

Composite Air Defense Artillery Formations

Converging Non-Kinetic and Kinetic Capabilities

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The character of airborne threats has evolved rapidly due to the proliferation of low-cost, high-density strike systems that blend diverse guidance methods and terminal behaviors. These salvos create engagement environments where defenders must optimize magazine expenditure, accelerate decision timelines, and sustain defended assets through extended operations. Traditionally, kinetic ADA, EW, cyber/CEMA, space support, and sensing capabilities were organized in separate structures with minimal habitual integration.^[1] These stovepipes generate seams across authorities, information sharing, logistics, and training that adversaries intentionally seek to exploit. Composite ADA formations provide a structural remedy by co-locating and institutionalizing integration of complementary capabilities at the battalion and brigade levels. Such formations allow commanders to execute defeat chains with greater speed, persistence, and efficiency.

Problem Statement: Seams, Latency, and Rising Costs

Air defense effectiveness is increasingly constrained by three persistent liabilities. First, sensor-to-shooter latency expands when detection systems, EW cells, cyber elements,

| An example of a UAS swarm.^[3]

and kinetic shooters operate in separate organizational stacks.^[2] Each handoff introduces friction that erodes engagement timelines and increases the likelihood of leakage. Second, when non-kinetic options are unavailable or insufficiently synchronized, commanders default to expensive interceptors against low-cost or low-value threats, accelerating stock depletion and creating brittle magazines. Third, centralized authorities and stovepiped C2 architectures introduce single points of failure in contested electromagnetic environments where jamming, deception, and cyber intrusion are routine. Ad hoc attachments and episodic cross-training cannot overcome these problems. Only permanent fusion of authorities, processes, sustainment, and personnel can ensure defeat chains function under the stress of modern high-intensity conflict.

Operational Lessons: Theater-Anchored Themes

Operational experience across multiple theaters reveals consistent themes in how non-kinetic effects create operational advantage. Saturation raids consisting of loitering munitions, UAS swarms, cruise missiles, and ballistic missiles succeed primarily by overwhelming kinetic responses and depleting interceptors. When applied early and in coordinated sequences, non-kinetic effects create time, force adversary errors, and preserve scarce missile



stocks. Targeted EW and cyber operations can degrade seekers, disrupt command links, and induce navigation or guidance failures. Decoys and signature-modulation techniques complicate adversary fire-control algorithms and force munitions to misallocate their terminal energy.

Distributed sensing is equally critical. Passive electro-optical/infrared (EO/IR), distributed RF receivers, high-altitude platforms, and space-based cueing collectively improve track quality against terrain-masked and low-observable threats. In parallel, resilient, delegated C2 shortens decision loops by empowering local commanders with pre-approved authorities, automated decision aides, and clear escalation ladders. Joint pooled magazine management has also emerged as decisive, allowing services and allies to allocate interceptors as a shared theater resource based on strategic prioritization.

Conflict-specific observations reinforce these themes. Prolonged European campaigns demonstrated how mass loitering munitions and persistent UAS activity demand layered responses that combine passive sensing, emission control, and distributed EW.^[4] Regional exchanges involving Iran and Israel in 2022–2023,^{[5][6]} as well as Russia and Ukraine through 2025,^[7] showed that layered air-defense architectures greatly benefit from coordinated EW, decoys, and signature-management capabilities. Subsequent analysis published in 2025 of the major Iran-Israel exchanges confirmed that while kinetic defenses were highly effective, their cost was unsustainable, driving a strategic imperative to integrate non-kinetic options to preserve expensive interceptor stockpiles for high-end threats.^[8]

The Composite Formation Concept: Organization and Core Components

A composite ADA formation is a permanent, modular organization designed to integrate kinetic shooters, EW teams, cyber/CEMA detachments, space support personnel, multispectral sensors, decoys and signature-management units, logistics elements, and resilient C2 nodes under unified, delegated authority. The formation is not a temporary task organization. It is a habitual construct optimized for shared doctrine, integrated sustainment, and consistent training currency across the full spectrum of defensive operations.^[9] This organizational model ensures commanders can generate multiple defeat chains rapidly and reliably in contested environments.

