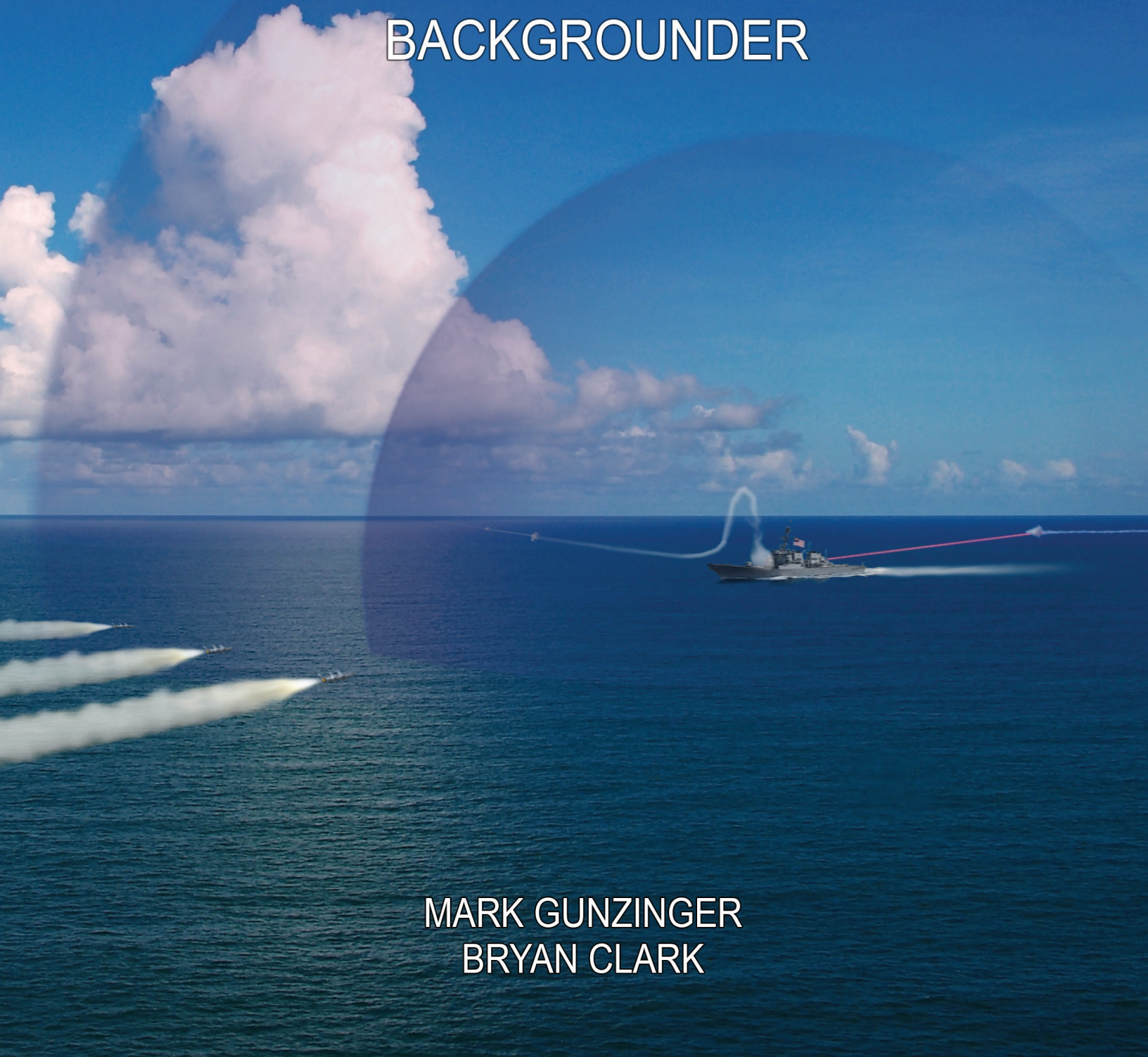




Center for Strategic and Budgetary Assessments

WINNING THE SALVO COMPETITION

BACKGROUNDER



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WINNING THE SALVO COMPETITION BACKGROUND

Over the last fifteen years, the Department of Defense (DoD) spent more than \$24 billion buying a mix of capabilities to defeat guided missile threats it views as a “cost-imposing challenge to U.S. and partner naval forces and land installations.”¹ Despite DoD’s urgency, these investments have fallen short of creating defensive architectures with sufficient capacity to counter large salvos of ballistic missiles, cruise missiles, and other precision-guided munitions (PGMs) that can now be launched by America’s enemies.

