by an NTW ship depends more on the location of the defending platform than that of the defended target. Rather than an enclave-like defended footprint surrounding a single target, NTW involves an "area of negation" within which a single Aegis ship can patrol in order to intercept TBMs en route from a hostile launch area to many different targets.

Herein lies the tremendous leverage of NTW, and also the explanation for TBMD briefing slides that show a handful of NTW ships defending all of southern Europe or all of Japan from TBM attack. The kinematics of the NTW interceptor eliminate the need for these ships to be collocated with individual defended points. Instead, they are positioned either somewhat forward in large areas of negation (allowing exoatmospheric midcourse and descent-phase intercepts in support of hard-pressed area defense systems) or far forward, where they can exercise the upper tier capability unique to the Navy theater-wide system—ascent-phase intercept.

As soon as a launch is detected and rules of engagement are met, an NTW interceptor can be launched to destroy the TBM as it rises above the atmosphere to an altitude of seventy kilometers (the minimum engagement altitude for LEAP).[5] By being forward, near a launch site that can fire ballistic missiles at many targets in a great arc, the NTW proactive interception capability produces a defended area covering tens of thousands of square miles.

The only TBMD weapon that will do this is the SM2/LEAP. At 6.56 meters, it will have the same length as the area defense SM2 Block IVA; however, the NTW missile is to be a four-stage system, starting with the Mark 72 booster and Mark 104 solid rocket motor it shares with the NAD interceptor. "The inertially guided, nozzle controlled Advanced Solid Axial Stage (ASAS) motor will constitute the third stage. . . . The fourth stage will be the autonomous LEAP KKV [Kinetic Kill Vehicle]."[6] Guidance technologies used in this extremely long-range system include missile command uplink and inertial, Global Positioning System, and imaging infrared terminal homing. The interceptor warhead is the LEAP itself, containing no explosive charge. Maneuvering autonomously with thrusters, it homes on the infrared signature of the hot TBM conspicuous against the cold vacuum of space, closing for the kill at 4.5 kilometers per second, more than three times the velocity of the fastest rifle bullet.

The kinetic energy of a moving object equals one-half the object's mass times the square of its velocity; thus the small (eighteen-kilogram) but very fast LEAP packs a serious kinetic punch. When combined with the squared inbound velocity and much greater mass of the incoming warhead, the energy released in the eventual collision is tremendously destructive. If that TBM is carrying a chemical, biological, or nuclear payload, the components are shattered and dispersed outside the atmosphere.

The potential capability of this system is so significant that challenges to its development have proven to be not only technical but political. There has been considerable controversy surrounding the potential effect of NTW on the 1972 Anti-Ballistic Missile (ABM) Treaty. Again, though, it is necessary to review the numbers carefully. For Russian strategic systems, an "ICBM speed of 6–7 km/sec easily outdistances the 4–5 km/sec of the interceptor, precluding an ascent phase intercept. If an AEGIS ship is near the terminal target of the ICBM—by the time an interceptor can be fired and flown out to intercept, the [Reentry Vehicles] are below the minimum altitude of the exoatmospheric hit to kill vehicle."[7] Consequently, while the SM2/LEAP should be extremely effective against medium-range ballistic missiles, it is not capable of effectively engaging the high-speed reentry vehicles of a strategic ICBM.

The eventual influence of modern *theater* ballistic missile defense technology on a treaty involving *strategic* defense and signed nearly a quarter-century ago is being hotly debated, but naval TBMD active defense development is continuing apace, and an initial degree of NTW capability should be available by 2005. "Both the Navy Area TBMD and the Theater Wide capability have been certified by the Department of Defense to the Congress as fully treaty compliant."[8]

Sensors. The primary sensor for naval TBMD active defense will be the Aegis SPY radar. Its TBM-tracking capabilities are being explored and expanded through the use of new computer software that will produce a TBMD-capable Aegis system. Thus altered, SPY radars have "demonstrated the ability to track TBMs at ranges well in excess of 500km."[9]

As with any radar, tracking range is highly dependent on the radar cross-section (RCS) of the target, and SPY autonomous ranges against TBMs with challengingly small cross-sections will decrease accordingly. Here, battlespace (i.e., distance, and therefore time) can be regained through cooperative tracking by two Aegis ships: the forward "picket" transmits track data to a consort downrange until the second ship can acquire the target. This capability has been demonstrated in several TBMD Extended Tracking Exercises, including Joint Task Force (JTF 95) demonstrations of the new "cooperative engagement capability," the present-day precursor to the "joint fire control network" postulated for 2005.[10]

Cooperative tracking against low-RCS targets can also be improved by not stationing ships directly under the threat trajectory. The TBM is thus illuminated from several angles by the SPY radars of more than one ship. What might be a very small target head-on may give a useful return from the side. The composite data shared via cooperative engagement takes advantage of this phenomenon and thus provides all platforms in the network the best possible track of the target.

