JANUARY 2018

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New Operational Concepts for Integrated Air and Missile Defense

AUTHORS
Thomas Karako
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Contents

List of Figures

List of Tables

List of Acronyms

A2/AD	anti-access/area denial
AMD	air and missile defense
AMRAAM	Advanced Medium-Range Air-to-Air Missile
ARCIC	Army Capabilities Integration Center
ATACMS	Army Tactical Missile System
BMDS	Ballistic Missile Defense System
C2	command and control
C2BMC	Command and Control, Battle Management, and Communications
CEC	Cooperative Engagement Capability
DOTMLPF	doctrine, organization, training, materiel, leadership and education, personnel, and facilities
DPICC	Dismounted Patriot Information Coordination Central
ECS	Engagement Control Station
ELES	Enhanced Launcher Electronics System
ENBAD	Extended-range Non-Ballistic Air Defense
ESSM	Evolved Seasparrow Missile
FCS	Future Combat System
GBI	Ground-based Interceptor
GEM	Guidance Enhanced Missile
GMD	Ground-based Midcourse Defense
HAWK	Homing All the Way Killer
HIMARS	High Mobility Artillery Rocket System
IAMD	integrated air and missile defense
IBCS	Integrated Air and Missile Defense Battle Command System
ICBM	intercontinental ballistic missile
ICC	Information Coordination Central
IFPC	Indirect Fire Protection Capability

ISR	intelligence, surveillance, and reconnaissance
JIAMDO	Joint Integrated Air and Missile Defense Organization
JLENS	Joint Land Attack Cruise Missile Defense Elevated Netted Sensor
LRASM	Long-Range Antiship Missile
MDAP	Major Defense Acquisition Program
MDB	Multi-Domain Battle
MEADS	Medium Extended Air Defense System
MLRS	Multiple Launch Rocket System
MML	Multi-Mission Launcher
MSE	Missile Segment Enhancement
NASAMS	National Advanced Surface-to-Air Missile System
NIFC-CA	Navy Integrated Fire Control-Counter Air
NLOS-LS	Non Line of Sight Launch System
OIF	Operation Iraqi Freedom
PAC-3	Patriot Advanced Capability-3
PACOM	Pacific Command
RAM	rocket, artillery, and mortar
SEAD	suppression of enemy air defenses
SHORAD	short-range air defense
SLAMRAAM	Surface-Launched AMRAAM
SM	Standard Missile
SMDC	U.S. Army Space and Missile Defense Command
THAAD	Terminal High Altitude Area Defense
TRADOC	U.S. Army Training and Doctrine Command
UAV	unmanned aerial vehicle
VLS	Vertical Launching System

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01

After Integration, What?

A new problem has arisen: the prospect of conflict with near-peer adversaries who have spent two decades going to school on the American way of war. Although a conversation is now under way about how to adapt the U.S. military to this new strategic environment, air and missile defense (AMD) forces have been all too absent from that conversation. Against near-peer threats, today's AMD force is unfortunately far too susceptible to suppression. One avenue for transformation is with new and more imaginative operational concepts. More distributed AMD operations would improve their flexibility and resilience and in turn strengthen the broader joint force.

NEW OPERATING ENVIRONMENT

Joint Staff and Service publications have long pointed to the emergence of high-end technology threats, and some of those predictions have now materialized.[1] Potential adversaries like Russia and China have acquired a spectrum of air and missile capabilities and emulated U.S. concepts for using deep precision strike to fracture ground and naval forces. Unmanned aerial vehicles (UAVs), for instance, might be used to provide reconnaissance and targeting data to enable cruise missile, artillery, and ballistic missile strikes.[2] Salvos or swarms may be used simultaneously, creating a complex, cluttered, and confusing battlespace. Advanced surface-to-air missiles could also hinder U.S. air operations, as well as the transport and supply of ground forces.

1. John M. Shalikashvili, *Joint Vision 2010* (Washington, DC: The Joint Staff, 1996), 22–24; Jonathan W. Greenert and Raymond T. Odierno, "Adjusting the Ballistic Missile Defense Strategy," Memorandum for Secretary of Defense, November 5, 2014; Martin E. Dempsey, *Joint Integrated Air and Missile Defense: Vision 2020* (Washington, DC: The Joint Staff, 2013), 1; Kevin D. Scott, *Joint Publication 3-01: Countering Air and Missile Threats* (Washington DC: Joint Chiefs of Staff, 2017).

2. Amos Fox, "Understanding Modern Russian War: Ubiquitous Rocket, Artillery to Enable Battlefield Swarming, Siege Warfare," *Fires Bulletin* (September–October 2017): 23.

A missile-heavy threat set already forms the backbone of the anti-access and area denial (A2/AD) capabilities that complicate American power projection, but those complications are growing. Although tenets of the Cold War–era AirLand Battle doctrine still have important applications and have worked well in smaller operations against lesser threats, the new operating environment has many contested domains. U.S. forces now have more limited forward presence, their numbers are far fewer, and air supremacy is no longer a given.[3] Potential adversaries' integrated air defenses and precision strike weapons hold forward-based U.S. forces at risk, complicate maneuver, and impair freedom of action.

In the face of complex integrated attack, integrated air and missile defense (IAMD) has become critical for joint operations.

Unfortunately, the United States is not well postured against this form of combined arms, and without swift adaptation it will not be for the foreseeable future. In the face of complex integrated attack, integrated air and missile defense (IAMD) has become critical for joint operations.

MULTI-DOMAIN BATTLE

The military Services have been generating new concepts to defeat these challenges, including the U.S. Navy's Distributed Lethality and the U.S. Army and Marine Corps' Multi-Domain Battle (MDB).[4] Distributed Lethality envisions putting strike assets on everything that floats in order to complicate the surveillance, targeting, and suppression of U.S. maritime operations. MDB likewise seeks innovative ways "to create temporary windows of superiority across multiple domains and throughout the depth of the battlefield" (see Figure 1.1).[5] Instead of attempting to simultaneously dominate at every level and in every domain, the "temporary" quality of these windows reflects the difficulty of the near-peer challenge. Ongoing air supremacy may not be a realistic goal, for instance, let alone the old aspiration of "full spectrum dominance."

Maneuver operations will reportedly be central to MDB, which envisions U.S. "forces capable of outmaneuvering adversaries physically and cognitively through the extension of combined arms across all domains."[6] But moving smartly around the battlefield will not be sufficient to hide from

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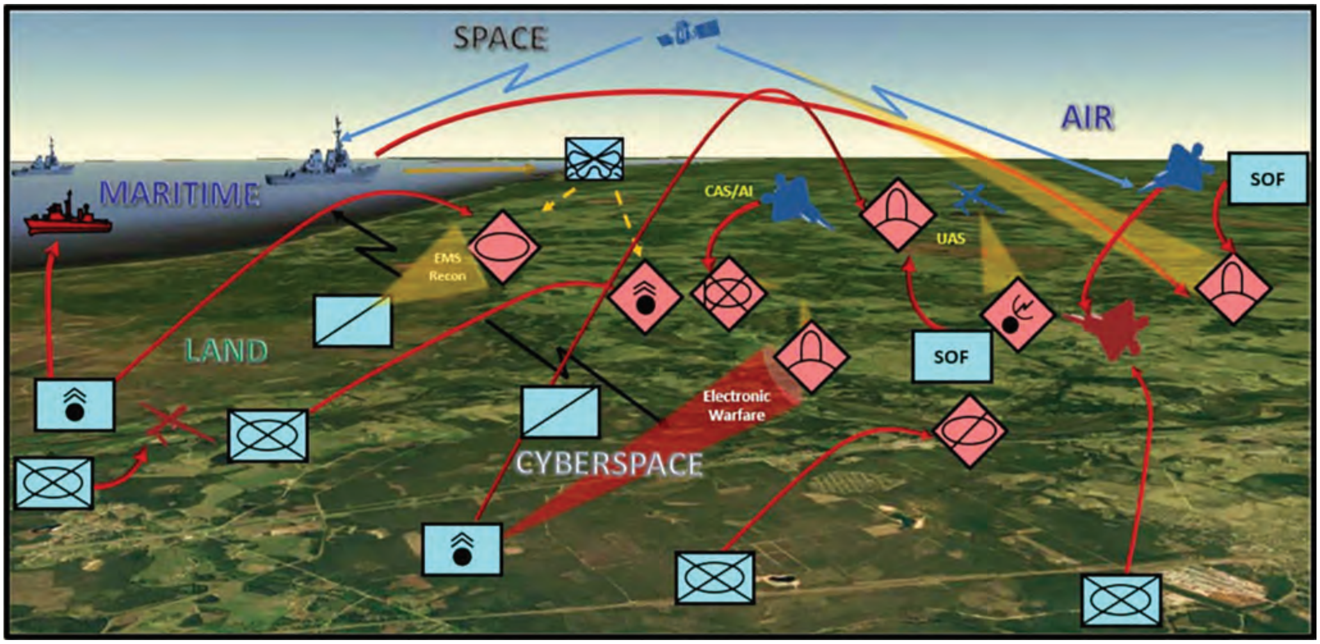
3. Christopher L. Spillman and Glenn A. Henke, "The New Threat: Air and Missile Defense for Brigade Combat Teams," Association of the United States Army, February 17, 2017, https://www.ausa.org/articles/new-threat-air-and-missile-defense-brigade-combat-teams.

4. Thomas Rowden, Peter Gumataotao, and Peter Fanta, "Distributed Lethality," *Proceedings Magazine* 141, no. 1 (January 2015): 343. More recently, the Navy has begun to adopt the phrase Distributed Maritime Operations. David G. Perkins, "Multi-Domain Battle: Joint Combined Arms Concept for the 21st Century," Association of the United States Army, November 14, 2016, https://www.ausa.org/articles/multi-domain-battle-joint-combined-arms-concept-21st-century. The Air Force has embraced a similar, Multi-Domain Command and Control concept as well. David L. Goldfein, March 10, 2017, *CSAF Letter to Airmen,* U.S. Air Force, http://www.af.mil/News/Article-Display/Article/1108931/csaf-letter-to-airmen/.

5. U.S. Army Training and Doctrine Command, "Multi-Domain Battle: Combined Arms for the 21st Century," TRADOC White Paper, February 24, 2017, http://www.tradoc.army.mil/MultiDomainBattle/docs/MDB_WhitePaper.pdf.

6. Ibid.

Figure 1.1. Multi-Domain Battle



This U.S. Army Training and Doctrine Command (TRADOC) graphic about Multi-Domain Battle depicts a complex and congested threat environment, including numerous air and missile defense threats. Source: U.S. Army Training and Doctrine Command.

precision strikes or penetrate enemy defenses. As a core Army function and competency for both combined arms maneuver and wide-area security, AMD operations should be reevaluated in light of more sophisticated threats.[7]

Just as Distributed Lethality does not dispense with the need for active fleet defense, some pockets of the battlefield on land will require more persistent windows of superiority and protection. Chairman of the Joint Chiefs of Staff Martin Dempsey warned in 2013 that commanders "will *always* rely on both active and passive IAMD to survive air and missile attacks."[8] Both forces themselves and the communication, transportation, and logistical hubs that support them require resilience and protection.

The authors of MDB issued a call to "reimagine" future operations and make them "more innovative."[9] Because air and missile threats are among those dangers that could most undermine freedom of maneuver, the AMD field is in special need of such imagination and innovation.

7. The U.S. Army had previously been the only Service formally tasked with conducting "air and missile defense to support joint campaigns," but this responsibility is becoming a joint one. U.S. Department of Defense, "Department of the Army, Air and Missile Defense Strategy" (Washington DC: Department of Defense, 2012), 2; Robert M. Gates, *Functions of the Department of Defense and Its Major Components*, DoD Directive 5100.01 (Washington, DC: Office of the Secretary of Defense, 2010), http://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodd/510001p.pdf.

8. Dempsey, *Joint Integrated Air and Missile Defense: Vision 2020*, 3. Emphasis added.

9. Perkins, "Multi-Domain Battle: Joint Combined Arms Concept for the 21st Century."

General David Perkins, commander of the U.S. Army Training and Doctrine Command (TRADOC), has suggested that "experimentation and adaptation are required to leverage capabilities including long range fires [and] air and missile defense."[10] Nevertheless, detailed discussions for how today's AMD force and associated doctrine should adapt seem thus far to still be at the margin.[11]

THE SPECTER OF SUPPRESSION

Relative to the near-peer threat, the current AMD force is far too susceptible to suppression. System stovepiping, too many single points of failure, sectored radar coverage, increased cost and diminished capacity, and a ballistic missile-heavy focus have created a brittle AMD force all too vulnerable to exploitation. These shortcomings have been formally recognized since the mid-1990s, but as a practical matter remain largely unaddressed. The necessary focus on ballistic missile threats, for instance, has left gaps and seams that can be exploited by air-breathing and other maneuvering threats.

The current AMD force is far too susceptible to suppression.

Today's U.S. AMD force lacks the capacity and flexibility to perform this larger mission set. Incoming threats may not even be seen prior to attack, and even if they were, an AMD unit may be forced to expend a more expensive interceptor in situations where a cheaper solution might suffice. The high cost and scarcity of interceptors both strains inventory capacity and encourages shots not to be taken, whereas the lack of operational flexibility risks leaving some critical assets underdefended or undefended.

