Missile Defense Challenges:

Defending a Distributed Network

of Temporary Airfields and Logistics Nodes

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Introduction

The 2018 National Defense Strategy (NDS) was a landmark document in reorienting the U.S. Department of Defense (DoD) on the threat posed by long-term, strategic competition with Russia and China (Department of Defense, 2018, p. 2). Both the previous Trump administration and the current Biden administration have emphasized China as the principal long-term threat to American security and prosperity (Biden, 2021, p. 6).

These potential U.S. adversaries, as well as other regional threats such as North Korea and Iran, possess cruise and ballistic missile capabilities that threaten areas military planners have traditionally considered “safe” (Mills, 2020, p. 1). These “rear” support areas are essential to enable successful military operations with lines of communication and supply between airfields and sea transit nodes. The Joint Force’s approach to address this challenge is characterized by dynamic, temporary support area nodes, especially airfields, that are resilient enough to sustain a short period of exposure to cruise and ballistic missile threats before dispersing and relocating elsewhere (Mills, 2020, p. 2). To facilitate this approach, the Joint Force must develop sustainable missile defense systems which are effective, mobile, interoperable, and have the longevity (rate-of-fire and munition load) to defend airfields and other nodes long enough for their on-going missions to be effective.

Today, the collective Joint Force does not sufficiently account for the cruise and ballistic missile threat to support area security and relies on an antiquated Service-driven model to provide robust and dynamic missile defense against a profoundly new threat. This paper will consider the cruise and ballistic missile threat, the Joint Force’s innovative approach to countering that threat, and the Services’ (Army, Navy, Air Force, Marine Corps, Space Force) and Missile Defense Agency’s (MDA) current development and acquisition approaches to support this innovative approach. Finally, it will consider other technological and policy approaches to missile defense to more effectively support the Joint Force's efforts to adapt to this new threat.

Missile Defense Threats

The 2018 NDS tasked the U.S. Armed Forces to prepare for a new reality, one defined by state-on-state near-peer competition, specifically with revisionist powers Russia and China who seek to alter the rules-based international order. Today these near-peer competitors are equipped with over-the-horizon intelligence, surveillance and reconnaissance and long-range precision fires capable of disrupting a U.S. or allied military intervention from thousands of miles away from a crisis area. In such a conflict, the idea of U.S. and allied forces building up large operational hubs over a period of months from which to address the regional crisis is simply infeasible. As the crisis in Ukraine has made clear, if a rapid Russian or Chinese military action is successful, attempting to reverse the results will require U.S. forces to deploy under the threat of the adversary's precision weapons, rather than safely mobilizing in an adjacent country as U.S. and allied forces did to prepare for Operation Desert Storm. In a modern scenario rapid mobility is key. As the U.S. Indo-Pacific Command Investment Plan for Implementing the National Defense Strategy Fiscal Years 2022-2026 notes:

> "…forward-based air and naval forces need the ability to disperse to expeditionary airfields and ports. This creates temporary windows of localized air-maritime superiority, enabling maneuver, while amphibious forces create and exploit temporal and geographic uncertainty to impose costs and conduct forcible entry operations." (U.S. Indo-Pacific Command, 2021, p. 3)