Battlespace can be increased not only through sharing track data between radars but also by using the transmitted energy of any given radar more efficiently. The SPY must search for and detect a TBM before the Aegis system can compute a track. If radar waveforms and anticipated search volumes can be "fine-tuned" early for TBM detection, SPY can acquire and Aegis can track the target much faster, thus gaining all-important time. Offboard cueing is the key to efficient radar management and early detection. In 2005, cueing to Aegis will be primarily a function of the U.S. Space Command. The joint force maritime component commander, or JFMCC, will therefore have to bear in mind that "as friendly operations shift in time and place, the T[B]MD planner must . . . effect continual coordination with USSPACECOM to obtain [sensor] coverage."[11]

A significant limitation of national overhead sensors is their inability to gather data on any TBM after its boost phase, that is, when the hot plume of the rocket motor no longer exists. Without post-boost information, it may be possible to perform search-volume limitation and waveform selection for the SPY but not to meet criteria for an optimum single-beam cue—"an uncertainty volume small enough to be covered by a single beam of a [fire control radar] system."[12] The importance of post-boost phase sensors to allow single-beam cueing has been clear to the Navy for several years, as shown by studies advocating infrared search and track (IRST) equipment for the E-2C early-warning aircraft.[13] Airborne infrared systems can continue to track a TBM after its motor burns out, by sensing skin heating of the missile body caused by the friction of its passage through the atmosphere. The E-2C/IRST concept, known as Gatekeeper, is currently unfunded.[14]

The Air Force has taken the lead in post-boost tracking systems with the AWACS EAGLE (extended airborne global launch evaluator). "This sensor consists of a passive infrared surveillance sensor (IRSS) and an eye-safe laser-ranger installed in the AWACS test E-3 [aircraft]."[15] The system has sufficient accuracy to pass a single-beam cue to SPY, a striking example of the essential joint synergy of effective theater ballistic missile defense.

Issues for the Maritime Component Commander

In a rapidly developing conflict against a TBM-capable foe, the joint force maritime component commander may find himself the joint force commander's Leonidas, holding the pass at Thermopylae as the Persian arrows rain down, buying time for reinforcements to arrive in the theater. If the limited naval ballistic missile defense capability initially available is likely to be overmatched at the outset of a fight by sheer numbers of hostile missiles, then that capability must be used both effectively and efficiently.

The joint force maritime component commander must commit the highly capable but numerically limited Aegis assets wisely, both in how they are apportioned for a variety of missions and how they are assigned to different tasks within the TBMD mission. Ships and missions are not created equal. For example, NTW brings more to the fight than Navy area defense; if, however, enemy TBMs are short-range and low-apogee (less than seventy kilometers), the difference is moot, for they will not be engageable by Navy theater-wide defenses.

Nonetheless, the highest-leverage hostile systems will generally be those with the longest range, able to reach political targets, able to threaten the political centers of gravity of coalition cohesion and the national will to fight. NTW counters this threat, and counters it efficiently, by fielding a system whose kinematics allow engagements in the ascent phase, midcourse, and during descent before area defense systems must come into play. One NTW platform can thus defend *many* key targets. Therefore, when faced with a tough TBM order of battle and supported only by whatever naval TBMD capability is currently deployed in the theater, the joint force maritime component commander should seek to maximize the NTW portion of the naval theater ballistic missile defense mission.

If possible, the JFMCC needs to get the NTW-capable Aegis ships close to the enemy TBM launch areas and keep them there. Herein is the rub. Both Aegis cruisers and destroyers should, by 2005, be potentially capable of performing the NTW mission. But which will be more *efficient* at a task which is, in effect, an antimissile deterrent patrol in a distant, perhaps isolated, NTW area of negation?