This situation is partly the result of DoD’s longstanding emphasis on fielding costly, long-range surface-to-air interceptors to defeat a small salvo of anti-ship cruise missiles or a handful of ballistic missiles launched by rogue states such as Iran and North Korea. It is also because the U.S. military has never fought an enemy who had the capability to strike distant targets with precision. Since the end of the Cold War, the Pentagon had the luxury of assuming that air and missile attacks on its bases and forces would either not occur or would be within the capacity of the limited defenses it has fielded. These assumptions are no longer valid, given that America’s adversaries have taken advantage of proliferating guidance and missile technologies to create their own precision strike capabilities. China, Russia, Iran, and North Korea have developed multiple variants of guided missiles and other weapons that are capable of striking targets with increasing range and precision. Salvos of guided weapons launched during future engagements could overwhelm the defenses of U.S. forces, reducing America’s ability to project power.

The number, accuracy, and reach of guided weapons fielded by China and Iran in particular represent significant conventional threats to the U.S. military’s ability to operate effectively in regions that are critical to the security of our nation and its allies and partners. China has deployed one of the world’s most sophisticated arsenals of anti-ship cruise missiles (ASCMs) and land-attack cruise missiles (LACMs) that can be launched from mobile ground launchers, aircraft, ships, and submarines. China’s ASCMs and LACMs are complemented by multiple types of ballistic missiles that can reach America’s Western Pacific bases and ships at sea. Newer versions of these missiles feature maneuverable reentry vehicles, and future variants may be armed with hypersonic glide vehicles. While Iran’s ballistic missiles lack the accuracy of China’s long-range weapons, it seeks to obtain improved guidance systems from North Korea, China, and other missile technology proliferators that will give its next generation of weapons the ability to hit small, discrete fixed targets or moving targets such as ships.

The thesis of this report is that new operational concepts combined with a different mix of capabilities could help the U.S. military achieve the air and missile defense capacity needed to prevail in future salvo competitions. Today’s “layered” defenses use multiple long-range interceptors against a single incoming missile, then medium-range interceptors, and, as a last resort, short-range defenses. This layered approach may be appropriate for defeating a handful of

¹ Department of Defense (DoD), *Quadrennial Defense Review 2014* (Washington, DC: DoD, March 2014), p. 6.

threats. Against large PGM salvos, however, it could quickly exhaust U.S. air defenses and leave its theater bases and forces vulnerable to successive strikes. By contrast, operational concepts that preferentially use medium-range interceptors, gun-launched guided projectiles, and non-kinetic defenses such as electronic warfare and directed energy (DE) weapons could improve the U.S. military's capacity to counter PGM salvos—and do so at less cost than relying almost exclusively on using multi-million dollar long-range interceptors.

This report proposes operational concepts and capabilities that could greatly improve our nation's ability to defeat guided weapon threats. As with a previous CSBA assessment, the report uses a "salvo competition" framework to assess promising operational concepts and capabilities for air and missile defense. This term refers to the dynamic between militaries that have PGMs and capabilities to counter one another's precision strikes. In a salvo competition, both combatants seek to gain advantages by improving their capabilities to attack with precision and defend against its opponent's strikes.

Recommendation: Develop Operational Concepts to Create Advantages in Future Salvo Competitions

Developing new operational concepts is a critical first step toward creating a new air and missile defense architecture for the U.S. military. The following concepts could reduce the size and lethality of enemy PGM salvos, which will have the same effect in salvo competitions as increasing U.S. defensive capacity:

Take greater advantage of theater bases located in lower threat areas. The U.S. military could reduce the size of PGM salvos by operating from bases and locations at sea situated outside the range of most enemy guided missiles and strike aircraft. A shift toward using more distant, secure operating locations where feasible could impose costs by inducing America's enemies to invest in more expensive, longer-range surveillance and strike systems. It could also increase the vulnerability of a key enemy center of gravity in salvo competitions: the command, control, communications, intelligence, surveillance, and reconnaissance (C3ISR) networks that enemies depend on to strike effectively over long ranges. Operating from longer ranges would, however, reduce the number of aircraft sorties U.S. forces could generate per day. These reduced sortie rates could be partially offset by increasing the number of long-range, large-payload strike aircraft in DoD's inventory and changing DoD's PGM mix toward smaller weapons that can be carried in greater numbers by strike aircraft.