CONCEPTS FOR MORE DISTRIBUTED OPERATIONS

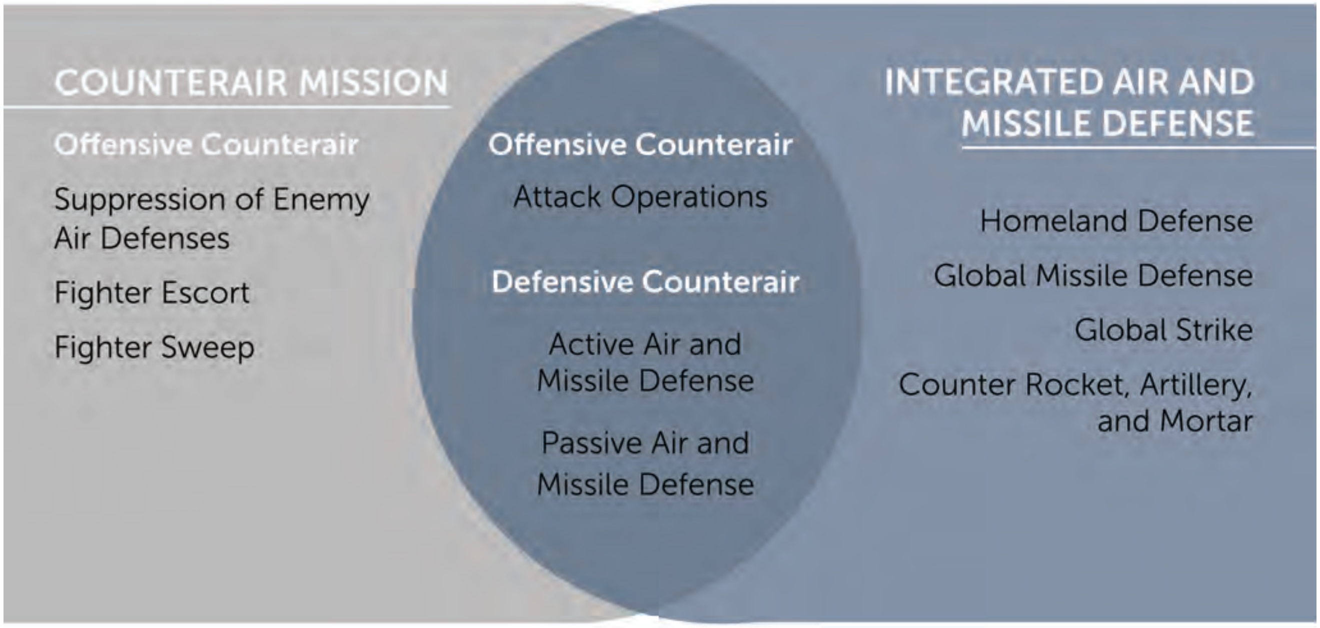
Discussions about improving AMD usually revolve around improvements to the capability and capacity of interceptors or sensors. Capability and capacity should remain high priorities in countering salvos of precision-guided munitions, but these efforts will not be enough to sustain effective defenses in the long term (see Figure 1.2). Rather than simply doing more of the same, AMD efforts might be well served by new or reinvigorated operational concepts, here discussed collectively as Distributed Defense. By leveraging networked integration, more flexible, resilient, and dispersible elements would be tailored to impose costs and dilemmas on adversaries and complicate their suppression.[12] Although capability and capacity improvements remain essential to

10. Robert Brown and David G. Perkins, "Multi-Domain Battle: Tonight, Tomorrow, and the Future Fight," *War on the Rocks*, August 18, 2017.

11. U.S. Army Training and Doctrine Command, "Multi-Domain Battle: Combined Arms for the 21st Century." This TRADOC white paper, for instance, discusses threats from adversary precision strikes with missiles and integrated air defense systems, but says very little about adapting U.S. AMD.

12. The phrase "distributed defense" seems to have rarely been used in discussions about air and missile defense. One exception is a 2001 Naval Studies Board report that recommended a "distributed defense development" program for naval theater missile defense, to which the evolution of Aegis has since moved toward. The Distributed Defense

Figure 1.2. Defining Integrated Air and Missile Defense



Sources: Scott, *Joint Publication 3-01*; CSIS Missile Defense Project.

outpacing high-end threats, the Distributed Defense concept focuses on creating a new architecture for today's fielded, or soon-to-be fielded, force (see Table 1.1).

Several material, enabling, and operational concepts would support more distributed air and missile defense operations, including:

1. *Network centrism.* Consistent with and expanding upon the current program of record, AMD should be integrated to better use "any sensor, best shooter" principles. Enabling launch and engage on remote capabilities would extend the range and defended area of U.S. AMD systems.
2. *Element dispersal.* Assuming adequate integration and networking, the current AMD battery or fire unit structure could be redefined. The radar, launcher, and command and control (C2) elements can be componentized, giving commanders greater flexibility to tailor defense designs or to disperse elements over a wider area.
3. *Mixed loads.* By making launchers more interceptor-agnostic, they could become more flexible and better provide a layered defense. An "any shooter, any launcher" approach could support a kind of "layered defense in a box" to help alleviate capacity and capability strains.

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concepts described here explicitly embrace many of the features of modularity, network-centrism, and offense-defense mix that characterize the Aegis Combat System. National Research Council, Committee for Naval Forces' Capability for Theater Missile Defense, *Naval Forces' Capability for Theater Missile Defense* (Washington, DC: National Academies Press, 2001), 6.

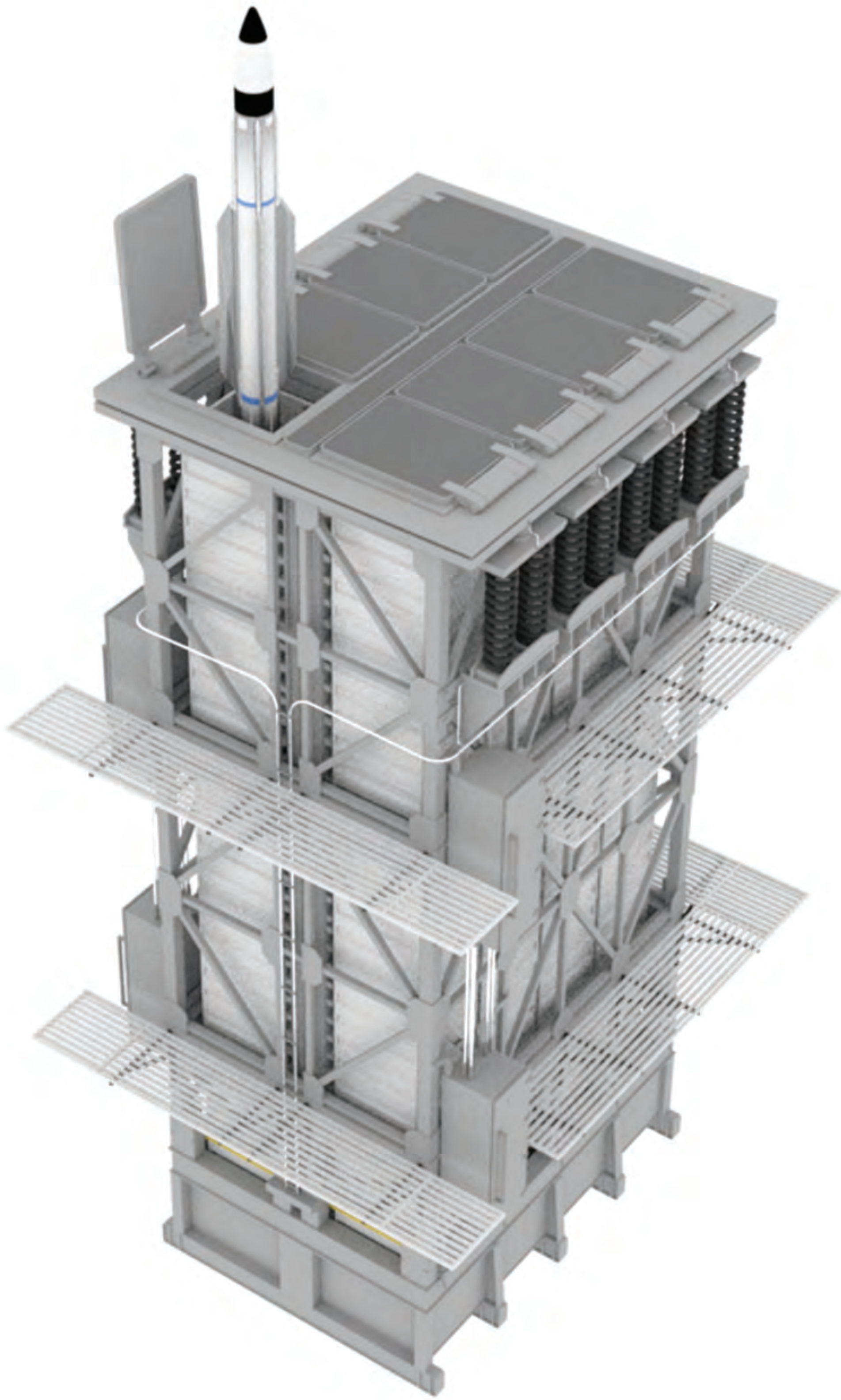
Table 1.1. Material and Operational Concepts for Distributed Defense

Concept	Tagline	Analogue	Characteristics		
			Modular	Resilient	Offense-Defense Integration
Network centrism	Any sensor, best shooter	IBCS, NIFC-CA			
Element dispersal	Redefine the firing unit	DPICC, Iron Dome			
Mixed loads	Layered defense in a box	MML, VLS			
Offense-defense launchers	Any launcher, any mission	VLS			
Multi-mission shooters	Any missile, any target	ESSM Bk II, SM-6, ENBAD			
Containerized launchers	Any launcher, anywhere	NLOS-LS, Club-K			
Passive defense shell game	Some full, many empty	MX racetrack			

Note: CEC: Cooperative Engagement Capability; DPICC: Dismounted Patriot Information Coordination Central; ENBAD: Extended-range Non-Ballistic Air Defense; ESSM: Evolved Seasparrow Missile; IBCS: IAMD Battle Command System; MML: Multi-Mission Launcher; NIFC-CA: Navy Integrated Fire Control-Counter Air; NLOS-LS: Non Line of Sight Launch System; VLS: Vertical Launching System.

4. *Offense-defense launchers.* By better integrating strike and defense within the same firing units (or even launchers), an "any launcher, any mission" capability could better defeat future missile threats rather than simply defend against them.
5. *Multi-mission shooters.* Adapting current missiles to support new missions against different kinds of targets can further boost the flexibility of multi-mission fires and reduce cost: the principle of "any missile, any target."
6. *Containerized launchers.* Embracing camouflage and concealment, networked launchers could be put into nondescript cargo containers—a sort of "any launcher, anywhere" model, making defenses more difficult to find, identify, and target.

Figure 1.3. Mark 41 Vertical Launching System



The Navy's Mk 41 Vertical Launching System (VLS) carries a mix of air and missile defense interceptors, as well as various offensive missiles such as the Tomahawk.
Source: CSIS Missile Defense Project.

7. *Passive defense shell game.* Reinvigorating attention to the passive defense of the AMD force itself, containerization would support deception in the form of a limited shell game, featuring numerous distributed dummy launchers with optical, thermal, and electronic signatures comparable to the real thing. Some would be full, but many would be empty. Such deployments could impose costs on an adversary, as well as present them with new dilemmas, such as the expenditure of resources on intelligence, surveillance, and reconnaissance (ISR) or the wastage of precision-guided munitions.

Building on one another in roughly sequential manner, these seven concepts are collectively marked by improved resilience, modularity, and greater offense-defense integration.[13] All of this is designed to deter or prevent an adversary from using its air and missile forces effectively.

To be sure, the U.S. Army is already pursuing some of these ideas, including the IAMD Battle Command System (IBCS). Programs to counter UAVs, such as the Indirect Fire Protection Capability (IFPC), likewise involve greater sensor-shooter connectivity by leveraging IBCS, the Sentinel radar, and the (mixed load) Multi-Mission Launcher (MML).[14] Distributed Defense applies and extends this logic to more capable Army interceptors like Terminal High Altitude Area Defense (THAAD) and the Patriot family, non-Army interceptors such as Standard Missiles, and various strike forces.

Other concepts not currently being pursued nevertheless have analogues in other Services, in the U.S. Army's past, or within foreign militaries. Containerized launchers, for example, had an analogue in a now-terminated part of the Future Combat System (FCS) program, and the U.S. Navy's Vertical Launching System (VLS) fires both offensive and defensive missiles (see Figure 1.3). For serious attention to a shell game for ground-based missiles, there are more examples in foreign practice.

The following discussion attempts to highlight the current shortcomings of the AMD force, articulate in greater detail the possibilities of Distributed Defense, and provide recommendations for the future.