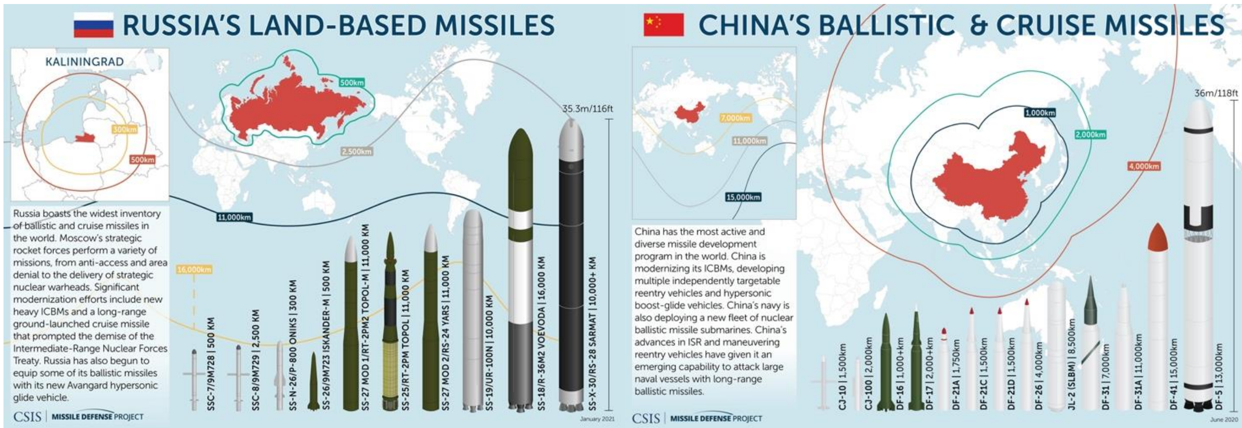
The Services have recognized the change in the strategic environment and begun adjusting their modernization objectives to meet them. However, both DoD and Services policies and processes risk adapting too slowly to need. In August 2020, Chief of Staff of the Air Force General C. Q. Brown published *Accelerate Change or Lose,* stating:

> Competitors, especially China, have made and continue aggressive efforts to negate long-enduring U.S. warfighting advantages and challenge the United States' interests and geopolitical position….While we and industry previously enjoyed the benefit of time, when U.S. Air Force dominance seemed unassailable, we are now seeing competitors outpace our current decision structures and fielding timelines. (Brown, 2020, p. 3)

Whereas previously Joint Force Commanders could assume that Joint Force missile defense systems would be sufficient to any potential scenario, today's reality is that the current suite of missile defense systems will be ineffective at meeting the requirements of what the Joint Force calls a highly contested environment. Then-Vice Chairman of the Joint Chiefs General John Hyten noted in an interview with Center for Strategic and International Studies in February 2021:

> [for] integrated air missile defense…it's important to look at China, Russia, North Korea, Iran, in particular…because those countries have been watching us for, really, the last 20, 25 years, developed strategies to deal with our strengths, and they've all decided that they will put significant investments in missiles. That's ballistic missiles, hypersonic missiles, cruise missiles, air-delivered missiles, sea-based-delivered missiles, land-based-delivered (Karako, 2021a, p. 2).

The emerging challenge of a military confrontation with Russia or China has tested the DoD to reinvigorate its capability development and acquisition model. In either case of a military confrontation with Russia in Eastern Europe or with China in the South China Sea, rapidly emerging ballistic, cruise, and hypersonic missile technologies will influence Joint Force employment to support international allies or partners in support of U.S. and Allied policy goals.



Figures 1 & 2: Missiles of Russia and Missiles of China (Missile Defense Project, 2018a & b)

According to the CSIS's Missile Defense Project, "Russia boasts the widest inventory of ballistic and cruise missiles in the world," while "China has the most active and diverse missile development program" (Missile Defense Project, 2018a & b). In recent years both China and Russia have increased the pace and technology of their ballistic and cruise missile development programs, to include hypersonics (Missile Defense Project, 2018 a & b). Recent tests of weapons such as the Russian Zircon and the Chinese WU-14 are two examples of these advanced hypersonic technologies (Shaikh, 2021a & b). The charts above depict current Russian and Chinese cruise and ballistic missile capabilities, both easily sufficient to dominate their region and contest outside intervention in local conflicts. In additional, Russia has recently demonstrated during its invasion of Ukraine its intent to utilize these weapons extensively in future conflicts, both to engage targets in the conflict zone as well as to deter U.S. or allied intervention, as its strikes near the Polish border suggest (Missile Defense Project, 2017b).