Disperse within contested areas. Where feasible, the U.S. military should disperse its forces that must be based within contested areas. Distributing and frequently redeploying U.S. forces across a network of military, civilian, and expeditionary operating locations in contested regions would require an enemy to launch more weapons to be able to attack the same number of targets. As a result, each individual operating location will receive a smaller salvo of strike weapons against which it must defend. Sustaining dispersed operations would require additional logistics capabilities and infrastructure compared to what is needed to operate from a small number of overseas main operating bases. This could be a major challenge in very large geographic areas such as the Western Pacific.

Conduct cluster base operations within contested areas. DoD should take advantage of clusters of theater bases and temporary operating locations to disperse its forces within localized areas. Cluster basing could dilute enemy strikes over larger target areas and enable U.S. air defenses within each cluster to conduct mutually supporting operations, and increase overall U.S. threat engagement capacity. This concept may be more practical for future operations in Eastern Europe and the Persian Gulf region than in areas such as the Western Pacific that have fewer suitable clusters of military, civilian, and expeditionary airfields.

Increase the resiliency of U.S. bases. To the extent possible, DoD should take steps to harden or deeply bury high-value facilities on its existing bases and employ camouflage, concealment, and deception tactics as part of a comprehensive approach to create more resilient theater base postures. These countermeasures would require enemy forces to launch more weapons at a base to ensure it can defeat the same number of targets, diluting the strikes against targets being protected by U.S. defenses.

Conduct “left-of-launch” operations. The U.S. military should be able to conduct offensive operations against enemy airbases, weapon launchers, and C3ISR networks used for targeting to reduce the size and frequency of enemy salvos. U.S. air forces should have sufficient long-range surface-to-air interceptors and capacity to sustain combat air patrols (CAPs) to defeat enemy strike aircraft before they can launch their weapons. Attacking an enemy’s “archers” instead of its “arrows” could have a much greater impact on the size of its strike salvos, while a blinding campaign that combines cyber warfare, electronic warfare, and physical attacks on its C3ISR networks could greatly reduce its ability to find, fix, track, and strike U.S. targets with large salvos.

The following operational concepts could also help to increase the density of air and missile defenses that protect the U.S. military’s overseas forces and installations:

Take an alternative approach for anti-air warfare. The Navy’s current operational concept for anti-air warfare (AAW) uses a layered architecture intended to progressively intercept missile threats to surface ships at long ranges, then medium ranges, and finally short ranges. Vertical launch systems (VLS) on Navy ships have a finite capacity to carry AAW interceptors that could be quickly expended in high threat areas. Since VLS cannot presently be reloaded at sea, these ships would have to return to a secure port to reload, taking them out of the fight for days or weeks at a time. A defensive AAW scheme that preferentially uses shorter-range interceptors and new kinetic and non-kinetic defenses could increase the number of air and missile threats individual ships can engage while retaining the ability for ships to protect each other. This approach could center on using medium-range (10–30 nm) interceptors such as the Evolved Sea Sparrow Missile (ESSM), four of which can be loaded in a single VLS cell compared to a single Standard Missile-2 (SM-2) or SM-6. The Navy could complement alternative VLS loadouts by equipping appropriate ships with electromagnetic railguns (EMRGs) and traditional guns that fire hypervelocity projectiles (HVPs), solid state lasers (SSLs), high power microwaves (HPM) weapons, and electronic warfare (EW) systems. In contrast to kinetic air and missile defenses with finite magazines, SSL, HPM, and EW defenses will be capable of engaging air and missile threats for as long as they are provided with sufficient power and cooling.