Endurance. Every ship has a unique fuel consumption curve, and consumption rates vary with sea conditions and bottom fouling. Nonetheless, using generic data contained in the engineering operational sequence system (known as EOSS) prepared for each class and also unclassified information from the Aegis program office, basic fuel consumption comparisons between the two Aegis classes can be made.[16] They are instructive.

After a thousand-mile sprint at twenty-five knots, the cruiser can remain on station nearly twice as long as an Aegis destroyer, with both ships patrolling at their quietest speed until a fuel state of 50 percent is reached. The on-station times of both classes can be extended, of course, by allowing fuel states to decline to 30 percent, but the cruiser still maintains a clear endurance advantage—and does so with 35 percent more vertical-launch missile cells.

While this simplistic arithmetic shows that the joint force maritime component commander may favor the cruiser for the NTW mission, it also highlights one of the JFMCC's greatest logistical challenges, the iron logic of fuel. Warships have redundant weapons, redundant sensors, and plenty of manpower. Fuel, however, is an absolute. Empires were once built around coaling stations, and for good reason. NTW cruiser captains who find themselves at 30 percent fuel in the face of the enemy will not sleep well.

By the very "geometry" of their missions, Navy theater-wide and area defense assets will tend to be widely separated, as they are best employed at opposite ends of a ballistic trajectory that may extend for hundreds of nautical miles. Under the umbrella of layered defense that they provide, other ships will go about other

Naval War College Review, Vol. 50 [1997], No. 2, Art. 3

essential missions as well—and they will all need fuel. Knowing this, the joint force maritime component commander must contrive to carry out a robust, flexible TBMD plan while still providing the ships with sufficient fuel.

Ordnance. A warship cannot live without fuel, and it cannot fight without ammunition. As weapons systems become increasingly complex and specialized, the ability of a platform to execute a given mission is increasingly tied to its reserves of specific munitions. If the Aegis cruiser demonstrates superior endurance for the remote NTW mission, that advantage is squandered if the ship carries an insufficient load of NTW interceptors. Superior fuel reserves are irrelevant if the SM2/LEAP missiles are gone after two days on station. Except as a sensor or cueing platform, the ship would then be useless for NTW, and probably out of position for any of the other missions it could still perform.

Furthermore, unlike fuel tanks, a vertical launch system (VLS) cannot be reloaded on station; the ship must leave its patrol area and proceed to port. It may have to take itself out of the fight entirely, since the most important VLS munitions in its inventory—Tomahawk, the SM2 Block IVA, and the SM2/LEAP—cannot be transferred at sea at all. They are several thousand pounds too heavy for the installed handling crane.

For Tomahawk, standard rearming procedures have been developed, tested, and implemented for the missile's land-attack variant (known as TLAM). The TLAM rearming procedures are interesting here because the logistical challenges for Tomahawk and TBMD missiles are similar. The Mark 14 VLS canister for TLAM and the Mark 21 canister for SM2 Block IV and its variants are the same size, and while TLAM is the heavier, their weights (in canisters) are within a thousand pounds of each other. TLAM rearming "requires pierside handling facilities, airfields and airlift capability (lower volume and higher expense), seaport and sealift capabilities (slower, higher volume, and lower expense), and trucking from seaport or airfield to pierside. . . . [Quick Reaction] teams may also be used to support loading and unloading operations at anchorage with a barge and floating crane or crossdecking operations with a destroyer [tender]."[17]

How many tenders will the Navy actually have in 2005? But even given a tender, the preferred conditions include a pier of sufficient length and with enough water to accommodate a ship more than 560 feet long and thirty-two feet in draft; cranes, forklifts, trucks, or flatbed rolling stock; and cargo ports or airfields nearby, if not adjacent. Such a facility is precisely the kind of "logistics node" that the JFMCC will be attempting either to defend or seize. When in friendly hands, such a facility is a prime TBM target in its own right—as was seen at Jubayl, Saudi Arabia, on 16 February 1991, when an Iraqi Scud struck within yards of an ammunition-covered pier alongside which were seven cargo ships, a supply barge, and the amphibious assault ship USS *Tarawa* (LHA 1).[18]

The logistics of supplying the rearming site itself are daunting. If airlift is used, more than four sorties by C-5 Galaxy transports will be needed to rearm fully a single Aegis cruiser with TBMD and TLAM munitions.[19] It must be borne in mind, though, that the Aegis ship thus reloaded can then protect that same airfield in order to allow the 128 C-5 sorties required to move a Patriot battalion into the theater.[20]

The logistical challenges associated with rearming VLS combatants in-theater make clear why current concepts of operations envision follow-on vertical-launch munitions arriving in the magazines of deploying combatants. It is very difficult to reload a VLS, or to "tailor" a unit's weapon mix by "crossdecking" missiles between ships, in a theater of operations in combat conditions. Therefore, the initial loadout with which a VLS Aegis ship departs its homeport is crucial to the combat effectiveness of that unit.