13. Dempsey, *Joint Integrated Air and Missile Defense: Vision 2020*, 4–5.

14. Spillman and Henke, "The New Threat: Air and Missile Defense for Brigade Combat Teams."

02

Shortcomings in the Current Force

In early 2017, then-director of the Army Capabilities Integration Center (ARCIC), Lieutenant General H. R. McMaster, described missile defenses as a "foundational capability" to support forward stationed forces and bolster deterrence.[1] In too many respects, however, the AMD forces fielded today and planned for the near future fall considerably short of being an effective foundation for the kind of conflict envisioned by MDB. Several factors contribute to this shortfall, including stovepiped organization, single points of failure, relative underattention to non-ballistic missile threats, increased cost and diminished capacity, and overreliance on sectored, ground-based radars. Whereas air and missile threats have become more capable and complex, U.S. AMD capabilities have undergone relatively more modest modernization. As a result, AMD forces may now find themselves outgunned and outmatched.[2]

Shortcomings of Current Air and Missile Defenses

1. *Stovepipes of Excellence*
2. *Single Points of Failure*
3. *Under-Focus on Non-Ballistic Threats*
4. *High Cost, Low Capacity*
5. *Sectored, Ground-Based Radar Coverage*

1. H. R. McMaster, "The U.S. Army Functional Concept for Movement and Maneuver," TRADOC Pamphlet 525-3-6, February 2017, 19.

2. "Active protection systems will mature, but will not protect against the full range [of] kinetic energy threats nor be fielded fully to the force during the 2020–2040 timeframe." McMaster, "U.S. Army Functional Concept for Movement and Maneuver," 9.

STOVEPIPES OF EXCELLENCE

Today, the shape of U.S. Army AMD is largely vertical, or stovepiped (see Figure 2.1). Information from one family of systems must first be passed to a higher echelon before being distributed to another family. A Patriot launcher, for instance, can usually only fire using tracks from a radar contained in its battery. This is at best rudimentary networking and interoperating; it is not integration. Specific cases of stovepiping and vertical integration may trace their roots to technological limitations at the time of the system's development or to Service parochialism. Whatever their origins, however, stovepipes create gaps and seams that adversaries can exploit.

This inability to communicate at low echelons between and across the joint AMD force stymies operational flexibility and increases risk. The two Patriot fratricides that occurred during Operation Iraqi Freedom (OIF) are prime examples of the cost of limited or vertical-only integration. After examining those incidents, the Defense Science Board in 2005 concluded that "a Patriot battery on the battlefield can be very much alone."[3] In that conflict, brigades and battalions were broken up and redistributed across several countries, stretching them thin. In the absence of better networking, this meant both less capability and more operational risk.

In an age of cloud computing and information sharing, the fact that today's force lacks a higher degree of integration may come as a surprise to some observers. That our adversaries stand ready to exploit those vulnerabilities, however, should surprise no one. To achieve air superiority and freedom of action, suppression of enemy air defenses (SEAD) is an early U.S. objective in virtually any conflict. With air superiority, for instance, short work was made of the Iraqi Republican Guard in 1991. The suppression of U.S. AMD would likewise substantially impair U.S. freedom of action and the broader goals of MDB.

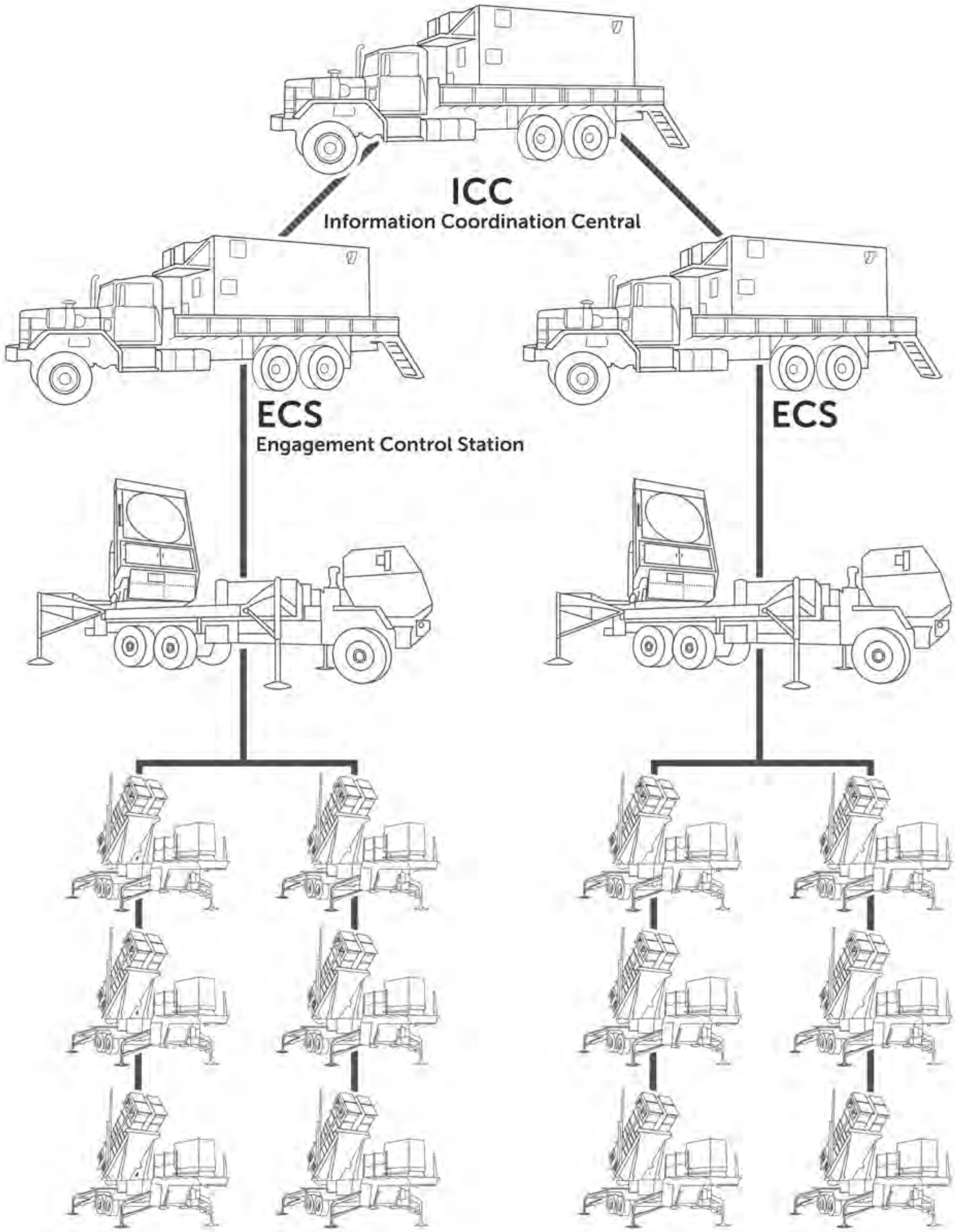
SINGLE POINTS OF FAILURE

Today's fire unit-centric and stovepiped systems make the Army's AMD force relatively more brittle than resilient. Precision strikes on a mere handful of sensors and C2 nodes could compromise the overall AMD force. In the opening salvo of Desert Storm, the Iraqi air defense system was cracked by Tomahawk cruise missile strikes and Apache helicopters firing volleys of Hellfire missiles. By destroying key Iraqi control nodes and AMD radars, and thereby rendering useless the remainder of their air defense weapons, coalition air forces opened low-risk routes into Iraqi airspace.

By defeating merely a few such points of failure, an adversary with a spectrum of air and missile capabilities could in turn create similar vulnerabilities for U.S. forces. In June 2017, North Korea

3. Michael Williams and William Delaney, "Patriot System Performance: Report Summary," *Defense Science Board Task Force Report* (Washington, DC: Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics, 2005), 28.

Figure 2.1. Stovepiping in Air and Missile Defense



The current standard configuration of Patriot batteries and battalions creates stovepipes in data transfer.

Figure 2.2. Crashed North Korean Drone

This North Korean drone was found near the Korean border in June 2017 after crashing, apparently on a mission to surveil the THAAD deployment site at Seongju, South Korea.
Source: Getty Images/Kyodo News.

used a drone to surveil the THAAD site in South Korea (see Figure 2.2).[4] Had that drone instead delivered an improvised explosive device to the TPY-2 radar on which the THAAD battery depends, it might have virtually incapacitated the THAAD capability on the Korean peninsula. Similar vulnerability applies to other regional defenses as well. NATO's Aegis Ashore–based ballistic missile defense capability today is largely dependent on two radars: the TPY-2 radar in Turkey and the SPY-1 radar in Romania. Should a THAAD battery be introduced into Europe, it too would be largely dependent on a single co-located TPY-2.

UNDER-FOCUS ON NON-BALLISTIC THREATS

Since the 1991 Gulf War, today's AMD force has also been relatively more focused on theater ballistic missile threats from smaller powers. The necessary and understandable attention to ballistic missile threats has come, however, at the expense of addressing the full complexity

4. "Suspected N. Korean Drone Photographed THAAD Site: S. Korean Military," *Yonhap News*, June 13, 2017, http://english.yonhapnews.co.kr/northkorea/2017/06/13/62/0401000000AEN20170613007451315F.html.

of air and missile battle. During OIF, the defense was not built to address potential cruise missile attacks. Although Patriot intercepted all the ballistic missiles it engaged during that 2003 conflict, it did not engage any of the several cruise missiles that Iraq fired.[5]

Today's force must address the threat in its full complexity, what a former director of the Joint Integrated Air and Missile Defense Organization (JIAMDO) described as "a complex and nearly continuous threat spectrum across the characteristics of altitude, speed, propulsion type, and range."[6] Antiship cruise missile threats are also growing, as witnessed by the attack on the *USS Mason* (DDG-87) off the coast of Yemen in October 2016. Thankfully, that Aegis destroyer successfully neutralized the threat with a mix of kinetic interceptors and non-kinetic countermeasures.[7] Similar missiles had significantly damaged an Emirati ship that same month, as they did an Israeli corvette in 2006.[8] Other types of cruise missiles could jam or spoof AMD elements. Years of overconfidence in joint air superiority have also contributed to the Army's neglect of short-range air defense (SHORAD), which the Army is now scrambling to reconstitute.[9] AMD must be effective at all those missions.

Years of overconfidence in joint air superiority have also contributed to the Army's neglect of short-range air defense (SHORAD), which the Army is now scrambling to reconstitute.

HIGH COST, LOW CAPACITY

As interceptors have become more capable, they have also become more expensive. To some extent the cost increases are the result of the focus on ballistics, as ballistic missile interceptors are typically more costly than other types. Smaller and more intermittent batch buys also impede economies of scale. Sophisticated maneuvering threats and those with countermeasures require more sophisticated interceptors, but others may not.[10] A Patriot Advanced Capability-3 (PAC-3)

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5. Charles A. Anderson, "Defense: Iraqi Freedom," *Army Magazine*, January 2004, 46, http://209.235.252.76/publications/armymagazine/archive/2004/1/Documents/Anderson_0104.pdf.

6. Edward Cashman, "The Missile Defeat Posture and Strategy of the United States—The FY17 President's Budget Request" (statement before House Armed Services Committee, Strategic Forces Subcommittee, 114th Congress, April 14, 2016).

7. Sam LaGrone, "USS Mason Fired 3 Missiles to Defend from Yemen Cruise Missiles Attack," *USNI News*, October 11, 2016, https://news.usni.org/2016/10/11/uss-mason-fired-3-missiles-to-defend-from-yemen-cruise-missiles-attack.

8. Roberta Pennington, "Crew Members of UAE Ship Attacked by Houthis Tell of Terrifying Raid," *National*, October 5, 2016, https://www.thenational.ae/uae/crew-members-of-uae-ship-attacked-by-houthis-tell-of-terrifying-raid-1.162275; Mark Mazzetti and Thom Shanker, "Arming of Hezbollah Reveals U.S. and Israeli Blind Spots," *New York Times*, July 19, 2006, http://www.nytimes.com/2006/07/19/world/middleeast/19missile.html.

9. Jen Judson, "Short-Range Air Defense Making a Fast Comeback," *Defense News*, February 10, 2017, https://www.defensenews.com/land/2017/02/10/short-range-air-defense-making-a-fast-comeback/.

10. For an analysis of the "salvo competition" imposed by considerable numbers of adversary precision-guided munitions, see Mark Gunzinger and Bryan Clark, *Winning the Salvo Competition: Rebalancing America's Air and Missile Defenses* (Washington, DC: Center for Strategic and Budgetary Assessments, 2016).

interceptor—well suited to ballistic threats—may be an unnecessarily expensive solution for UAVs, cruise missiles, or aircraft and unsuitable for rockets, artillery, and mortars (RAM). In the face of what might be a UAV attack, one can hardly fault the expenditure of a Patriot interceptor if no other cheaper solution is immediately available.[11] But many air and missile threats may not require an exquisite solution. A more diverse high-low mix of interceptors for both ballistic and non-ballistic missile threats could help balance cost, capacity, and capability. Unfortunately, an air defender may not know at the time of engagement whether the incoming threat is of the more or less sophisticated variety, which is one reason why more capable, multi-mission (and more expensive) interceptors have been preferred, for instance in the case of Patriot.