Additionally rogue nations like Iran and North Korea maintain extensive stockpiles of ballistic and cruise missiles. Under the current regime since 2010 North Korea has exponentially increased their missile research and development efforts (Missile Defense Project, 2017a). Iran has recently demonstrated its ability and willingness to use ballistic and cruise missiles to influence regional military interventions extensively, including the January 2020 attack on Al Asad airbase and Houthi attacks on Saudi and Emeriti forces throughout the ongoing conflict in Yemen (DIBMAC, 202, p. 19; and Williams & Shaikh, 2020).

Given the ongoing crisis in Ukraine and the increasingly tense and bellicose exchanges between China and Taiwan, the Joint Force must consider how it might need to prepare to support U.S. policy were China to attempt a forceful reunification and if U.S. policymakers directed military intervention, or in a similar scenario in eastern Europe. In either case, the Joint Force can expect a confrontation with any of these adversaries to develop at a speed, scope, and complexity exceeding the pace of what it has become accustomed to in Iraq, Afghanistan, and Syria.

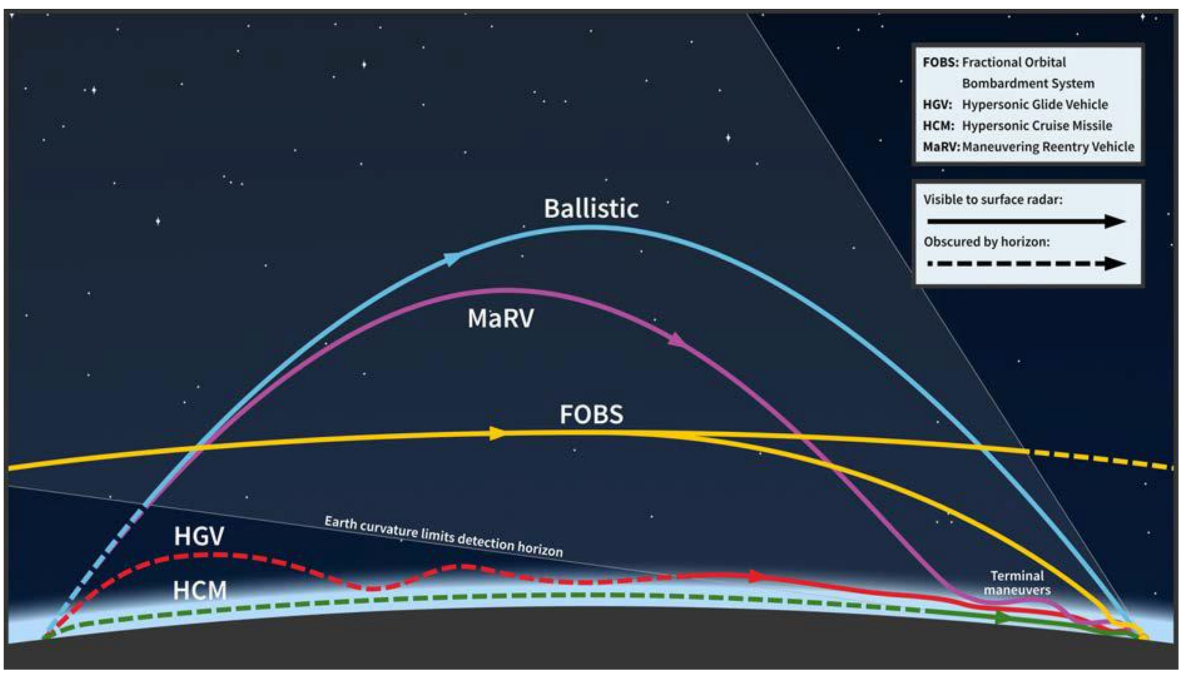


Figure 3: Hypersonic and Ballistic Trajectory Comparison (Karako & Dahlgren, 2022, p. 6)