By 2005, there will be over 5,500 VLS cells arming the Aegis combatants of the fleet.[21] Competing for this finite space will be SM2 Block IVA, SM2/LEAP, four-missile packs of the "Evolved Sea Sparrow," vertical-launch antisubmarine rockets, several different Tomahawk TLAM variants, and perhaps also the anti-armor Tomahawk (TSTARS) and a navalized version of the Army Tactical Missile System (ATACMS). Only one of these missiles, the area defense SM2 Block IVA, is a true multimission weapon, with capability against aircraft, cruise missiles, and theater ballistic missiles. With single-mission weapons, however, initial VLS loadout is a zero-sum game. With every missile loaded to support a given mission, another mission loses one. Given the multimission capability of Aegis warships, the variety of threats, and the tactical uncertainties of most crisis situations, there will be a tendency toward "mixed loadouts" for these ships—that is, a few of everything. That could be a grave mistake, which only good threat intelligence and firm command decisions can preclude.

Firing Doctrine. One possible JFMCC force for 2005 and the years soon after is an "Aegis-rich" carrier battlegroup structure that includes four DDGs and two CGs.[22] Each DDG has ninety vertical launch system cells, and each cruiser 122. If we postulate a generic loadout in each ship that allows four cells for antisubmarine rockets and apportions the remainder between SM2 and TLAM (70 percent and 30 percent respectively), then each DDG has sixty NAD/NTW cells and each CG has eighty-two.[23] Current sources indicate a projected availability of approximately ten Navy theater-wide interceptors per Aegis combatant in the 2002–2008 timeframe, leaving fifty Navy area defense cells in the destroyer and seventy-two in the cruiser.[24] In the area defense role, SM2 Block IVA is an "endgame" weapon; therefore, we may presume a "shoot-shoot" salvo doctrine (i.e., two interceptors launched against a single TBM). The result is a total ballistic missile defense capacity of ten theater-wide and twenty-five area defense engagements for every DDG, with ten and thirty-six respectively for every cruiser. In a battlegroup with four DDGs and two CGs, the grand total will be sixty NTW and 172 NAD engagements.

This seems impressive, but it is simplistic. Navy area defense "shooters" must be near the assets they are protecting, while Navy theater-wide engagements are best conducted as close to the TBM launch point as possible (in order to attempt an intercept in the ascent phase). To be in position for one mission is to be out of position for the other. Moreover, ships assigned to the joint force maritime component commander may be given missions, including escort duty, maritime interdiction force patrol, or TLAM strike, that put them out of position for *either* NAD or NTW. Finally, equipment performance must be taken into account; the reliability of systems so complex is somewhat less than 100 percent.

Thus, once the joint force commander (JFC) and JFMCC complete their initial appraisal of the list of places to be protected and targets to be struck, and have decided what portion of the naval component can be dedicated to theater ballistic missile defense (or can conduct TBMD while executing other missions), the maritime component commander will find the force's actual engagement capability to be much more modest than the numbers suggest. When set against the likelihood of a preemptive maximum effort by enemy TBM forces, the need for rigorous fire discipline becomes obvious.

The traditional naval response to limited surface-to-air missile inventories has been close control of the inner air battle. But the TBMD battle is likely to be fluid, dispersed, and sporadic, characterized by flurries of rapid launches followed by periods of quiet (as enemy launchers attempt to relocate, rearm, and hide from counterattack). Fluid conditions in battle are best dealt with by tactical formations that favor good communications; by a thorough grasp of doctrine; and by mission-type orders that allow flexibility in achieving coordinated, but decentralized, execution of the commander's intent. In the context of theater ballistic missile defense, fire discipline must derive from doctrine and planning rather than from centralized control by an air defense commander. If correctly designed and promulgated to TBMD units through mission-style orders, the theater ballistic missile defense plan will be amenable to execution with minimal direct intervention. The air defense commander is then free to *coordinate* by monitoring remaining VLS inventories, observing the enemy's level of effort, and realigning forces as necessary as the battle progresses.