SECTORED, GROUND-BASED RADAR COVERAGE

Limitations in sensor coverage also represent a major shortcoming for today's AMD force. Today's Patriot and THAAD radars do not provide 360-degree coverage, despite the U.S. Army recognizing the need for such a capability as far back as 1993.[12] Today's 120-degree Patriot radar may be useful against an enemy's ballistic missiles or air forces that would come from a predictable direction, but it would face numerous challenges in today's more cluttered air environment. Interceptor launchers are likewise optimized to fire toward a particular sector. These inherent limitations mean that the radars and launchers are vulnerable from behind or require a circling of the wagons to get radar coverage from all directions.

The use of the ballistic missile in Desert Storm and belief in U.S. air supremacy made 360-degree defense seem less pressing, contributing to the retirement of the Homing All the Way Killer (HAWK) weapon system. HAWK and its 360-degree radar had previously been integrated with Patriot and helped to provide the needed backdoor coverage. The Patriot command and control system could also control the HAWK batteries.[13] In that respect, today's capabilities are less than they were in the not-so-distant past. The Army's follow-on plan had included the Medium Extended Air Defense System (MEADS), which would have provided 360-degree radar coverage and a vertical (omnidirectional) launcher (see Figure 2.4). Although previously expected to come on line in the 2024 timeframe, U.S. participation in the multinational MEADS development program ended in 2012, necessitating IBCS, other Patriot improvements, and a renewed effort in the Army to acquire some new Lower Tier Air and Missile Defense Sensor.

But even 360-degree ground-based radars are still limited by the horizon and therefore would not be enough for low-flying aerial threats. The IFPC launcher and the IBCS network are designed to help fill some of these gaps, allowing detection by one sensor to support a shooter in another

11. Derek Hawkins, "A U.S. 'Ally' Fired a $3 Million Patriot Missile at a $200 Drone. Spoiler: The Missile Won," *Washington Post*, March 17, 2017, https://www.washingtonpost.com/news/morning-mix/wp/2017/03/17/a-u-s-ally-fired-a-3-million-patriot-missile-at-a-200-drone-spoiler-the-missile-won/.

12. Ronald H. Lafond and Steve Crump, *CORPS Surface-to-Air Missile (SAM) System Manpower, Personnel, and Training Analysis* (Ft. Eustis, VA: U.S Army Training and Doctrine Command, 1993).

13. Department of the U.S. Army, *Patriot Battalion and Battery Operations,* FM 44-85 (Washington, DC: Government Printing Office, 1997), 5–9.

Figure 2.3. Patriot and Terminal High Altitude Area Defense Radars

Radars for U.S. Army missile defense systems include the Patriot radar (left) and the TPY-2 radar for the THAAD system (right). These sectored, ground-based radars both have single panel arrays with azimuths of approximately 120 and 180 degrees, respectively.
Sources: 35th Air Defense Artillery Brigade Public Affairs, Missile Defense Agency.

place, but overhead and wide sensor coverage is still lacking. Had an elevated sensor for cruise missile detection been fielded in 2003, the Patriots might have been better able to engage the cruise missiles during OIF. The now-terminated Joint Land Attack Cruise Missile Defense Elevated Netted Sensor (JLENS) aerostat was one attempt to provide such a capability for a large area. Although there are opportunities to mitigate the lack of persistent coverage using sensors on manned aircraft, there is still no program of record to adequately service these requirements.

Whatever the material solutions, however, the future AMD force requires 360-degree coverage, ground and elevated sensors, omnidirectional fires, and tactical mobility.

LONG-RECOGNIZED CHALLENGES

If some of these shortfalls sound familiar, they should. Numerous Joint and Service publications have for years pointed to the emergence of threats that challenge U.S. operational preeminence and called for increased offense-defense integration and joint networks. In retrospect, the description of the problem and the solution in some earlier documents from decades ago seem remarkably prescient. In its description of both the threat and solution sets, for instance, MDB in some respects echoes *Joint Vision 2010* (issued in 1996). Its Full-Dimensional Protection concept included "an integrated in-depth theater air and missile defense" that incorporated offense, active defense, and passive defense.[14] The MDB imperative to create and exploit temporary windows of superiority sounds like a more modest version of *Joint Vision 2010*'s Full Spectrum Dominance.[15]

14. John M. Shalikashvili, *Joint Vision 2010* (Washington, DC: U.S. Government Printing Office, 1996), 22–24.

15. Joint Chiefs of Staff, *Joint Vision 2020* (Washington, DC: U.S. Government Printing Office, June 2000), 26–27.

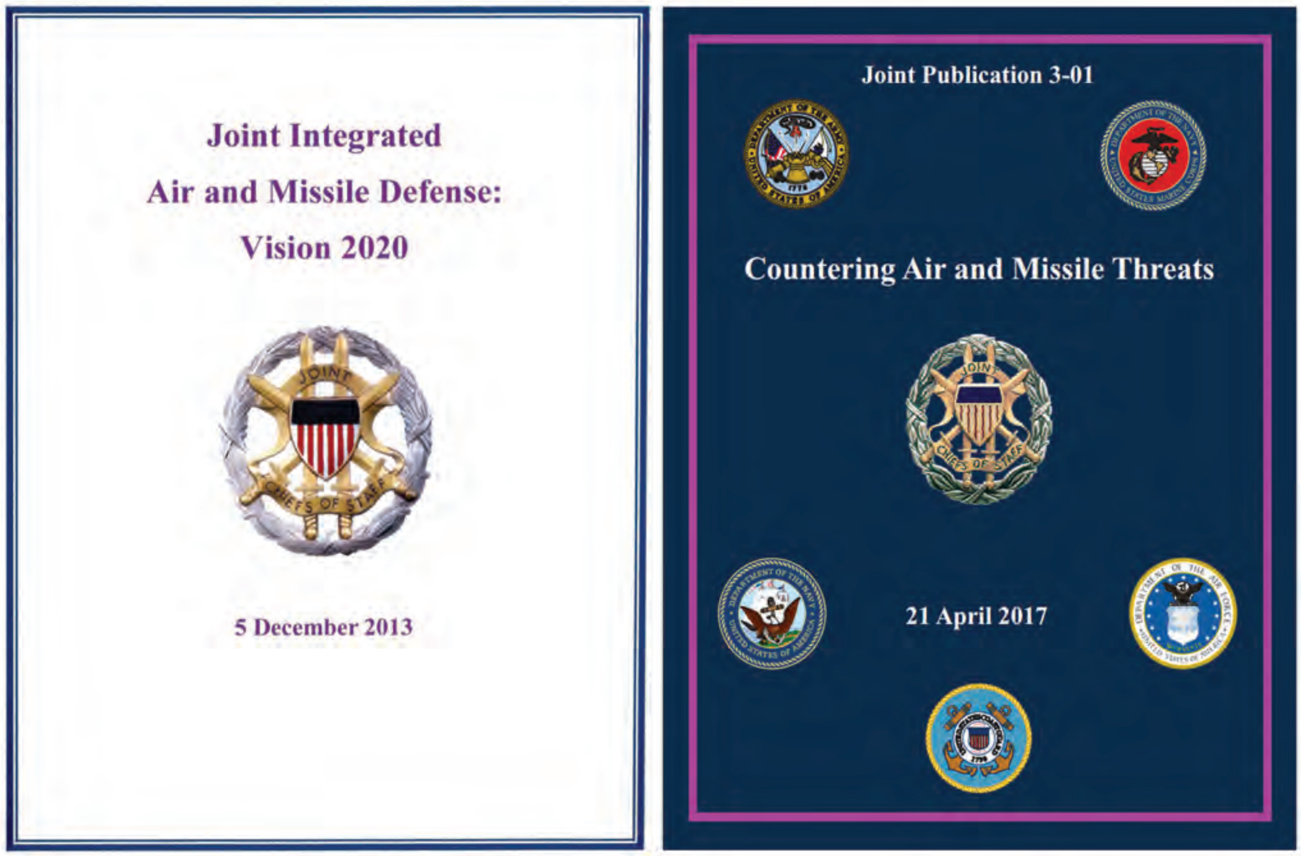
Figure 2.4. Medium Extended Air Defense System Radar

The MEADS Multifunction Fire Control Radar is designed to provide 360-degree coverage in combination with a 360-degree surveillance radar. The U.S. Army canceled its participation in the program in 2012.
Source: Wikimedia Commons.

Similar descriptions of air and missile threats, and aspirations to counter them, were found again in *Sustaining U.S. Global Leadership* (2012), *Joint IAMD: Vision 2020* (2013), and the 2014 "eight stars memo" by Admiral Jonathan Greenert and General Raymond Odierno.[16]

16. Department of Defense, *Sustaining U.S. Global Leadership: Priorities for 21st Century Defense* (Washington, DC: Department of Defense, 2012), 8; Jonathan W. Greenert and Raymond T. Odierno, "Adjusting the Ballistic Missile Defense Strategy," Memorandum for Secretary of Defense, November 5, 2014; Martin E. Dempsey, *Joint Integrated Air and Missile Defense: Vision 2020* (Washington, DC: The Joint Staff, 2013), 1.

Figure 2.5. Calls for Joint Integrated Air and Missile Defense



Two notable Joint Staff publications stressing the importance of integrated air and missile defense included *Joint Integrated Air and Missile Defense: Vision 2020* (2013) and *Joint Publication 3-01: Countering Air and Missile Threats* (2017).

These and other documents foresaw these challenges when they were still emerging, but they are felt much more acutely today. The imperative for 21st century IAMD is a present rather than a future need, and its implementation can no longer be in the realm of vision. AMD modernization is unfortunately decades behind where it should be. MDB should be the impetus to more seriously prosecute the ever-elusive quest for IAMD.

MDB should be the impetus to more seriously prosecute the ever-elusive quest for IAMD.

The need for IAMD is not merely a U.S. Army or even a Joint Staff problem, but a larger policy issue for the Department of Defense. Congress has mandated a review of the wide range of air and missile threats, including ballistic missiles, hypersonic boost glide vehicles, and cruise missile threats, as well as the kinetic, non-kinetic, active, and passive measures to handle them.[17] This ongoing missile defense and defeat policy review offers a ripe opportunity to renew the course toward IAMD.

17. National Defense Authorization Act for Fiscal Year 2017, *Conference Report to Accompany S.2943*, Sec.1684, 114th Congress (2016): 629–632.

03

New Operational Concepts for IAMD

The future AMD force should be more dispersed, modular, and integrated relative to the force of today. The Distributed Defense approach includes seven notional concepts that build on one another in roughly sequential order:

1. Network centrism: "any sensor, best shooter"
2. Element dispersal: "redefine the firing unit"
3. Mixed loads: "layered defense in a box"
4. Offense-defense launchers: "any launcher, any mission"
5. Multi-mission shooters: "any missile, any target"
6. Containerized launchers: "any launcher, anywhere"
7. Passive defense shell game: "some full, many empty"

Distributed Defense proposes to create an AMD architecture that would be more flexible and resilient, bolster power projection, impose costs on potential adversaries, and complicate adversary planning.

NETWORK CENTRISM: ANY SENSOR, BEST SHOOTER

The first imperative of *Joint Integrated Air and Missile Defense: Vision 2020* was to "incorporate, fuse, exploit, and leverage every bit of information available regardless of source or classification, and distribute it as needed to U.S. Forces and selected partners."[1] Integration and interoperability are also characteristics expressly required of the Missile Defense Agency–developed Ballistic Missile Defense System.[2] The prerequisite for a more distributed air and missile defense

1. Martin E. Dempsey, *Joint Integrated Air and Missile Defense: Vision 2020* (Washington, DC: The Joint Staff, 2013), 4.

2. William J. Lynn III, *The Missile Defense Agency (MDA)*, DoD Directive 5134.09 (Washington, DC: Office of the Deputy Secretary of Defense, 2009), http://www.dtic.mil/whs/directives/corres/pdf/513409p.pdf.

Figure 3.1. Terminal High Altitude Area Defense Launcher

The Terminal High Altitude Area Defense (THAAD) system is not currently integrated for seamless communication with other U.S. Army air and missile defense assets, such as Patriot.
Source: Missile Defense Agency.

architecture is an interconnected, network-centric force—in the words of General H. R. McMaster, "sensor-to-shooter linkages as a state of being."[3] Integration is said to be the U.S. Army's top AMD priority within the program of record.[4] At the current pace, however, Chairman Dempsey's vision for IAMD may not arrive by 2040, much less 2020.[5]

3. H. R. McMaster, "The U.S. Army Functional Concept for Movement and Maneuver," TRADOC Pamphlet 525-3-6, February 2017, 28.

4. Barry Pike, "Fiscal Year 2018 Priorities and Posture of Missile Defeat Programs and Activities" (statement before the House Committee on Armed Services, Subcommittee on Strategic Forces, 115th Cong., 1st sess., June 7, 2017), http://docs.house.gov/meetings/AS/AS29/20170607/106064/HHRG-115-AS29-Wstate-PikeB-20170607.pdf.

5. Jesse A. Wilson Jr., *Concept for Regional Command and Control Operations within IAMD* (Washington, DC: Joint Integrated Air and Missile Defense Organization, 2015), 7; McMaster, "U.S. Army Functional Concept for Movement and Maneuver," 9.