Defending maneuver forces against these advanced threats pose multiple problems for the Joint Force that current defensive capabilities are ill-equipped to tackle. Tom Karako and Masao Dahlgren of CSIS describe how hypersonic weapons' "combined characteristics of high speed, lower altitude, and maneuverability stress existing defenses" (Karako & Dahlgren, 2022, p. 6). The problems are three-fold: first the increased ranges of these weapons allow adversaries to reach further without risking their own forces. These long-range threats can be fired from the relative safety of the enemy rear areas, making it extremely difficult and risky for US forces to try to "shoot the archer". Second, these advanced threats operate at various altitudes from very near-ground level to well into space. Current missile defense systems have limited capability to defeat threats at some of these altitudes. Additionally, lower-altitude threats, based on curvature of the earth present reduced lines-of-sight as the threats approach, which results in less time for the defensive munition to intercept the threat (Karako & Dahlgren, 2022, 23).

Finally, the speed and maneuverability of these threats create technological challenges with intercepting them. Any missile defeat mechanism must have the ability to intercept the threat whether the threat is turning or flying in a straight trajectory. "Today's air and missile defense interceptors, designed for slower or more predictable targets, lack the kinematic and divert performance to reliably intercept terminal-phase hypersonic maneuverability" (Karako & Dahlgren, 2022, p. 23). Compounding the velocity and altitude of some of these new threats presents a difficulty intercepting them due to the short time it may take hypervelocity threats to travel great distances or the short target exposure window of low-flying cruise missile threats.

Joint Force Innovation and Requirements

The 2018 NDS directed the Joint Force to develop and employ innovative operational concepts and new technologies to be more lethal, adaptive, and resilient against these threats.

The Joint Warfighting Concept is the Joint Force's capstone document to evaluate emerging threats and identify Joint Force requirements to deter and, if required, defeat them. In the interview above with CSIS, General Hyten described what the Joint Force needs to do to mitigate the ballistic and cruise missile threat these adversaries will employ:

> …in the Joint Warfighting Concept the critical structure is basically expanded maneuver – maneuver in every domain, every structure, every command…and we have to do it faster than the adversary. Which means that our ground forces have to move faster than the adversary and they have to be able to defend themselves wherever they go…The same with the maritime forces. Same with air. (Karako, 2021a, p. 19)

To meet the requirements of this new operational model, enterprise adaptations and innovations that support mission generation in a distributed and contested environment will be key to success (Pacific Air Forces, 2020, p. 2). The Joint Force's success in combat hinges on the ability to achieve air superiority in contested environments. As General Hyten noted, maneuverability is the key to success in this environment (Karako, 2021a, p. 19). The Air Force took this cue and identified agile, dispersed basing as the critical element for wartime success and developed the Agile Combat Employment (ACE) operational concept (U.S. Air Force, 2021, p. 1). ACE relies upon an adaptive cluster, hub-and-spoke operations concept to posture, protect, maneuver, command and control, and sustain air forces (U.S. Air Force, 2021, p. 3). These distributed, dynamic hub-and-spoke networks present the adversary missile threat far greater unpredictability, preventing them from massing the full effects of threat missile capabilities while presenting multiple options and vectors for holding the adversary at risk (U.S. Air Force, 2021, p. 3). However, current missile defense technology is insufficient in quantity, capability, and maneuverability to defend against many of these new missile threats while rapidly relocating from one airfield or logistical node to the next.

The DoD should consider innovation across a number of areas to meet future challenges, of which the ACE concept is only the first step. Technology is only part of the solution; doctrine, force design, and policy innovation together with technology may provide advantages, enabling greater synergy and resource efficiency. Joint air and missile defense system development and redesigning forces to operate multiple Joint systems in a distributed approach could enable Joint Force Commanders the necessary flexibility to defend remote, distributed installations.

Technology

As the DoD pursues technological solutions to the missile defense problem, it has not enforced jointness within science and technology or program development, resulting in a disjointed and “siloed” effect between Service solutions. To the observer there seems to be little or no meeting of components and Services to work through Joint requirements before receiving funding, thus reducing their ability to honestly share information and work together to become more efficient and give the warfighter the tools they need to win.