Intelligence, and Final Choices. "The days, weeks and months preceding hostilities must be used to plan, prepare and organize for the execution of TMD active defense, which is accomplished in terms of minutes and seconds."[25] The joint force maritime component commander must make the transition from the comfortable generalities of a theater concept of operations to the difficult specificity required for combat operations. A tool that will help the JFMCC do that is a structured process known as the "intelligence preparation of the battlespace," or IPB. (In fact, responsibility for producing a formal IPB accrues to the "area air defense commander," but the maritime component commander may be assigned that title.)[26] A number of intelligence issues arise for the JFMCC with respect to theater ballistic missile defense.

The first is enemy TBM ranges. Their maximum range will determine the rough size of the area to be protected. Also (since short-range systems are not engageable by NTW), if the enemy order of battle is short-range only, ships that would otherwise be assigned to theater-wide patrol areas may be given other duties. On the other hand, area-defense capabilities can be severely tested by such short-range systems as the FROG-7 and SS-21. The limited leverage of NAD may increase the need to strike the launchers themselves and thus make the success of the air defense commander's mission more dependent on successful offensive air operations.

A second intelligence issue is the enemy TBM inventory. Once the TBM-versus-TBMD interceptor correlation of forces is calculated, the severity of the defender's initial window of vulnerability can be determined and the potential impact of TBMD on the arrival of follow-on forces in-theater can be evaluated. In a pre-hostilities crisis scenario, if the correlation is so heavily unfavorable that U.S. objectives would be jeopardized before the balance could be redressed, the National Command Authorities (or NCA, i.e., the president and the secretary of defense), the regional commander in chief, the joint force commander, and the JFMCC may have to consider the military, political, and rules-of-engagement implications of preemptive attacks upon launchers.

Third, what types of TBM warheads does the enemy have? If there is confidence that the enemy has both the technical capability and the political will to use weapons of mass destruction, the joint force maritime component commander can expect far more intrusive guidance from the JFC, regional commander in chief, and the NCA. The threat of an enemy WMD attack is very likely to lead to more centralized control of the TBMD battle *down* the chain of command. Correspondingly, the inability of area-defense weapons to obliterate completely the *warheads* of descending TBMs dramatically raises the importance of the exoatmospheric destruction, by NTW missiles, of nuclear, biological, or chemical warheads.

Enemy TBM reentry-vehicle (RV) radar cross-section is a fourth matter requiring intelligence assessment. If "measurement and signals intelligence" has been collected against the RV types known to be deployed, it will guide ship stationing, because of both cued and uncued acquisition ranges for the SPY radar as well as the need for Aegis to share track data against difficult low-RCS targets. Also, for Aegis ships, meteorological information regarding local influences upon SPY radar propagation and interceptor infrared-seeker performance must be collected and allowed for.

A further intelligence issue—one that is less technical but, as implied above, affects those that are more directly measurable—is the question of enemy intent. To begin with, will the enemy use theater ballistic missiles, and if so, when? In future conflicts, several factors may motivate them not only to use their TBM capabilities but to do so early. First is the defensive window of vulnerability. Interceptor inventory in-theater is unlikely to be high at first, and it may be spread over a wide range of political as well as military targets to be protected. A second is a relic of strategic deterrence theory—"use it or lose it."[27] Potential enemies with a grasp of the open literature will appreciate that by 2005 the United States will be able to pose a significant threat to their TBM forces. Thus, if the correlation of offense and defense is favorable to them before U.S. assets build up in the area, and if they understand that U.S. attacks will become increasingly effective as a conflict progresses, they will be sorely tempted to launch early—and often.

Furthermore, what other threats will the enemy present that may affect execution of the primary TBMD missions? Such areas as undersea and mine warfare must be particularly taken into account. For NTW ships in far-forward, ascent-phase-intercept areas, the capabilities of enemy fast patrol craft, diesel submarines, coast surveillance, maritime strike, and shore-based antiship cruise missiles must be considered. The IPB is an iterative process, a constantly evolving game of "What if?" designed to produce answers to issues raised by enemy capabilities, actions, and apparent intentions.[28] Comprehensive intelligence preparation allows the maritime commander to anticipate and, presumably, counter possible enemy courses of action during every stage of the conflict.