The lack of integration consists of insufficient connectivity between sensors, shooters, and C2. In some cases, this lack of integration is present even within the same weapon system, such as Patriot. The joint force has over 20 external networks, including Link 16, Cooperative Engagement Capability (CEC), and many others. Because of gaps and shortcomings in passing sensor data, both Army and joint AMD forces lack a common air picture, and interceptors cannot be used to their full potential.[6] Fire control for regional AMD interceptors is likewise disaggregated across the various systems and networks. The Army still has far to go to implement it, but IBCS is intended to eventually tie together all Army assets for air and missile defense into a single, integrated air picture that will boost capability, help reduce fratricide risks, and enable coordinated mission execution among launchers.[7] A pervasive sensor network that allows battle managers to use track data from any sensor and then pick the best interceptor or shooter would use scarce AMD resources more efficiently.

Interceptor missiles can only engage what their sensors and fire control are able to tell them to engage, and dependence on co-located line-of-sight radars significantly reduces defended area. Threat missiles can be hidden from view if outside a radar's range or if obscured by terrain or the curvature of the earth. Passing information from forward-based sensors to interceptors based further away can permit interceptors to be fired earlier. As the Defense Science Board noted in 2011, "Robust networking is the only realistic protocol to achieve operationally useful, large-area defense coverage, effectiveness, and fire power for regional missile defense."[8]

Several of today's interceptors have inherent ranges in excess of what geography and physics allow of their dedicated, co-located radars. Improved integration would therefore better actualize the current potential of interceptors. The PAC-3 Missile Segment Enhancement (MSE), for instance, might fly significantly farther than the MPQ-65 Patriot radar can see, and thus would benefit from the longer view of a TPY-2. Lower tier interceptors like the PAC-3 that are capable of defeating cruise missile threats may nevertheless be precluded from doing so if the threat is behind a mountain or out of range of its own radar. The benefit of integration was seen in a 2015 test, wherein a PAC-3 engaged a cruise missile target outside its indigenous radar solely on the basis of two

6. The sort of networking considered here was also envisioned in the Future Combat System (FCS) program, which the U.S. Army pursued to transform itself into a lighter, more modular, and more deployable force. General Erick Shinseki, cited in Andrew Feickert, *The Army's Future Combat System (FCS): Background and Issues for Congress* (Washington DC: Congressional Research Service, 2009), 1.

7. One partial example of both the challenges and utility of such networking is already fielded. The Ground-based Midcourse Defense (GMD) system draws on a global network of diverse sensors to execute intercepts. An early challenge to fielding GMD was piecing together adequate sensors, which included several Cold War–era early warning sensors that were not designed for the task and had indeed been operated under treaty restrictions that prohibited national missile defense. Today, GMD and other programs draw on the Command and Control, Battle Management, and Communications (C2BMC) network and a variety of terminals talk to interceptors in flight, although admittedly limited to line-of-sight and thus by the curvature of the earth. GMD furthermore has remote fire control; interceptors in Alaska are just as likely to be launched from Schriever Air Force Base in Colorado Springs as from Fort Greely. To better facilitate integration within and among these systems, the Missile Defense Agency organization combines several systems—e.g., GMD, THAAD, and Aegis—into a single Major Defense Acquisition Program (MDAP) called the Ballistic Missile Defense System (BMDS).

8. William J. Fallon and Lester L. Lyles, "Science and Technology Issues of Early Intercept Ballistic Missile Defense Feasibility," *Defense Science Board Task Force Report* (Washington, DC: Defense Science Board, 2011), 28.

remote Sentinel radars (see Figure 3.2).[9] In 2012, a PAC-3 engaged a cruise missile target using track data from the JLENS aerostat.[10]

In a similar way, today's Standard Missile (SM) can fly well beyond the view of the SPY-1 radar. In 2013, an Aegis ship used space sensor tracking data from a satellite to "launch on remote," firing the SM well before the onboard SPY-1 radar might have picked it up.[11] Engaging earlier and farther away buys time, which in turn helps alleviate capacity by permitting "shoot-look-shoot" or more conservative shot doctrine. Further confidence in tracking data from other sources permits still earlier engagements and "engage on remote," with no tie to the organic radar. Earlier acquisition of track-quality data permits interceptors to be fired earlier and engage threats farther away, which in turn expands the defended area. Finally, more networking and integration of sensor data helps to build resilience by mitigating single points of sensor failure.

With sufficient integration, the U.S. Army could do what the U.S. Navy can and may yet do with Navy Integrated Fire Control-Counter Air (NIFC-CA). The Navy now deploys surface combatants with NIFC-CA as well as Aegis Baseline 9 software, which enables simultaneous air and missile defense operations. NIFC-CA nets together disparate sensors with a sensor quality of service sufficient to close the fire control loop, thereby enabling intercepts beyond the radar horizon.[12] The U.S. Air Force vision for the F-35 similarly considers each aircraft as an independent node able to act as a shooter, sensor, and battle manager—in effect fusing data from numerous sources as a kind of "flying combat system."[13]

A further challenge concerns the integration of AMD across the Services. A joint approach would leverage the unique contributions, assets, and responsibilities of each Service. AMD assets generally might then become more "purple," or joint, sharing interceptors and sensors across both domains and Services.[14] U.S. Pacific Command (PACOM) Commander Admiral Harry Harris has called for such cross-Service integration, with maritime and land-based systems sharing and using

9. Jen Judson, "U.S. Army's Integrated Air and Missile Defense System Defeats Cruise-Missile Target," *Defense News*, November 13, 2015, https://www.defensenews.com/pentagon/2015/11/13/us-army-s-integrated-air-and-missile-defense-system-defeats-cruise-missile-target/.

10. Tamir Eshel, "Patriot PAC-3 Assisted by JLENS, Successfully Intercept a Cruise Missile Target," *Defense Update*, April 26, 2012, http://defense-update.com/20120426_patriot-pac-3-assisted-by-jlens-successfully-intercepted-a-cruise-missile-target.html.

11. "Aegis Ballistic Missile Defense Intercepts Target Using Space Tracking and Surveillance System-Demonstrators (STSS-D) Data," *Missile Defense Agency News Release,* February 13, 2013, https://www.mda.mil/news/13news0002.html.

12. John F. Morton, "The Aegis Warship: Joint Force Linchpin for IAMD and Access Control," *Joint Force Quarterly* 80 (January 2016), http://ndupress.ndu.edu/JFQ/Joint-Force-Quarterly-80/Article/643226/the-aegis-warship-joint-force-linchpin-for-iamd-and-access-control/.

13. Robbin F. Laird, "A 21st-century Concept of Air and Military Operations," *Defense Horizons* 66 (March 2009): 4.

14. The Limited User Test of IBCS attempted integration of sensor tracks from the Marine Tactical Air Operations Center. Office of the Director, Operational Test and Evaluation, "FY 2016 Annual Report," December 2016, 146, http://www.dote.osd.mil/pub/reports/FY2016/pdf/other/2016DOTEAnnualReport.pdf.

Figure 3.2. Sentinel Radar System

Supporting U.S. Army short-range air defense weapons and in the future the Multi-Mission Launcher (MML), the 360-degree Sentinel radar will provide additional sensor capability for Army integrated air and missile defense.
Source: U.S. Army.

sensors from anywhere.[15] Air Force operators, for instance, may not own many dedicated missile defense assets, but various Air Force sensors could contribute greatly to the common air picture. A joint construct would further support efficient coordination and even the blending of offensive strike operations and active defenses. Coalition interoperability and integration is an additional challenge. Giving all land, air, and maritime forces a unified operating system would be expensive, difficult, and probably unnecessary. A shared air picture with sensor tracks of air and missile threats, however, remains a worthy and achievable goal.

Interconnectivity and dispersal could of course carry downsides and risks. That which is spread thin can be overwhelmed. AMD networking must therefore not be permitted to introduce new vulnerabilities or dependence, and defense architectures should be constructed so that

15. Sydney J. Freedberg Jr., "We CAN Tie Army, Navy Missile Defense Networks: Navy Experts," *Breaking Defense*, February 24, 2017, http://breakingdefense.com/2017/02/we-can-tie-army-navy-missile-defense-networks-navy-experts/.

degradation of an IAMD network is graceful rather than catastrophic. Adversary attempts to defeat, disrupt, and deny networked communication must be assumed.

Network integration is a necessary foundation for IAMD, but in another sense, it represents just the first step on which other innovative operational concepts can build. The question must then be asked: *After integration, what?* The several operational, material, and enabling concepts described below represent possibilities for what might come after the realization of General McMaster's challenge: sensor-shooter integration "as a state of being."

ELEMENT DISPERSAL: REDEFINE THE FIRING UNIT

The 2010 *Ballistic Missile Defense Review* called for more mobile and flexible missile defenses, but today's AMD force remains too rigid.[16] Being able to better distribute the interceptor, sensor, and fire control elements without loss of capability would permit a more flexible deployment footprint. Network integration like that described previously would be less vertical (through layers of command and control unique to a given system) and more horizontal (both among fire units of a single system and between different systems altogether). *Vision 2020* expressly called for the "the horizontal integration of these capabilities," but much implementation remains.[17]

Greater horizontal integration would create new organizational possibilities, such as increased dispersal and movement of elements and enhanced flexibility to redefine the battery and battalion for administrative and C2 functions. A subset of a battery or battalion, even single launchers or sensors, could be moved, surged as needed, or spread out to expand the defended area and complicate adversary targeting.[18] Remote fire control also becomes possible, a feature already available to Israel's Iron Dome defenses (see Figure 3.3). The dispersal of launchers and C2, and a more horizontal integration structure, might also enable a more flexible and fluid modernization pace, potentially precluding an entire battalion being removed from service for upgrades.[19]

To some extent this dispersal is already done; certain Patriot batteries deployed in the Persian Gulf region can utilize remote launch from a Patriot radar as well as some dismounted tabletop C2 suites to provide the control functions and the joint connectivity provided by a battalion

16. Department of Defense, *Ballistic Missile Defense Review Report* (Washington, DC: Department of Defense, 2010), 12, 23.

17. Dempsey, *Joint Integrated Air and Missile Defense: Vision 2020*, 3.

18. The effort to "distribute offensive capability geographically" to complicate adversary surveillance and targeting is also an express characteristic of Distributed Lethality. T. S. Rowden, *Surface Force Strategy: Return to Sea Control* (San Diego, CA: Commander Naval Surface Forces Pacific, 2017), 10, http://www.navy.mil/strategic/SurfaceForceStrategy-ReturntoSeaControl.pdf.

19. While this more modular approach may not decrease the time required to modernize the entire Patriot force, it might permit modernization with less disruption to operational tempo. Jen Judson, "Army Seeks to Alleviate Overburdened Patriot Units," *Defense News*, March 16, 2016, https://www.defensenews.com/digital-show-dailies/global-force-symposium/2016/03/16/army-seeks-to-alleviate-overburdened-patriot-units/.

Figure 3.3. Israel's Iron Dome Launcher

Israel's Iron Dome system is capable of remote fire control, a desirable characteristic for more distributed air and missile defense launchers.
Source: Getty Images/Ilia Yefimovich.

headquarters.[20] These techniques increase defended area, improve flexibility, provide a lighter footprint, and add resilience to the C2 structure—but they are today the exception, not the norm. Former U.S. Army Space and Missile Defense Command (SMDC) Commander Lieutenant General David Mann points to the basic opportunity here to push defensive capability down and out, rather than relying on top-down direction:

> Instead of deploying a whole battalion we can maximize what that battalion brings to the table by not having to send the whole battalion, but by using the dismounted capability to take different components within the Patriot battalion to different locations and really kind of spread its capability . . . on the battlefield.[21]

20. This suite provides the C2 functions currently embedded in the battalion's Information Coordination Central (ICC) system, for example fire direction and joint connectivity. Brandt A. Ange and Kevin Kruthers, "10th Army Air and Missile Defense Command," in *Fires: The 2016 Red Book* (Fort Sill, OK: Fires Center of Excellence, January–February 2017), 31.

21. David Mann, quoted in C. Todd Lopez, "Missile System Would Greatly Increase Defense Capability in South Korea," *U.S. Pacific Command News*, March 29, 2016, http://www.pacom.mil/Media/News/News-Article-View/Article/707735

Instead of a single high-value command and control truck for an adversary to target, distributed command and control units could add a level of resilience. Instead of parking an entire Patriot battery near an Aegis Ashore site or other NATO C2 node to provide antiair warfare protection, one would have the flexibility to disperse smaller numbers of launchers.[22] The IBCS program currently expected for U.S. Army AMD systems in the 2022 timeframe is intended to provide this kind of integration. The distribution of Information Coordination Central (ICC) command and control suites could, however, provide some improved integration and improved manning flexibility for U.S. and allied Patriot forces in the near term.[23]

Greater dispersal and resilience in the sensor network would also be a key part of Distributed Defense. One limiting factor to launcher distribution is sensors—in terms of 360-degree coverage, multiple altitudes, quality of track data, and redundancy. It does little good to deploy interceptors to defend areas without sensor coverage of the airspace in which such interceptors would engage. Ground-based radars might also be further dispersed, mixing those of higher frequency and range with those of lower capability. Airborne infrared sensors aboard a UAV or a tethered aerostat might be natural ways to supplement the architecture. Such an architecture in some respects resembles the more distributed air defense radars of the 1960s designed to detect and track Soviet bombers. Today, distributed and omnidirectional sensor coverage from land, sea, air, and space may assume renewed importance given the spectrum of maneuvering threats, including aircraft, cruise missiles, UAVs, and hypersonic boost glide vehicles.