The Army, Navy, and MDA are continuing to pursue incremental kinetic missile defeat solutions to address the growing challenge posed by potential adversaries’ ballistic and cruise missile threats. Navy efforts with MDA focus on continued development of the Aegis combat system, the current cruise and ballistic missile defense staple on Navy cruisers and destroyers to protect carrier strike groups, amphibious assault groups, and limited defense of land sites (O’Rourke, 2022, p. 1). Additionally, MDA has been the lead for developing and fielding the Aegis Ashore capability, which was first fielded in 2016, a system which the Navy has expressed a desire to divest (O’Rourke, 2022, p. 6). Air and Missile Defense is one of the Army’s six modernization priorities (Camarillo, 2022, p. 11), but that effort is necessarily divided between Short Range Air Defense (SHORAD) of Army maneuver forces from shorter range missiles, rockets, low-flying aircraft, and drones; High to Medium Air Defense (HIMAD) systems like the current PATRIOT and new Indirect Fire Protection Capability (IFPC) Increment 2 which protect larger fixed sites like airfields and logistics bases from cruise and ballistic missiles; and the Terminal High Altitude Area Defense (THAAD), which defends larger geographic areas from ballistic missile threats (cities) (Vick et. al., 2020, p. 2). In particular, the IFPC Increment 2 has been slow to develop and field (Vick et. al, 2020, p. 42), and in Fiscal Year (FY) 2022 received only 78 percent of the Army's requested funding from Congress, whereas its SHORAD procurement and research, development, testing, and evaluation (RDT&E) were fully funded (Rumbaugh, 2022). In the case of defending temporary sites where neither Service may be primary force contributor or mission owner, both the Navy's and Army's lack of focus on the problem is somewhat understandable (Vick et. al., 2020, p. 95 & 97-99).

For the Army systems in particular, a major disadvantage of these systems is the size, weight, and consequently slow deployment timelines. Army Field Manual 3-01.85 describes the aircraft requirements to deploy a PATRIOT minimum engagement package, consisting of two of the four launchers in the battery and representing the minimum functional PATRIOT organization. Assuming a PATRIOT unit is pre-identified on the shortest possible SecDef-approved 96-hour Prepare To Deploy Order (PTDO), the unit would require five days and seven C-17 aircraft to deploy, plus an additional C-17 for interceptors (U.S. Army, 2002, p. F-3).

An alternative approach to missile defense technology which is gaining momentum in the Department is Directed Energy (DE) weapons. Joint Publication 3–85 Joint Electromagnetic Spectrum Operations, describes directed energy (DE) as an:

> Umbrella term covering technologies that produce a beam of concentrated electromagnetic energy or atomic or subatomic particles. A DE weapon is a system using DE primarily as a direct means to disable, damage or destroy adversary equipment, facilities, and personnel. (GL-6)

DE weapons include many technologies that utilize electromagnetic energy such as high energy lasers (HEL) and high-power microwaves (HPM) as well as charged or neutral particle beams. Figure 4 below depicts the differences in characteristics between HEL and HPM (Gunzinger, 2012, p. 40). These types of weapons have been in development for decades and are closer to being operationally realized now more than ever (Obering, 2019, p. 27). As Obering points out, DE weapons provide several advantages and possible mitigations to the challenges presented with the advancing threat. DE weapons are fast, moving at the speed of light, virtually unlimited shot magazines, offer very little signature that an engagement is occurring, can be very accurate, and offer a relatively low cost per kill ratio (Obering, 2019, p. 39).