A final intelligence-related item in theater ballistic missile defense planning is the application of intelligence assessments to the all-important matter (already alluded to) of VLS missile loadout. One of the historical strengths of naval forces has been their ability to carry out a variety of missions. The maritime component is versatile, flexible, mobile, and survivable; it is an adaptable "force package" for the JFMCC to use as required. There is thus, as noted, a strong institutional prejudice toward mixed-mission loadouts for VLS Aegis ships: these combatants were designed and built at great expense to do many missions and do them all well; furthermore, the true nature of a regional contingency seldom becomes clear before battle is joined, and if maritime forces are to be first on the scene, they must be capable of responding immediately to whatever they find. This is all true—to a point. Mixed munitions loadouts are appropriate, but the theater commander in chief, the joint force commander, and the JFMCC should use the peacetime intelligence preparation of the battlespace process as a tool to match munitions to potential requirements upon combatants, prior to deployment and (when possible) upon arrival in the theater.

Command and Control. Issues of command and control (C2) contrast with those of logistics in that C2 is less susceptible to the rationality of numbers. Considered in isolation, logistical problems lend themselves to mathematical solutions, to the computational clarity of operations analysis. This is not true of command in war. Martin Van Creveld writes, "I have spoken of command as if it were solely a rational process (or rather, a combination of processes) in which information is used to orchestrate men and things toward performing their missions in war. This is not strictly true, however, since war is an irrational business par excellence."[29] When studying any new and evolving form of warfare, there is a substantial danger of being seduced into oversimplification, into generalized force-on-force comparisons, into enumeration of technical characteristics at the expense of operational complexities. The purpose of discussing TBMD command, control, and intelligence issues here is to muddy the waters upon which the preceding logistical arguments float, and thus prepare for the complex realities of actual warfighting.

The commander who exercises effective command and control is the one who can resolve the tension between conflicting missions and limited means, a tension inherent in all military operations. It will affect the joint force maritime component commander at three levels: above, i.e., in the joint force, regional, and national arenas, where theater ballistic missile defense will be highly visible; at the theater level, where the maritime component commander must work out initial TBMD plans in competition with other missions and prepare for the eventual shift of air defense control ashore; and at the unit level, where the JFMCC must balance the importance and visibility of the TBMD mission with the distinctly limited number of naval platforms and interceptor missiles initially present.

The disproportionate power granted an aggressor by TBMs elicits an asymmetric response from those threatened by that power. In 2005, the commanding officer of an NTW-capable Aegis cruiser positioned for ascent-phase intercept off the North African littoral could well be responsible for defending many of the capitals of southern Europe from attack by nuclear, biological, or chemical-capable TBMs. This degree of threat, and the potential leverage of a single ship against that threat, will resonate up the chain of command in a way that the conventional antiair warfare mission never has. The joint force maritime component commander must anticipate both support and interference in degrees commensurate with that resonance. How astutely this inevitable phenomenon is handled will directly affect the ability of the joint force to conduct theater ballistic missile defense and the other essential missions the situation may require.

Military forces possessing unique capabilities related to political centers of gravity are likely to see their traditional lines of command and control paralleled by a direct link to the National Command Authorities. Strategic nuclear forces assigned to the U.S. Strategic Command (USSTRATCOM) or special-mission units assigned to the Joint Special Operations Command (JSOC) of the U.S. Special Operations Command (USSOCOM) come immediately to mind. Naval forces have traditionally been resistant to such consolidation of control, as was seen in the debate over the ballistic missile submarine force during the post–Cold War creation of USSTRATCOM, over the degree of naval special warfare autonomy within USSOCOM, and, during the years that a nuclear Tomahawk variant was deployed, whether that weapon could be designated as "tactical"—thus keeping the ships and submarines carrying it under Navy control. To this day, naval doctrine espouses flexibility and individual initiative based on a clear understanding of the mission. Indeed, Naval Doctrine Publication 6, *Naval Command and Control,* cites as historical precedent the view that "armed with an understanding of their senior's intent, the subordinate commanders were expected to conduct a wide range of operations on their own initiative. This style of command has been an enduring characteristic of naval operations and continues to distinguish the way naval commanders exercise command and control today."[30]

The spirit of independent initiative, then, lies at the soul of the naval service. Nonetheless, the joint force maritime component commander must face the fact that modern command and control technology will erode that independence. In the specific arena of naval TBMD, especially high-leverage theater-wide defense, that erosion will be accelerated due to the overarching political importance of particular targets to be protected. NTW assets may well come under the direct control of the joint force commander, the regional commander in chief, or even the NCA; and as a theater matures, joint and area air defense control may well be consolidated—potentially putting ships dedicated to that mission at the disposal of an Air Force general ashore.