To be sure, the potential dispersal of such a highly networked IAMD force would need to be tempered with careful management so that it is not spread too thin. Logistical support, security, and manning requirements would remain, even if the manning is reduced with remote fire control. But capacity limitations and the pressure to defend more assets have already resulted in scattering isolated batteries across regions without a supporting C2 architecture and with some elements not positioned to optimize performance.

MIXED LOADS: LAYERED DEFENSE IN A BOX

Another potential area for innovation concerns more flexible loadouts of Army AMD launchers. Today, most interceptors are paired with a specific type of launcher. THAAD interceptors, for instance, are fired from dedicated THAAD launchers, and Standard Missiles are only fired from the

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/missile-system-would-greatly-increase-defense-capability-in-south-korea/; TRADOC Capabilities Manager Army Air and Missile Defense Command, "Dismounted Patriot Information Coordination Central," *Fires Bulletin* (March–April 2016): 9, http://sill-www.army.mil/firesbulletin/archives/2016/mar-apr/mar-apr.pdf; and Jen Judson, "New Army Missile-Defense Chief Faces Pressure to Deploy and Modernize," *Defense News*, February 9, 2017, http://www.defensenews.com/land/2017/02/09/new-army-missile-defense-chief-faces-pressure-to-deploy-and-modernize/.

22. National Defense Authorization Act for Fiscal Year 2017, *Conference Report to Accompany S.2943*, Sec.1685, 114th Congress (2016): 632–633.

23. James Dickinson, interview by Jen Judson, "Soldiers Attached to Patriot System May Get Decreased Deployment," *Defense News*, October 11, 2017, https://www.defensenews.com/video/2017/10/11/soldiers-attached-to-patriot-system-may-get-decreased-deployment/.

Figure 3.4. Multi-Mission Launcher

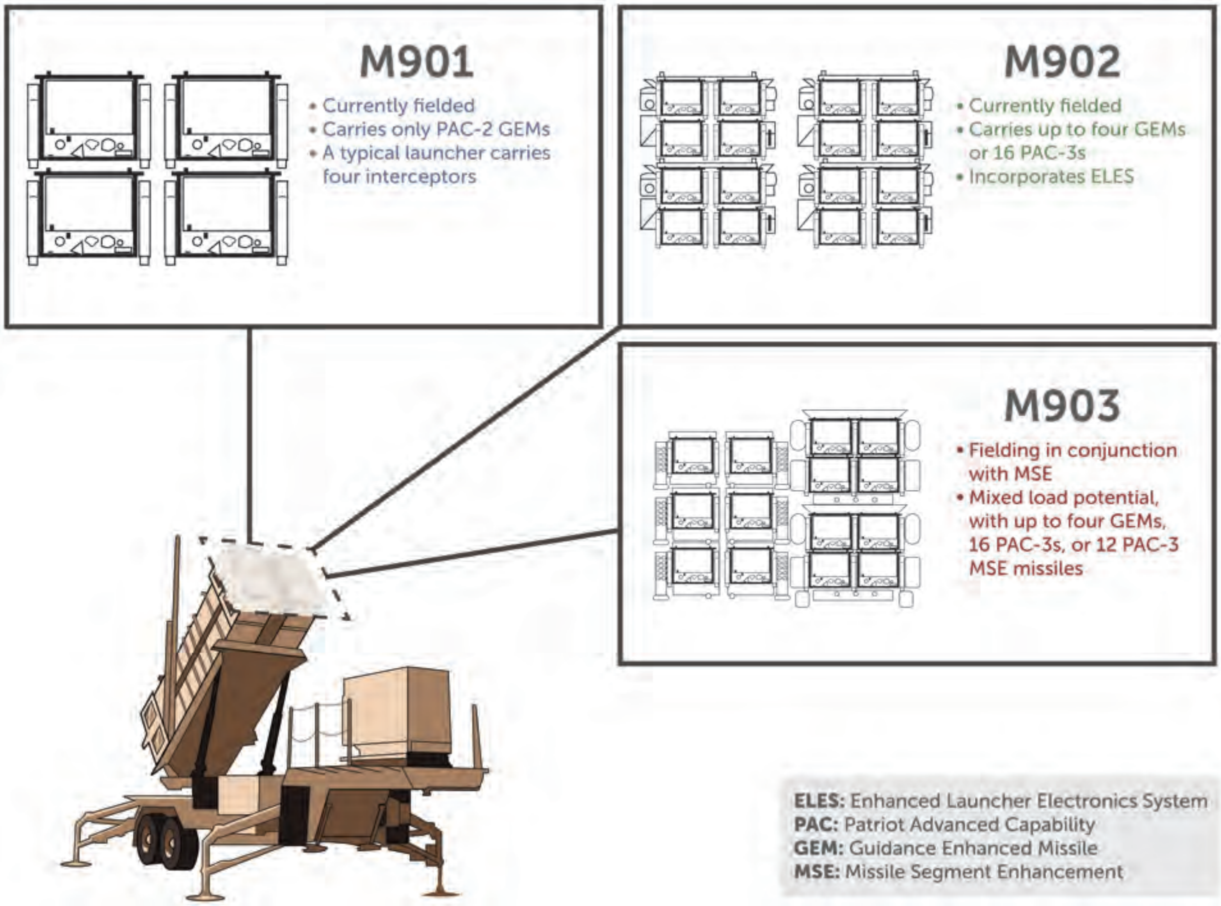
The Army is developing the Multi-Mission Launcher, which can fire a variety of interceptors for air defense missions.
Source: U.S. Army.

Mk 41 and Mk 57 VLS. Much of this specificity is due to unique attributes or requirements of the various launch platforms and interceptors. But shifting to a mix-and-match approach could support greater flexibility and defensive depth. Mixed loads within batteries, and even within launchers, could replace single-capability launchers, creating the possibility of a "layered defense in a box."

This sort of mixing and matching is already envisioned for IBCS and the Multi-Mission Launcher (MML) (see Figure 3.4), which will launch AIM-9X, Stingers, and other fires for counter-UAV and other SHORAD missions. Brigadier General Christopher Spillman and Lieutenant Colonel Glenn Henke of the 32d Army Air and Missile Defense Command say that the MML-IBCS combination "will provide the most capable short-range air defense in the Army's history."[24]

24. Christopher L. Spillman and Glenn A. Henke, "The New Threat: Air and Missile Defense for Brigade Combat Teams," Association of the United States Army, February 17, 2017, https://www.ausa.org/articles/new-threat-air-and-missile-defense-brigade-combat-teams.

Figure 3.5. Patriot Launcher Configurations



Patriot launchers have several configurations, and recent upgrades enable a degree of mixed loads within the same launcher.
Source: CSIS Missile Defense Project; Army Program Executive Office Missile and Space, "Patriot Overview," 6.

Other models also exist for mixed loadouts. Today, the VLS on a given Aegis ship might well contain a mixed load containing Evolved Seasparrow Missiles (ESSM), SM-2, SM-6, and SM-3 to support both air and ballistic missile defense missions. Patriot batteries today share some similar flexibility, with a battery and even individual launchers capable of mixing different kinds of Patriot interceptors (see Figure 3.5).[25]

Additional mixing and matching might be possible. Instead of deploying a Patriot battery alongside a THAAD battery to protect the latter, for instance, a THAAD battery might also contain an MSE-equipped launcher for lower-tier ballistic threats, or SM-3s for higher ones. Patriot launchers could

25. U.S. Army Patriot launchers currently have some flexibility to mix and match, limited by canister size and by electronics. PAC-3 and MSE can be mixed within a single launcher, but one cannot mix PAC-3/MSE with PAC-2/GEM. An M901 launcher can hold 4 PAC-2 or GEMs; an M902 can hold 16 PAC-3 or 4 GEMs; an M903 can hold 12 MSEs, 16 PAC-3s, or a mix, such as 6 MSEs and 8 PAC-3s. The older M901 can fire only PAC-2 and GEM, but not the PAC-3 or MSE; the M902 and M903 have an Enhanced Launcher Electronics System to do so. Army Program Executive Office Missiles and Space, "Patriot Overview," August 2013, 6, https://www.msl.army.mil/Documents/Briefings/LTPO/LTPO.pdf.

carry Stunner interceptors, which are less capable than PAC-3 and MSE interceptors, but also cheaper. Mixing and matching could well have cross-Service applications as well. A firing unit for THAAD, Patriot, and a wide variety of other interceptors might be connected to Aegis Ashore sites or potentially integrated into the Aegis system with missiles inserted directly into VLS tubes, as had previously been considered with a maritime THAAD.

Such an approach could improve adaptability by better anticipating the need to divide a battalion or battery, and help alleviate capacity strains that result from having to deploy entire battalions or batteries to a given place. Instead of facing the decision whether to deploy one of only a few garrisoned THAAD batteries into a troubled area complete with all the support equipment, another option might be to merely float interceptors forward on an incremental basis, similar to how Aegis ships select a load of effectors before leaving port. Unlike Aegis ships, however, the mix in ground-based launchers might be more easily adjusted.[26] Mixed AMD loads would have implications for training and operations, as well as for maintenance, loading, and storage. Rather than soldiers training on a single interceptor or single family of interceptors like Patriot, they would train to fire a wide array—as sailors do with the many effectors in VLS tubes. Such a fire control system would indicate to soldiers which effectors should be fired against a given threat, and in what order, just as the Aegis Combat System does for its operators.

OFFENSE-DEFENSE LAUNCHERS: ANY LAUNCHER, ANY MISSION

Another way to evolve today's AMD into IAMD is to change how we tend to think and talk about it—moving from *defending* to *countering* air and missile threats (see Figures 3.6 and 3.7).[27]

It is true that there are simply not enough interceptors to sit and play catch in any conflict with large numbers of missiles. In the event of an active missile threat, missile defenses would counter or negate the threat to help buy time, but offensive strike capabilities would play a prominent role in defeating the missile threat. Brigadier General Randall McIntire, commandant of the Army Air Defense Artillery School and chief of the Army Air Defense Artillery, has called for an ability to "combine offensive and defensive fires into one entity that is fast and agile."[28]

There are simply not enough interceptors to sit and play catch.

26. Hunter Stires, "Exclusive: CNO Announces the Return of Vertical Launch System At-Sea Reloading," *National Interest*, July 5, 2017, http://nationalinterest.org/feature/exclusive-cno-announces-the-return-vertical-launch-system-21425.

27. Henry A. Obering III, "The Future of Global Missile Defense" (speech, Defense One Panel Discussion, Huntsville, AL, August 15, 2016), http://www.defenseone.com/feature/cocktails-and-conversations/#watch-now.

28. Randall McIntire, quoted in "Northrop Grumman, U.S. Army Successfully Complete Integrated Air, Missile Defense Test," *Aerotech News*, October 9, 2017, http://www.aerotechnews.com/blog/2017/10/09/northrop-grumman-u-s-army-successfully-complete-integrated-air-missile-defense-test/.

Figure 3.6. Multiple Launch Rocket System

The Multiple Launch Rocket System (MLRS) can launch a mix of offensive munitions, including the Army Tactical Missile System (ATACMS) and other rockets.
Source: U.S. Army.

Figure 3.7. Notional Distributed Defense Launcher Concepts

The notional launchers depicted here represent possible mixed load outs for IAMD.
Source: CSIS Missile Defense Project.

One way to get at this problem is with co-location of strike and defense within firing units, or even within the launcher. Another way to get away from the "purely defensive" paradigm is to better process inputs from AMD sensors—for instance, a TPY-2 radar—to trace the launch point of hostile air and missile threats so that enemy launchers can be targeted before they can fire again.

This mixture and integration of strike and defense assets could be a type of "deep shaping fires" to influence the multi-domain battlefield.[29] The combination of surface-to-surface counterbattery fire and surface-to-air fires seemingly resembles the idea of "multifunctional Army fires" endorsed by General David Perkins.[30] The Future Combat Systems' notional Non Line of Sight Launch System (NLOS-LS) launchers had been envisioned for strike assets, but there apparently were plans to add air defense missiles in later iterations.[31]

29. McMaster, "U.S. Army Functional Concept for Movement and Maneuver," 28.

30. Perkins stated, "Future multifunctional army fires units will provide the joint task force with a single unit combining surface-to-surface (land and maritime), surface-to-air, electromagnetic, and cyberspace cross-domain fires." David G. Perkins, "Multi-Domain Battle: Joint Combined Arms Concept for the 21st Century," Association of the United States Army, November 14, 2016, https://www.ausa.org/articles/multi-domain-battle-joint-combined-arms-concept-21st-century.

31. Rod Summers, "Non-Line-of-Sight Launch System," *Army AL&T* (January–February 2004): 41.

Figure 3.8. Ground-Based Test of the Vertical Launching System

An SM-6 is launched from a ground-based Vertical Launching System (VLS) test facility at the White Sands Missile Range.
Source: U.S. Navy.

These concepts clearly envision the spreading of certain concepts and capabilities across Services. For the Army, dispersed and containerized strike assets would provide a kind of "ground-based Distributed Lethality." Making launchers dual purpose would also make them akin to the Navy's VLS, which contain a mix of offensive and defensive effectors.