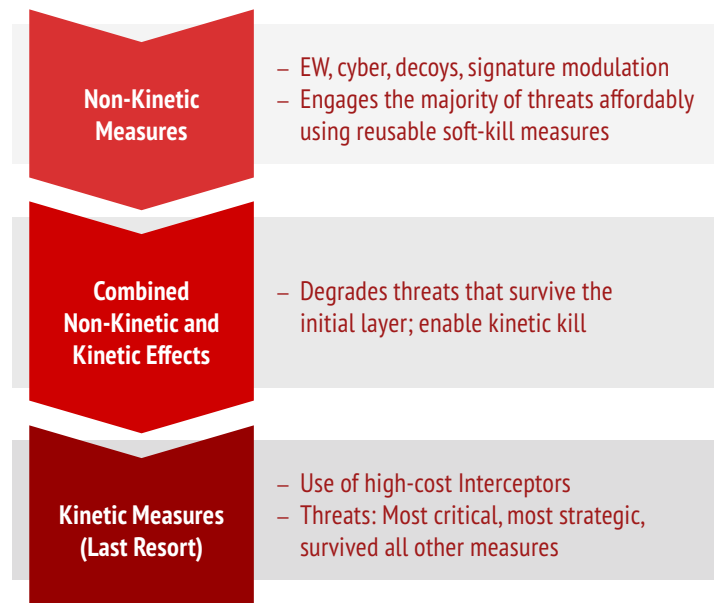
Command, Control, and Authorities

Composite formations require doctrinal changes to command relationships and engagement authorities. Commanders must receive explicit delegation to employ kinetic and non-kinetic options within well-defined parameters aligned with theater guidance.^[10] This delegation is bounded and accountable, supported by automated logs, legal oversight, and post-action review. Rules of engagement for non-kinetic effects must include thresholds, deconfliction requirements, and collateral-risk mitigation procedures, particularly given the shared nature of the

electromagnetic spectrum with civilian infrastructure. C2 architecture must be open and interoperable, relying on standardized APIs and data models that allow rapid integration of sensors and effectors while reducing vendor lock. Pooled theater magazine management must also be institutionalized to optimize interceptor allocation across services and allies.^[11] Standardized reporting, secure cross-cueing, and automated prioritization tools support strategic allocation of limited hard-kill assets.

Doctrine and Kill Chains

Composite formations employ codified defeat logic executed in parallel. The first kill chain, “Non-Kinetic First,” prioritizes soft-kill measures such as EW, cyber, decoys, and signature modulation against threats that can be degraded affordably. The second, “Combined Non-Kinetic + Kinetic,” applies coordinated soft-kill effects to reduce threat fidelity prior to lower-tier kinetic engagement. The third, “Kinetic Last Resort,” preserves high-cost interceptors for threats that are inherently strategic, have advanced terminal behavior, or have survived previous measures. This doctrinal construct optimizes cost, reduces collateral damage, and enhances survivability across the defended area.^[12]



Layered, defense-in-depth strategy for a composite ADA Battalion.

Tactics, Techniques, and Procedures (TTPs)

TTPs for composite formations must be prescriptive, executable, and scalable under stress. Pre-engagement routines include Emissions Posture Matrices that define authorized emissions levels based on threat posture and automatically adjust during elevated alert states. A comprehensive Non-Kinetic Playbook is essential and should include prioritized effects, thresholds, risk profiles, and fallback actions for each major threat type. Kill-chain decision ladders integrate automation while preserving human oversight. If a track meets non-kinetic thresholds, predefined EW or cyber actions are executed automatically

to generate early disruption. Residual threats are then queued to kinetic shooters with human notification and oversight for high-value tracks.^[13]

Training and Readiness

Composite formations require habitual training that integrates the full sensor-to-shooter sequence under contested conditions. Home station exercises must incorporate degraded PNT, communications jamming, cyber intrusion, and realistic adversary tactics. Live/Virtual/Constructive (LVC) environments enable comprehensive training of EW, cyber, space, and kinetic effects without exhausting interceptors. Red-team adversary emulation ensures formations are exposed to realistic electronic attack, cyber deception, and spoofing attempts. Joint and multinational exercises validate pooled magazine management and ensure allies operate effectively within a shared defensive architecture.^[14] Standardized certification and TTPs allow composite battalions to be measured and maintained at uniform readiness levels.