Such command relationships represent novel arrangements for both the JFMCC and the surface Navy. The potential of naval TBMD is so great; however, that conventional notions of naval autonomy must be respected only insofar as they bring to bear the maximum effect of these new capabilities. As with other naval assets of recognized political or strategic importance, such as ballistic missile submarines and carrier battle groups, commanders of naval surface forces may well have to alter familiar arrangements to cope with new expectations. Theater ballistic missiles represent so dramatic a challenge in our age that they may impose new command and control relationships on maritime forces.

Competing Missions. JFMCCs are unlikely to have enough ships, aircraft, or VLS cells to deal by themselves with the joint target list; to provide initial defense in depth to vital political, population, and logistics centers; to protect arriving forces; and to ready (for example) an amphibious objective area for power projection operations ashore. The commander must, in effect, continually prioritize, subjecting to risk analysis all these subordinate maritime and air defense missions in order to meet the overall intent of the joint force commander. The maritime component commander must be utterly forthright in assessing naval force capabilities and evaluating the directions given from above. If theater ballistic missile defense is a priority and forces are spread too thinly to protect key strategic centers, the JFMCC—serving also as the area air defense commander—must call for either more assets or a reduction in the points to be defended. To this end, a precise delineation of mission, from the regional commander in chief through the joint force commander to the JFMCC, is essential so that the conflicts among competing responsibilities can be resolved. That statement also will provide guidance and continuity should the joint force or the area air defense commander duties shift to other service components later in the campaign.

Since a chief strength of naval combatants is their innate ability to perform many different missions, one of the challenges facing the maritime component commander will be to prioritize those missions in support of the joint force commander's operational intent, apportioning limited assets accordingly. In anticipation of regional contingencies, operational planners can try to illuminate constants, "first principles" of conflict that do not vary much. For instance, missions are mutable, but ships and their associated systems are known and quantifiable. Confusion and friction can be decreased through careful forethought to match missions and platforms. Similarly, other constants—such as the requirement for redundancy in case the primary ship is unable to engage—have been repeatedly confirmed with similar complex weapon systems, such as Tomahawk.

The unique characteristics and challenges of Navy theater-wide defense highlight the central issue of resolving conflicting missions and limited means, but Navy area defense must not be neglected. It is a complementary capability, not an inferior one, and it is essential to the tenet of layered TBMD defense. Indeed, in specific areas of the joint force commander's operational concept and intent, Navy area defense may indeed dominate planning.

Amphibious operations represent just such an area. In a perverse twist of operational logic, the spread of TBMs and the proliferation of weapons of mass destruction may increase the utility of some types of amphibious operations, but one center of gravity TBMs place at risk is the power projection force itself. Large, geographically fixed land buildups (such as took place in Saudi Arabia during DESERT SHIELD) and all ground installations clearly will be vulnerable if they fall within the range of WMD-capable TBM systems. Operational maneuver from the sea can give the joint force commander alternatives. The Navy's Director for Theater Air Defense has written: "We must be able to force our way ashore even under the threat or actual conduct of TBM strikes."[31] To operate in such a manner with confidence, however, the joint force commander will require NAD assets.

Toward 2005

When making an initial reckoning of what is known and what is unknown, the joint force maritime component commander must consider the nature of the threat, the nature of the mission responding to that threat, and the operational intent of the NCA, the regional commander in chief, and the joint force commander. The nature of the threat will determine how the JFMCC would wish to apportion TBMD forces; then, the limited means on hand and the scope of the mission will reveal whether or not that approach will be possible. The operational intent of the national and theater-level commanders will indicate how much or how little freedom of action the JFMCC can expect to have in supporting that intent.

For example, if the immediate goal of the National Command Authorities centers on coalition-building prior to initiation of offensive operations, TBMD efforts are likely to be politically driven, dedicated to highly visible protection of friendly regional population centers. These actions will be closely controlled from above. Conversely, should the operational focus be on preparations for an imminent offensive, the JFMCC may have more latitude in force positioning—but also a far greater number of tasks to accomplish.