Dispersed and containerized strike assets would provide a kind of "ground-based Distributed Lethality."

This degree of integration between strike and AMD assets would carry policy questions, given the likely opposition from major adversaries. Yet those are precisely the sort of adversaries against whom MDB is tailored.

MULTI-MISSION SHOOTERS: ANY MISSILE, ANY TARGET

Besides co-locating strike and defense fires in the same unit or even the same launcher, still another path to integrating offense and defense is within the interceptor itself—by carrying both offensive and defensive effectors. Such multi-mission flexibility further blurs the line between "Distributed Lethality" and "Distributed Defense."

Seekers and terminal guidance are tailored to a particular mission, but the continued growth in the missiles' reach and continued miniaturization of technology could permit and encourage greater flexibility. Even if optimized for one purpose, the addition of seeker types or attack modes may allow the expansion of mission sets. The SM-6 (see Figure 3.9) is a major example of such multi-mission evolution within a single airframe. The SM-6 was originally designed as an SM-2 follow-on to defeat aircraft and cruise missiles. Additional capability was then added for terminal-phase intercept of ballistic missiles. With additional guidance changes, it can also function as an antiship missile, thereby assuming a strike capability. Additional changes to the seeker and warhead could potentially add a land-attack mission to the SM-6, essentially assuming the role of the missile once known as the SM-4.[32]

Recent modifications to the Tomahawk Block IV, the ESSM Block 2, and the Army Tactical Missile System (ATACMS) have also apparently adapted those missiles to the antiship mission.[33] Given that the ATACMS is an Army missile, its multi-mission characteristics represent a kind of model for the cross-domain, multi-mission fires envisioned in MDB. Here again, there is nothing new: past surface-to-air missiles like the Nike Hercules had a secondary surface-to-surface capability, and its transfer to South Korea provided the basis for the Hyunmoo ballistic missile program.[34]

Lessons from SM-6 development might be transferred to other airframes as well. The motor stack of the SM-3 Block IIA, for instance, has substantially longer legs than that currently employed by the SM-2 or SM-6.[35] Should that larger, 21-inch motor and airframe be paired with an alternative

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32. Matthew Montoya, "Standard Missile: A Cornerstone of Navy Theater Air and Missile Defense," *Johns Hopkins University Applied Physics Laboratory Technical Digest* 22, no. 3 (2011): 241–243.

33. Sam LaGrone, "WEST: U.S. Navy Anti-Ship Tomahawk Set for Surface Ships, Subs Starting in 2021," *USNI News*, February 18, 2016, https://news.usni.org/2016/02/18/west-u-s-navy-anti-ship-tomahawk-set-for-surface-ships-subs-starting-in-2021; Kris Osborn, "Navy Readies ESSM Block 2 Ship Defense Missile for 2020 to Stop High-Tech Attacks," *Scout Warrior*, September 30, 2016, http://www.scout.com/military/warrior/story/1643358-navy-essm-2-missile-to-stop-high-tech-attacks; Ashton Carter, "The Path to an Innovative Future for Defense" (speech, CSIS, Washington, DC, October 28, 2015).

34. "NHK-1," CSIS Missile Threat, last updated October 11, 2017, https://missilethreat.csis.org/missile/nhk-1-nike-hercules-korea/.

35. National Research Council, Committee for Naval Forces' Capability for Theater Missile Defense, *Naval Forces' Capability for Theater Missile Defense* (Washington, DC: National Academies Press, 2001), 69.

Figure 3.9. Standard Missile-6

The U.S. Navy Standard Missile-6 (SM-6) can perform multiple missions using the same airframe, including antiair, terminal ballistic missile defense, and antiship strike.
Source: Missile Defense Agency.

payload, the new missile could provide the basis for a medium-range strike asset of sorts for basing at sea or elsewhere for antiship and land-attack missions.

Such multi-mission applications would probably not make sense for scarce assets like Ground-based Interceptors (GBI), THAAD, and SM-3s—the kill vehicles on which are quite expensive—but could be promising as a secondary mission for low-cost interceptors.

Other strike assets might also acquire alternative missions. The forthcoming Long-Range Anti-ship Missile (LRASM), for instance, might acquire both land-attack missions and alternative basing modes.

CONTAINERIZED LAUNCHERS: ANY LAUNCHER, ANYWHERE

Today's AMD and ground-launched strike rockets and missiles are fired almost exclusively from trucks, trailers, and silos. While these platforms are mobile, they are also highly identifiable. One way to disperse launchers and make them more survivable is to remove them from their trucks or trailers and put them into nondescript cargo containers, which the military calls MILVANs (see Figure 3.10). To all outward appearances, these launchers might look like any other shipping container, but inside could have self-contained power, communications, and cooling. As with today's launchers, each container would be wirelessly linked to the larger network of sensors and command and control. The containers could be relocated as needed to provide surge capacity where required, whether at sea or on land. Although lacking the mobility of a wheeled launcher, the intermodal character of containers provides a different form of flexibility.

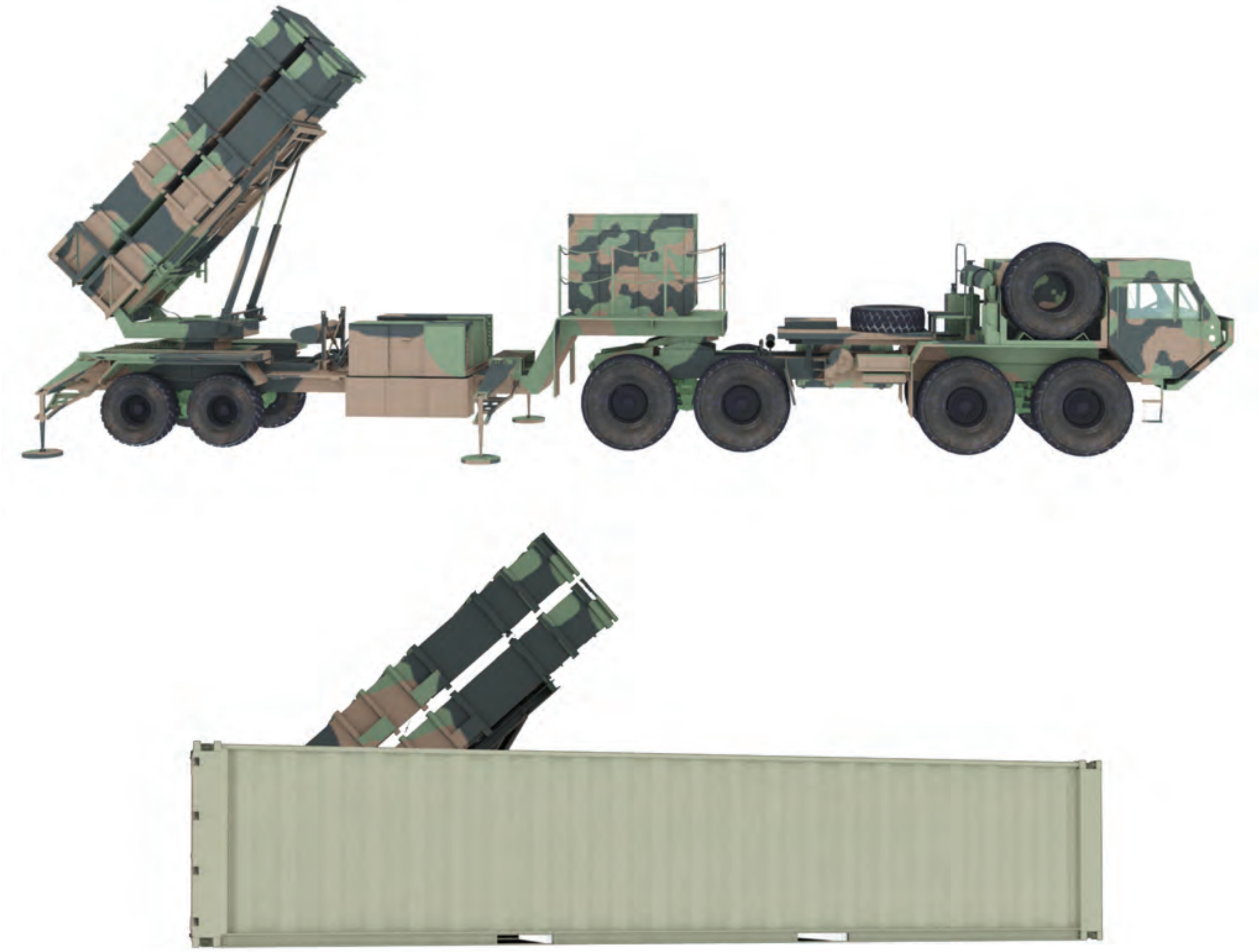
Israel's Iron Dome system provides a real-world analogue to this concept. The boxed launcher is carried by a truck but does not need to be fired from it and instead may be deposited where needed. The Iron Dome launcher could be containerized, does not necessarily require manning on site, and can engage targets remotely through its fire control network. Iron Dome interceptors and launchers are now also being deployed aboard ships.[36] Israel's Long-Range Artillery (LORA) missile can also be launched from a barge, showcasing the concept of making launchers multi-domain.[37]

To be clear, a containerized launcher might not be optimal for a maneuvering force, but might be well suited for the defense of fixed assets, such as a base, port, logistics hub, or command and control node. Trucked or trailered elements are perfectly capable of being parked at a fixed base, but the containerized launcher adds concealment and deception, thereby creating uncertainty about their location. Greater distribution and mobility of the launchers may impose challenges for

36. Rory Jones and Robert Wall, "Israel Plans to Expand 'Iron Dome' to Warships to Protect Offshore Facilities," *Wall Street Journal*, May 18, 2016, https://www.wsj.com/articles/israel-plans-to-expand-iron-dome-to-warships-to-protect-offshore-facilities-1463594486.

37. Joseph Trevithick, "Israel Just Launched a Containerized Ballistic Missile from the Deck of a Ship," *The Drive*, June 21, 2017, http://www.thedrive.com/the-war-zone/11723/israel-just-launched-a-containerized-ballistic-missile-from-the-deck-of-a-ship.

Figure 3.10. Containerized Launcher Concept



Source: CSIS Missile Defense Project.

network connectivity, data latency, and ease of retargeting, so resilience and possibility for graceful degradation will grow even more important.

Such an approach may at first glance seem unconventional for the U.S. Army, but a similar concept was the aforementioned NLOS-LS "net-fires" within the Army's Future Combat Systems program (see Figure 3.11). NLOS-LS envisioned the ability to distribute small, modular, containerized missile launchers around the battlefield.[38] These containers would have been platform-agnostic and might have included both offensive and defensive loads.[39] These "missiles in a box" consisted of a small platform-independent (and potentially unmanned) vertical launch system that

38. Feickert, *The Army's Future Combat System (FCS)*, 10–15.

39. Summers, "Non-Line-of-Sight Launch System," 41.

Figure 3.11. Non Line of Sight Launch System

Part of the Army's now defunct Future Combat System (FCS), the Non Line of Sight Launch System (NLOS-LS) envisioned unmanned launchers distributed around the battlefield.
Source: U.S. Army.

could be fired remotely. Another foreign analogy comes from Taiwan, which has deployed land-attack cruise missiles on mobile launchers disguised as delivery trucks.[40]

Today's Patriot launchers, consisting of four canisters in a two-by-two configuration, might fit into a standard container measuring 8 or 8.5 feet in width, with the support equipment being placed in front of the launcher. Two or more Mk 41 VLS tubes, for instance, might fit well into such a space (see Table 3.1). Today's operationally deployed THAAD launchers typically consist of eight canisters in a two-by-four configuration that would be too wide, so a reduced pack of canisters might be necessary to fit. High Mobility Artillery Rocket System (HIMARS), National Advanced Surface-to-Air Missile System (NASAMS), and MML launchers might also be accommodated to such a size,

40. J. Michael Cole, "Military Passes Off Missile Launchers as Delivery Vehicles," *Taipei Times*, March 4, 2013, http://www.taipeitimes.com/News/taiwan/archives/2013/03/04/2003556239.

Table 3.1. Container and Canister Dimensions

	MILVAN Cargo Container	Canisters				
		Patriot PAC-2/3	THAAD	Mk 41 VLS	Mk 57 VLS	ATACMS
Height (in feet)	8.5	3.27	3.85	2	2.3	2.7
Width	8.5	3.52	3	2	2.3	3.3
Length	40	20	22	22.3	23.6	13.7

Note: ATACMS: Army Tactical Missile System; PAC: Patriot Advanced Capability.

thereby boxing up ATACMS, Multiple Launch Rocket System (MLRS), Advanced Medium-Range Air-to-Air Missile (AMRAAM), AIM-9X, and other missiles.[41]

PASSIVE DEFENSE SHELL GAME: SOME FULL, MANY EMPTY

Containerized launchers would enable far more than merely intermodal transport of offensive and defensive launchers. Specifically, it would support "a robust approach to passive defenses" by means of deception, and potentially a shell game.[42] Brigadier General Spillman has suggested that greater use of electronic decoys might support the increased survivability and resilience of the Army's AMD force.[43] One might go further and envision decoys with a full spectrum of optical, thermal, electromagnetic, and logistical signatures.