Beyond technology, this model requires a significant human capital investment. Creating a true composite formation demands more than temporary attachments; it necessitates the development of new career paths that merge skills from Air Defense (14-series), Cyber (17-series), and Electronic Warfare. TRADOC must be directed to establish integrated training pipelines and professional development models that cultivate and retain leaders who are fluent across multiple domains, ensuring that a battalion commander is not the sole point of integration.

Logistics, Sustainment, and Industrial Posture

Sustaining composite formations requires shifting planning from platform sustainment to magazine and effect sustainment. Interceptor stockpiles must reflect surge requirements and assume non-kinetic measures that will extend operational endurance. Forward repair capability, modular spares, and component commonality reduce downtime and ease logistics burdens. Mobility and dispersion complicate enemy targeting and help preserve both kinetic and non-kinetic assets. Industrial resilience—including diversified supply chains, increased domestic production of critical components, and contingency stocks—is essential for long-duration conflicts.^[15]

Technical and Acquisition Priorities

Achieving the full potential of composite formations is contingent upon an acquisition strategy that aggressively pursues several key technological goals. Priorities must be aligned with operational needs, focusing on fielding the following capabilities: hardened, open-architecture C2 systems and fusion middleware that enable rapid integration of sensors and effectors, supporting distributed decision making and sensor-to-shooter efficiency. Passive, multispectral, and low-probability-of-intercept sensors reduce risk, improve track fidelity, and enhance detection of low-observable threats. Directed energy and low-cost kinetic options expand defensive choices against UAS and loitering

munitions, providing flexibility for layered engagements. Positioning and navigation timing (PNT) resilience—including local clocks, inertial augmentation, and eLoran—reduces vulnerability to jamming. Modular EW pods and software-defined radios allow rapid reprogramming to adapt to evolving adversary tactics. Procurement emphasizes modularity, software-centric upgrades, and rapid fielding to ensure formations evolve at the speed of conflict, preserving both magazine depth and operational agility.^[16]

Risks and Mitigations

The most significant operational risk is the assumption of a static adversary. A peer competitor will not allow a non-kinetic advantage to go uncontested. We must anticipate that adversaries will rapidly develop and field countermeasures, such as hardened guidance systems, home-on-jam seekers, and advanced cyber techniques designed to attack the C2 networks that bind these formations together. Therefore, the composite formation should not be seen as a final solution but as the next evolution in a continuous cycle of measure and countermeasure. Non-kinetic measures carry escalation and collateral risks requiring calibrated employment and legal oversight. Overreliance on non-kinetic effects may create gaps in kill certainty or expose vulnerabilities to adversary countermeasures. Conversely, kinetic-only approaches accelerate magazine depletion and increase escalation potential. Both extremes create exploitable seams unless systems are fully integrated. Integration complexity can be mitigated through sandbox testing, modular architectures, role-based dashboards, and progressive fielding. Industrial bottlenecks must be addressed by diversifying suppliers and expanding surge capacity to sustain high-tempo operations.

A Patriot launcher executing a live fire exercise at MacGregor Range Complex, November 2025. (U.S. Army photo by Sgt. Christian Morton)



Operational risk is further mitigated by codifying rules of engagement, maintaining automated logs, and ensuring post-action review for accountability.

Operational Metrics

Operational performance must be measured to refine tactics and inform acquisition decisions. Key metrics include Interceptor Expenditure per Defeated Weapon (IE/DW), Sensor-to-Shooter Latency (STSL), Non-Kinetic Success Rate (NKSR), mission persistence, and an Escalation Index to track broader strategic implications. IE/DW highlights efficiency gains from non-kinetic integration, while STSL measures the speed of C2 and fusion operations. NKSR quantifies the effectiveness of EW, cyber, and decoy measures in degrading threats prior to kinetic engagement. Mission persistence captures operational endurance without resupply, and the Escalation Index ensures that tactical actions remain within theater-level strategic guidance. Transparent metrics allow commanders and acquisition planners to align resources and investments with operational realities.