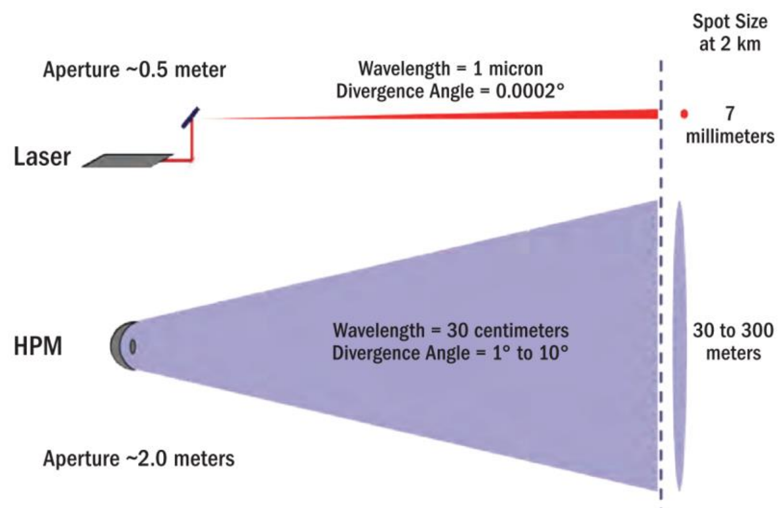


Figure 4: Illustrative Effects of HELs vs HPM Weapons (Gunzinger, 2012, p. 40)

In FY22, DoD requested at least $578 million for unclassified DE research, development, test, and evaluation (RDT&E) and at least $331 million for unclassified DE weapons procurement (Sayler, et. al., 2021, p. 4). These investments support the Department's DE

Roadmap, with a stated objective of "[achieving] dominance in DE military applications in every mission and domain where they give advantage" (Trebes, 2020). DoD analysis indicates that a laser of approximately 100 kW could engage UASs, rockets, artillery, and mortars; a laser of around 300 kW could additionally engage small boats and some cruise missiles; and lasers of 1 MW could potentially neutralize ballistic missiles and hypersonic weapons (Trebes, 2020). The DoD roadmap outlines DoD's plan to increase power levels of HEL weapons from around 150 kilowatts (kW—a unit of power), as is currently feasible, to around 300 kW by FY2022, 500 kW by FY2024, and 1 megawatt (MW) by FY2030. (Sayler et. al, 2021, p. 3)

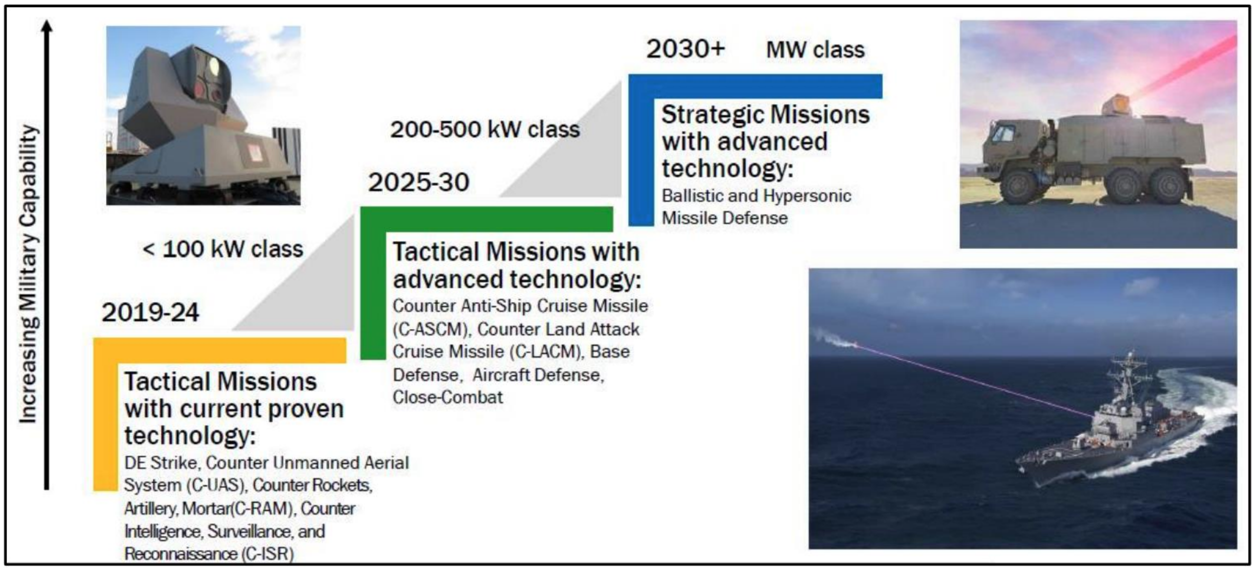


Figure 5: Summary of DoD Directed Energy Roadmap (Sayler, et. al., 2021, p. 3)