Defend U.S. theater bases and forces against complex weapon salvos. Compared to the Navy’s current AAW architecture, U.S. military theater bases and land-based forces have few defenses against PGM salvos. DoD has deployed a small number of Terminal High Altitude Area Defense (THAAD) and Patriot missile batteries to counter small-scale ballistic missile attacks from North Korea and Iran. It is also deploying a limited ballistic missile defense (BMD) in Europe. Overall, however, DoD lacks sufficient defenses against cruise missiles, G-RAMM, and other PGMs that could compose the majority of future attacks against its overseas bases and forces. Similar to the defensive AAW alternative recommended above, the U.S. military could shift toward using medium-range interceptors and new weapon systems to counter PGM salvos. This shift could increase the density of its land-based air defenses and ultimately improve operating tempo at bases supporting U.S. offensive operations. Moreover, placing greater reliance on EW, SSLs, HVPs, and HPM defenses that can counter threats for thousands and possibly hundreds of dollars per engagement has the potential to create cost exchange advantages for the U.S. military.

Recommendation: Invest in New Technologies and Capabilities to Defeat PGM Salvos

A shift toward operational concepts that will help the U.S. military to prevail in future salvo competitions will require investments in appropriate enabling technologies and capabilities. The following capabilities would help DoD to create a future air and missile defense complex that could counter enemy weapons salvos at a cost that is advantageous to the United States:

Lower-cost, medium-range kinetic interceptors. DoD should take advantage of mature technologies to develop and acquire lower-cost medium-range interceptors that will increase the defense capacity of its ships and theater bases. These interceptors should incorporate advanced target seekers and other technologies that increase the number of effective engagements against enemy salvos in a given period of time and reduce the need for U.S. fire control systems to provide target updates to individual interceptors after launch.

Guns that launch guided or hypervelocity projectiles (HVPs). DoD should develop and field mobile EMRGs and artillery that can launch guided projectiles to intercept air and missile threats within the next five to ten years. These capabilities promise to dramatically increase the U.S. military's salvo defense capacity. DoD is working on some medium caliber guns that can launch guided projectiles at high rates of fire to intercept threats at less than 5 nm. Capabilities in development would enable larger caliber guns to launch HVPs at air and missile threats over medium ranges (10–30 nm). DoD should also develop highly accurate radars to provide precise target information to cue guns and guide their projectiles toward incoming air or missile threats. Future HVPs should have on-board sensors that will guide them to threats that maneuver during their terminal stage of flight.

Directed energy weapons. DoD should augment its kinetic salvo defenses with non-kinetic SSLs and HPM weapons that can engage threats as long as they are provided sufficient power and cooling. Shifting toward medium-range air defense schemes would enable the U.S. military to take advantage of the large magazine potential of these line-of-sight weapons, since they are constrained by the horizon. Given adequate resources, DoD should field within five years SSLs with sufficient power (150 kW to 500 kW) to counter unmanned aircraft, G-RAMM, and some cruise missiles. The Services should also prioritize the fielding of land-based and sea-based broadband HPM systems capable of defeating multiple threats in a salvo.

Electronic warfare countermeasures. Today, EW systems that jam, deceive, or decoy incoming missiles are often considered to be weapons of last resort that are only to be used after kinetic interceptors have failed or been expended. U.S. forces could partially reverse this dynamic by preferentially employing EW systems, SSLs, and HPM weapons against threats that are most vulnerable to their effects while reserving more expensive interceptors for threats requiring kinetic engagements. The Services should cooperatively develop complexes of jammers, decoys, and other counter-salvo EW capabilities that are networked, capable of autonomously sensing the electromagnetic spectrum, assessing air and missile threats, and supporting counter-targeting operations.

Supporting battle management and fire control systems. DoD should develop battle management systems capable of rapidly evaluating and responding to large salvos of PGMs at ranges of 10–30 nm. These systems should determine which threats should be engaged and in what order; assign non-kinetic or kinetic defenses to appropriate targets; and continuously reevaluate the operational picture to determine when salvos have been negated or respond to new PGM salvos. Current combat systems such as Aegis have this capability, but are designed to

manage smaller numbers of threats using a layered defense approach and do not incorporate new capabilities such as SSLs and HPM systems. Future battle management and fire control systems should also have the capacity to provide target updates and command guidance for multiple kinetic interceptors simultaneously, including HVPs and other guided projectiles.

Capabilities for left-of-launch salvo suppression operations. DoD should increase its capacity to suppress enemy land, sea, and airborne PGM launchers and degrade opposing C3ISR networks. Defeating enemy strike systems before they can launch their weapons will impose costs and help reduce the size of salvos to within the capacity of U.S. defenses. Missile suppression operations against land-based missile launchers will require sufficient long-range, penetrating ISR and strike platforms capable of enduring in contested and denied areas. In addition to advanced SAMs, DoD should develop and field long-endurance, large-payload manned and unmanned aircraft that can sustain counterair CAPs over long ranges.