Most open discussions of passive defenses against air and missile threats have focused on ways of moving the defended asset around, such as flying aircraft between bases. Patriot and certain SHORAD forces also permit some passive defense through simple mobility. Maneuver and movement alone, however, cannot hide their distinctive signatures. A launcher that shoots-and-scoots may well have moved by the time an adversary identifies its location, but a near-peer adversary may be capable of tracking it. Adding elements of a shell game would present a more cluttered and confused picture of the battlefield, imposing costs on an attacker—whether by increasing uncertainty, encouraging an adversary to expend resources on surveillance, or encouraging wastage of precision-guided munitions.

41. The U.S. Army intended for the Surface Launched AMRAAM (SLAMRAAM) had been intended to replace Avenger and Stinger in the 2014 timeframe, but it too was canceled, although Norway now operates a similar system called NASAMS, which several other countries are now acquiring..

42. Dempsey, *Joint Integrated Air and Missile Defense: Vision 2020*, 1.

43. Christopher Spillman, "Defense Dialogues: The Future of Missile Defenses" (speech, Huntsville, AL, August 7, 2017), https://www.youtube.com/watch?v=Wm-PhXeWOWc.

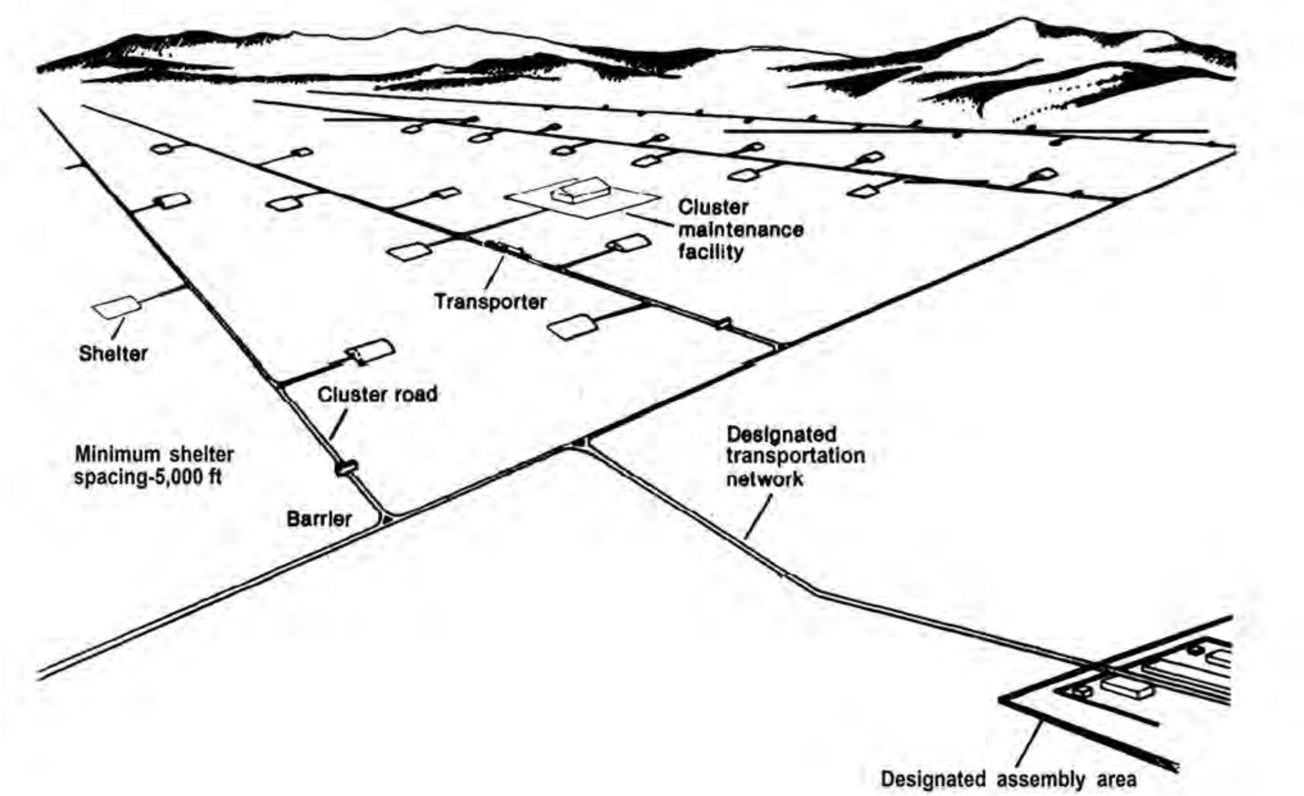
Figure 3.12. British Tank Decoy

British soldiers carrying an inflatable decoy tank during the 1956 Suez Crisis.
Source: Getty Images/Keystone.

Imagine a military base or countryside littered with hundreds of innocuous, moderately rusty cargo containers. Some would contain defensive or strike assets, but most would be empty.

Imagine a military base or countryside littered with hundreds of innocuous, moderately rusty cargo containers. Some would contain defensive or strike assets, but most would be empty—and an adversary would have a difficult time distinguishing them. Decoy containers would be outfitted with fake antennas and made to emit comparable heat and other electronic signatures, and troop or maintenance movements might occur between decoys and real containers alike. Such an approach exploits tactics used by those who have faced U.S. air superiority. During the Kosovo bombing campaign in the 1990s, Serbian troops employed dummy tanks filled with heated water to confuse infrared sensors

Figure 3.13. MX Peacekeeper Basing Mode Concept



One proposal for basing for the MX Peacekeeper missile involved a shell game with multiple protective shelters between which missiles could be moved, creating a complex targeting problem for the Soviet Union. Source: U.S. Air Force.

and draw fire from NATO aircraft.[44] North Vietnam also used decoys to complicate American airstrikes, as did the British in the Suez Crisis (see Figure 3.12).[45]

The idea of a shell game for ground-based missiles has been somewhat dormant, but was among the basing modes considered in the 1980s for the MX Peacekeeper intercontinental ballistic missile (see Figure 3.13). One MX option was a "racetrack," whereby the missiles would be trucked between hardened shelters, potentially along covered or underground tunnels. With many more shelters than there were missiles, it would be nearly impossible to know where the missiles were at any given time.[46] Destroying all the shelters might require the expenditure of virtually the entire

---

44. Anthony Cordesman, *The Lessons and Non-Lessons of the Air and Missile Campaign in Kosovo* (Westport, CT: Praeger, 2001), 264–265.

45. Edward F. Puchalla, "Communist Defense against Aerial Surveillance in Southeast Asia," *Studies in Intelligence* 14, no. 2 (1970): 34, released in full, https://www.cia.gov/library/center-for-the-study-of-intelligence/csi-publications/books-and-monographs/Anthology-CIA-and-the-Wars-in-Southeast-Asia/pdfs/puchalla-communist-defense-against-aerial-surveillance.pdf.

46. Harry Woolf, *MX Missile Basing* (Washington, DC: Office of Technology and Assessment, September 1981), 8.

Figure 3.14. Russian Club-K Containerized Launcher

Russia openly markets a containerized launcher that can launch a variety of cruise missiles.
Source: Wikimedia Commons.

Soviet nuclear force, thereby making suppression of the ICBM force impossible. Such an extensive architecture would be inappropriate for AMD assets, but the effect could perhaps be achieved in other ways.

The containerized missile launcher would not be a replacement for the current mobile or relocatable AMD launchers, but rather a supplement. Given the utility of mobility to support maneuver operations, containerized launchers might be better suited to the defense of fixed sites or as a broader area defense, so as to complicate their suppression.[47] Containerized long-range strike assets might also require less mobility.

47. Containerized launchers might also have application for maritime deployments. Just as the Distributed Lethality concept envisions that anything that floats might be made to carry strike forces, so too certain kinds of maritime platforms might be equipped with containerized launchers. Communicating that such assets would only be placed on military platforms or bases, albeit with greater dispersal, would be important to alleviate the concern that civilian areas not be put at risk.

Exploiting a shell game to improve survivability is also not contingent on containerized launchers. Randomly and frequently moving launchers between several predesignated firing positions would complicate adversary targeting without any additional camouflage or concealment. Even today's launchers might be driven regularly between shelters, which can be simple, inexpensive covered garages or hardened against attack. Dummy launchers might also be set up and moved around in some manner, like the fake Scud targets that the United States repeatedly bombed during the Gulf War.[48]

Although of broad application, a distributed AMD deployment construct might have particular use supporting MDB in the European theater. Russian planners considering using their substantial ballistic and cruise missile arsenal as cover for aggressive actions in the Baltics, for instance, would face significant planning problems in confronting a more dispersed force with offensive and defensive fires. Moscow would have to devote significant ISR resources to finding and fixing dispersed launchers and determining which were real and which were decoys. Containerized launchers prepositioned or surged into regions of concern to defend important air and sea points of debarkation for NATO would raise the threshold for quick counterforce strikes.

Large numbers of containerized launchers would not be necessary for the shell game to serve some of its purposes. Once the capability was publicized, an adversary might have no way of knowing when, where, or to what extent the launchers were deployed. The idea for a containerized launcher is not dissimilar to one that Russia has openly advertised for its Club-K cruise missile system (see Figure 3.14) available for export.[49]

Our adversaries have gone to school on us; here is an instance where we may go to school on them.

48. Marlise Simons, "Decoys; A Firm's Fake Weapons Have Real Use: Deception," *New York Times*, January 27, 1991, http://www.nytimes.com/1991/01/27/world/war-in-the-gulf-decoys-a-firm-s-fake-weapons-have-real-use-deception.html.

49. "Club-K Container Missile System 2013," YouTube, April 3, 2013, https://www.youtube.com/watch?v=mbUU_9bOcnM.

04

Toward More Distributed IAMD Operations

By applying aspects of the U.S. Navy's concept of Distributed Lethality to ground-based air and missile defense, the Distributed Defense concept proposes to adapt U.S. Army air and missile defense to the sophisticated threat environment presupposed by MDB. Although some elements of more distributed air and missile defense operations are already within the Army's program of record, these concepts attempt to consider what comes next. The IAMD force envisioned here would be more flexible and resilient, harder to suppress, and better suited to more challenging adversaries. For the last two decades, potential adversaries have worked to impose costs on U.S. protection of allies and power projection. Embracing the principles of launcher flexibility, passive defense, and a shell game could, to some degree, reverse that relationship.

The need to transform Army AMD has long been recognized in the face of more advanced combined arms threat, but actions taken have so far been insufficient. The current prominence of Multi-Domain Battle, however, represents a good opportunity to engage the matter in a more imaginative way. The time is ripe to candidly evaluate just how well *Vision 2020* is moving from vision to reality, and whether its goals should be revised in light of near-peer competitors—including in terms of resilience, modularity, and offense-defense integration.

The Distributed Defense concept proposes to adapt U.S. Army air and missile defense to the sophisticated threat environment presupposed by MDB.

Should elements of Distributed Defense seem worthy of further consideration, the Army or perhaps the Department of Defense might assess their feasibility and effectiveness to support Multi-Domain Battle. This assessment should include the likely cost and schedule for potential implementation and additional considerations for doctrine, organization, training, materiel, leadership and education, personnel, and facilities (DOTMLPF). Further thinking might be stimulated with the prototyping of material solutions, including more flexible launchers, decoys, and other means of camouflage, concealment, and deception. The mere construction of a containerized missile launcher and its public display at a trade show might have the secondary effect of communicating

Figure 4.1. Post–Gulf War Highway of Death

Remnants of the Iraqi Republican Guard on the "highway of death" following the 1991 Gulf War.
Source: U.S. Navy.

to allies and adversaries the seriousness of U.S. resolve, and potentially begin to impose costs on adversary planning, even in the short term.

Although herein applied to U.S. Army AMD, it bears repeating that the principles of Distributed Defense need not be restricted to a single Service or even to ground-basing. Given that the dispersal of AMD and fires endorsed here resembles and draws on the Aegis Combat System and Distributed Lethality, the elements of mixed loads, containerized launchers, and the shell game they support could in turn extend to various maritime platforms.

The principles of Distributed Defense need not be restricted to a single Service or even to ground-basing.

General David Perkins, the leading proponent of Multi-Domain Battle, has said that smoking tanks and planes littering the Golan Heights in 1973 were an inspiration for AirLand Battle.[1] Another vivid

1. David G. Perkins, "Multi-Domain Battle: Joint Combined Arms Concept for the 21st Century," Association of the United States Army, November 14, 2016, https://www.ausa.org/articles/multi-domain-battle-joint-combined-arms-concept-21st-century.

picture of vulnerability, the smoking ruins of the Iraqi Republican Guard (see Figure 4.1), provided the inspiration for our adversaries to develop more sophisticated and longer-range air defenses and precision strike. Today, near-peer adversaries have developed and fielded capabilities that now hold at risk U.S. fixed forward bases and operational concepts. Should U.S. AMD forces be suppressed early in a near-peer conflict, maneuver and retaliation could in turn be complicated.

While Multi-Domain Battle still emerges, the time is right for more innovative and imaginative air and missile defense concepts. We cannot wait for the specter of smoking Patriot launchers in the Polish countryside or on the Korean peninsula to be the inspiration for transforming and adapting the air and missile defense force.

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