Examples of potential laser weapon programs which would be applicable to temporary airfield and logistic node defense include the Army's IFPC-HEL and the Navy's HELCAP (Sayler, et. al., 2021, p. 9 & 15). The IFPC-HEL will leverage technology from the HEL Tactical Vehicle Demonstrator (HEL-TVD), whose goal is development of a 100 kW-class laser to an existing military truck to provide a counter rocket, artillery, and mortar (C-RAM) capability to protect fixed sites and potentially in a SHORAD role to protect against UAVs and, if successfully scaled to higher power levels, cruise missiles (Sayler, et. al., 2021, p. 9). The Army seeks to increase the power output of HEL TVD to 300 kW and leverage the technology toward the IFPC-HEL program with a goal of initial demonstrations in FY2022, prototypes in FY2024, and transition to a program of record in FY2025 (Sayler, et. al., 2021, p. 9). The Navy is also pursuing High Energy Laser Counter-ASCM (Anti-Ship Cruise Missile) Program (HELCAP), which may have land-based applications as well. HELCAP will utilize a 300 kW laser with scheduled demonstrations in FY2023 (Sayler, et. al., 2021, p. 15).

A second key area of DE missile defense capability development is HPM. In a demonstration of the increased effort and potential payoffs of HPM, the Naval Surface Warfare Center Dahlgren Division (NSWCDD) recently reorganized its Directed Energy division into two, one for laser development and a second for HPM. Examples of HPM weapon technology include the Air Force Tactical High Power Operational Responder (THOR) HPM, Army IFPC-HPM systems, and Raytheon's Phaser, which are intended to be used in conjunction with counter-missile systems to defend against groups or swarms of drones (Sayler, et. al., 2021, p. 5-6 & 9-10).

While these programs are evidence that the Services and MDA are making some progress at new missile defeat technologies, they also reflect an incremental, unsynchronized, and unintegrated approach. This approach seems unlikely to deliver the leap ahead missile defense capabilities the Joint Force needs, and those systems Services field are likely to be difficult, if not impossible, to integrate smoothly into the dynamic Joint warfighting model Hyten described.

Policy

DoD policy itself needs to adjust to enable air and missile defense across distributed operating sites. First, air defense acquisition policy should shift away from Service-driven to threat-driven, Service-agnostic requirements. Second, Service roles and responsibilities should be adjusted to allow Services the flexibility to defend their own operating locations rather than relying on another Service. Current roles and responsibilities for missile defense place an unrealistic demand on Services to anticipate where, when, and how long they will need to operate at particular locations and other Services to anticipate where, when, and how many air defense forces they will need to provide.

Although the 2018 NDS states the Joint Force will develop and employ innovative operational concepts and new technologies to be more lethal, adaptive and resilient against the threat, it doesn't specify how the Services should do this (p. 7). Hence each Service competes for funding for unique capabilities to employ in the Joint fight. In 1986, the Goldwater-Nichols Act was revolutionary in establishing a Joint Force construct under the Chairman of the Joint Chiefs. This need was amplified with the 1980 unsuccessful rescue of 52 diplomats held in captivity by Iran. Operation Eagle Claw was a failure and in its aftermath birthed drastic change in the DoD. Analysis of the operation identified that, "no one service had the capabilities to undertake the mission," and the Services were not trained or prepared to "operate a complex of independent missions" (Hamre, 2016, p. 1). With adversaries such as China, Russia, Iran and North Korea, focusing their efforts to outpace the United States at every turn on the world stage, the U.S. should not wait for another catastrophic failure to make the next revolutionary change in how the DoD defends the Nation and our Allies.