The overarching constraint of limited means must inform the JFMCC's every decision. While by no means unique to the TBMD mission, this constraint will be especially acute due to the dreadful consequences of even a single failure. A clear grasp of the joint force commander's operational intent will allow an initial "triage" of missions—what must be done *now* and what can wait. But even then, the tyranny of numbers and the challenge of distance may spread assets more thinly than doctrine demands. Escorts may have to be pulled away from the carrier in order to guard, say, a logistics facility. An NAD ship, its SM2 Block IVA interceptors expended, may have to transit, without rearming, to a vital TLAM launch area when the primary Tomahawk shooter suffers an equipment casualty. An NTW ship may have to remain on station despite a critical fuel state. This inevitable collision of limited means and conflicting missions implies that while doctrine can be a guide, any presumptive answer will have to be scrutinized with regard to the actual situation. Every decision will be a compromise, and every compromise implies hard choices.

The hard choices faced by the joint force maritime component commander will involve more than mission priority and unit tasking. The JFMCC must understand the essential nature of the TBMD mission well enough to take a vigorous and articulate stand on fundamental issues of command and control. With centralized planning and decentralized execution as the goal, the maritime component commander must balance the need for defensive effectiveness with the requirement for efficiency, driven by a limited interceptor inventory—and choose.

Hard choices also imply acceptance of risk. Constrained by limited means, the JFMCC may be able to defer some missions. Others will plainly and simply have to be carried out. Indeed, the matter of *calculated risk* permeates realistic planning for TBMD, from logistical questions of acceptable fuel states and marginal rearming ports, to political compromises between force protection and foreign population defense. Thus, if the ascent-phase NTW mission is deemed essential by the NCA but not enough Aegis ships are available to send them forward in mutually supporting pairs, then the JFMCC may choose to press on anyway, knowingly putting NTW ships in harm's way, either with a non-Aegis consort or, perhaps, alone.

Political factors bear directly on choices regarding rules of engagement. The JFMCC has a duty to subordinate commanders to press for ROE that increase their freedom of action and decrease the risk to their ships, aircraft, and crews. The JFMCC also has a duty *up* the chain of command: to display the nicest respect for the responsibilities of senior civilian and military authorities, and to do the utmost to understand the policies, objectives, and instructions that forward-deployed naval forces are being used to implement. Thus, the JFMCC must place tactical and operational concerns in context, with due regard for their subordination to overall national policy; what is tactically or operationally attractive may be politically repugnant or strategically counterproductive. The aim must be to assure that the use of naval power truly supports national policy, helping to resolve conflict rather than accelerating or exacerbating it.

Not least important, we should keep in mind that when directed by the joint force commander, the JFMCC must be able to relinquish the TBMD battle to the commander of another component. To be made effectively, this transition must be well planned both doctrinally and specifically, beginning with a decision to structure the TBMD fight jointly. To the greatest extent possible, planning methods, language, and execution should adhere to commonly held joint standards. Otherwise, the TBMD battle cannot be handed off expeditiously as the fight moves inland from the littoral.

The importance of that turnover from component to component, of the transition from afloat to ashore, is at the heart of theater ballistic missile defense, properly conceived. Though this mission may begin under the purview of the maritime component, it belongs to *all* components, for, like the threat which it counters, TBMD transcends traditional boundaries. It is a single mission that enables many.

That said, commanders must beware of technological overconfidence. New systems will work, and work well—but seldom as well as engineers and tacticians hope. For that reason, planners and commanders must hold to the goal of centralized planning with decentralized execution. Such a vision will better allow for Clausewitz's "friction," which comprehends why even the most reliable technological systems perform less than perfectly under the tremendous pressure of war.

Of course, the pressure of war affects the performance of humans as well as machines. Both high-level reasoning and creative thinking decline abruptly under stress. The JFMCC—and everyone in the chain of command above and below—must bear this in mind as they envision operations against the terrible threat of WMD-armed ballistic missiles. Whether commanders succeed or fail in countering that threat probably will be determined principally by how well they have prepared themselves and their subordinates for so demanding a trial by combat.

In a fractious world that often seems to have lost its bearings, theater ballistic missile defense delivered from the sea will give the United States a vital and flexible capability to counter the growing threat of TBMs—and the horrific weapons of mass destruction they can carry. For the naval officer who must actually sail upon that sea and personally contribute to the defeat of an enemy who would use such weapons, this great seaborne defensive capability cannot be considered in isolation from other services' systems, competing naval missions, and the timeless constants of battle.

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