Operational Vignettes

Vignette 1 – Saturation Raid Countered by Non-Kinetic First:

A logistics hub faces a dawn raid by cruise missiles and loitering munitions. The composite formation shifts emissions posture, deploying a coordinated EW package that disrupts seeker bands and communication links. Decoys and signature modulation create false targets, forcing inbound munitions to misallocate terminal energy. Passive sensors and space-based cueing refine tracks, leaving only a handful of threats for kinetic engagement. Low-tier interceptors neutralize most residuals, preserving high-value interceptors and maintaining hub operations.

Vignette 2 – Multi-Axis Attack with Distributed Sensing:

Terrain-masked launchers fire a mixed raid into a contested corridor. Passive sensors detect early activity and cue space-based and high-altitude assets for refinement. Local EW disrupts guidance, allowing short-range kinetic systems to defeat the majority of threats. High-tier interceptors remain in pooled theater reserves, allocated later through automated reallocation. This approach sustains defensive tempo while optimizing magazine usage and preserving readiness across multiple echelons.

Vignette 3 – Evolving TTPs in the Levant, 2025:

Drawing lessons from the costly kinetic-only defense of 2024, a composite Israeli ADA battalion faces a simulated raid of advanced drones and cruise missiles in a 2025 training exercise. Instead of defaulting to high-cost interceptors, the formation executes a “Non-Kinetic First” kill chain. An organic cyber/EW cell initiates coordinated jamming and spoofing of the drones’ GPS and command links, causing the majority of the swarm to lose navigation and fail. Simultaneously, decoys are deployed to confuse the

seekers of the inbound cruise missiles. Only three high-priority threats that penetrate this initial screen are engaged by kinetic interceptors. This new TTP, as analyzed in recent strategic studies, demonstrates a dramatic improvement in the interceptor expenditure ratio and preserves the high-tier missile magazine for a potential follow-on ballistic missile attack.^[17]

Legal and Escalation Controls

Formation commanders may employ pre-authorized non-kinetic measures against inbound threats when technical criteria—including speed, vector and time to impact—are met. All actions remain within defined legal and collateral-risk boundaries and are logged for post-action review. Broader effects with potential cross-border or third-party implications require theater-level legal concurrence and, when necessary, political notification. These controls provide tactical agility while ensuring strategic oversight and accountability.

Recommendations

Establish two pilot composite ADA battalions with organic EW, cyber, space, sensor, and decoy capabilities. Institutionalize integrated training across EW, cyber, space, and kinetic operators at home station and combat training center rotations. Implement theater-wide pooled magazine management structures with automated priority arbitration. Accelerate development of low-cost interceptors, directed energy prototypes and distributed passive sensors. Embed legal and interagency liaisons at composite C2 nodes with mandatory machine-readable attribution logs. Align acquisition and sustainment planning with operationally validated performance metrics, emphasizing magazine preservation, kill-chain efficiency, and non-kinetic integration.

Conclusion

The evolving threat environment requires organizational and doctrinal innovation to defeat adversaries efficiently and sustainably. Composite Air Defense Artillery formations—integrating non-kinetic effects, kinetic shooters, multispectral sensors, space support, resilient C2, and unified logistics—provide a scalable approach to preserve magazines, accelerate engagements, and maintain defended-asset availability. Operational lessons from past conflicts involving Israel and Iran,^{[18][19]} as well as the Russia-Ukraine War,^[20] have been reinforced by 2025 analyses emphasizing the unsustainable cost of purely kinetic defenses and the critical need to integrate non-kinetic measures to maintain magazine depth against state-level adversaries.^[21] By updating doctrine, enhancing training, and aligning acquisition, the U.S. Army can significantly increase its capacity to defeat massed, networked, and adaptive air and missile threats.

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