Is DoD meeting the true need for joint employment when implementing missile defense? While the Joint Force is executing the 1986 Goldwater-Nichols Act as written, the Services which remain primarily responsible for new capability development are grounded in a culture of Service needs and perceptions first (Vick et. al., 202, p. 95), versus the needs of the Joint Force Commander who will employ the capability. As the Joint Force rethinks how to implement concepts like ACE with primarily expeditionary, vice in-theater prepositioned forces, it becomes clear that this antiquated Service-driven missile defense model will not work in today's environment. The new threat environment requires DoD to engineer a new missile defense construct for warfighters in an effort to adequately defend our Nation from near-peer adversaries.

An alternative approach might be pursuing Joint development of a limited number of common platforms for employment by any Service forces according to the circumstances in support of the Joint Force Commander and applied to the hub-and-spoke model. Such an approach, unencumbered by the fixed Service missile defense roles established in DoD Instruction (DoDI) 5100.01, would enable the versatile, scalable, survivable, and data-centric missile defense model critical for success in the highly dynamic and lethal emerging threat environment. This integration would enable air forces to protect ACE hub and spoke nodes (U.S. Air Force, 2020), naval forces to protect carrier strike groups (Vick et. al., 2020, p. 98-99), and land forces to protect ground forces (Vick et. al., 2020, p. 95 & 97-99) as required to rapidly aggregate, employ and disperse combat capability. Simplistic as this may seem, it would provide greater versatility in the defense of Joint Force sites around the world. It would also streamline the disparate weapon systems Services continue to build, deploy and then find undesirably expensive to maintain. As noted by both General Hyten and Army Space and Missile Defense Commander Lieutenant General Karbler, there are never enough PATRIOT systems (Karako, 2021a, p. 5; Karako, 2021b, p. 8) to meet Joint Force needs, and the case is similar for Navy Aegis systems. Joint development would allow greater interchangeability, allowing Joint Force Commanders to pool or dynamically redistribute limited air defense resources. It would also enable the Joint Force to focus on developing technology necessary to defeat threat missiles, rather than specific Service domains, platforms, or doctrinal employment models.

Per DoDI 5100.01, the Army has been charged to “conduct air and missile defense to support joint campaigns and assist in achieving air superiority” (p. 35), but it cannot deploy rapidly enough to defend against all possible contingencies at all locations. Additionally, this places a burden on the Army to prioritize Joint air defense requirements over other Service specific requirements for ground combat, a no-win scenario for the entire Joint Force. In contrast, what if, for instance, a prepositioned PATRIOT (or Aegis Ashore) battery could be operated by Airmen at a forward airbase? This would significantly reduce response time, provide base defense resiliency and allow the Army time to arrive, or deploy forces elsewhere.

Developing common weapon systems that are prepositioned to defend until reinforcements are able to arrive, and training units to operate them could reduce the burden on any one Service to be everywhere at once. DoD does this today to a degree. Hand weapons like rifles and pistols are interchangeable across Services, and despite its challenges, the F-35 is an example of the benefits of Joint development. While the functions of DoD components are updated periodically in DoDI 5100.01, a more radical step is needed when it comes to addressing the missile defense threat, one that enables threat-focused capability development and increases options for Joint Force Commanders faced with new and dynamic challenges.

Conclusion

This paper began with the hypothesis that current Joint Force investments may not sufficiently account for the cruise and ballistic missile threat to support area security. Reviewing emerging threats, the Joint Force’s response, Services’ planned development and acquisition, and emerging technologies, there is more that can be done. The Joint Force needs to pursue both kinetic and DE missile defeat capabilities while reducing system size and weight to maximize deployment speed and agility. Service-specific programs for each will inherently cost more and result in less interoperable systems which are in turn more expensive to operate, staff, and maintain. In contrast, Joint Force Commanders need greater flexibility and responsiveness to address dynamic and lethal threats. While Goldwater-Nichols was revolutionary in its day, further steps are required to enable Joint employment in a missile defense context. Joint development of a suite of common missile defense systems is that next step.

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