Overcoming Barriers to Rebalancing DoD's Air and Missile Defenses

Operating concepts and capabilities suggested above would help create a future air and missile defense complex capable of prevailing in future salvo competitions. For this to occur, however, DoD will need to address organizational and resource issues that hinder progress.

A continuing bias for long-range missile interceptors. A key barrier to implementing concepts summarized in this report is cultural in nature. For instance, the Navy prefers to rely on multiple layers of defenses that can engage missile threats multiple times before they reach its surface ships. This approach provides a false confidence, however. A layered missile defense that begins at long ranges (greater than 100 nm) depends on the use of large, expensive interceptors and could consume a ship's VLS capacity much faster without substantially improving AAW effectiveness compared to a single medium-range defensive layer. The alternative defensive AAW scheme proposed by this report would give commanders the ability to rapidly engage a threat, assess the engagement's effectiveness, then if necessary re-engage an incoming missile multiple times using medium and short-range defenses guided by automated decision aids such as Aegis. The challenge is significantly different for DoD's theater land-based air and missile defenses. While they are also biased toward large and expensive long-range interceptors, DoD lacks short- and medium-range capabilities needed to defeat salvo attacks against its bases and forces.

Old assumptions for defending theater bases. Pentagon leaders are quick to point out that none of the seven million U.S. military men and women who have supported contingency operations since the end of the Korean War "died as the result of air attack."² While DoD should take great pride in this accomplishment, it doesn't make sense for it to invest billions of dollars to enhance the survivability of its air forces in the air, yet leave U.S. regional bases vulnerable to attack by the panoply of guided weapons that transit the air domain. Since the end of the Cold War, the Pentagon has assumed air and missile attacks on its bases would either not occur or would be within the capacity of the limited defenses it has fielded. Acknowledging this assumption is no longer valid would be a major step toward securing one of the U.S. military's most critical centers of gravity: the overseas installations it depends on to conduct power-projection operations.

² "Squaring the Circle: General Mark Welsh III on American Military Strategy in a Time of Declining Resources," American Enterprise Institute, December 11, 2013, p. 3, available at https://www.aei.org/wp-content/uploads/2013/12/-general-welsh-transcript_141054774567.pdf.

Unclear responsibilities. Responsibilities within DoD for preparing to defeat salvo attacks are not well demarcated. While the mission of the Missile Defense Agency (MDA) is to create a ballistic missile defense architecture, it is not presently responsible for defining requirements and initiating programs to defeat cruise missiles. Guidance to the Services on who should prepare to defend America's forward bases against PGM salvos is also ambiguous. Working with Congress, the Pentagon should clarify the responsibilities of MDA, the Services, and other major DoD components to organize, train, and equip forces to defeat PGM salvos that include cruise missiles and air-delivered PGMs as well as ballistic missiles.

Insufficient resources. Congress and DoD should allocate sufficient resources to build air and missile defense architectures on land and at sea that will help America's military to prevail in future salvo competitions. Of the \$524 billion requested by the FY2017 President's Budget for DoD, less than \$3 billion was allocated to procure missile interceptors of all types. Continued funding at this level may prove insufficient to develop effective defenses against salvos of ballistic missiles, cruise missiles, and other guided weapons that threaten America's vital interests at home and abroad.

Conclusion

In conclusion, over the last twenty-five years DoD has heavily weighted its air and missile defense investments toward defeating a small number of cruise or ballistic missiles. As a result, it is inadequately prepared for salvo competitions with enemies that have developed their own sophisticated precision strike complexes. DoD has the opportunity to adopt operational concepts and rebalance its capabilities to defend against a wider range of guided weapons. This would require congressional support for new programs and an allocation of resources commensurate with this growing threat. Continuing to adhere to traditional concepts and capabilities for missile defense, however, could invite America's adversaries to continue, if not accelerate, their investments in guided weapons, further eroding the U.S. military's ability to project power.

ABOUT THE CENTER FOR STRATEGIC AND BUDGETARY ASSESSMENTS (CSBA)

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