Countering A2/AD Through EABO: The Role and Feasibility of Distributed ISR in the Indo-Pacific

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ABSTRACT

The potential for conflict in the Indo-Pacific is rapidly growing as the People's Republic of China (PRC) consistently increases its military exercises in the vicinity of Taiwan and harassment of Philippine vessels in the South China Sea. The United States and its allies are preparing how they will respond in the event one of these flashpoints escalates.

The U.S. Navy has operated consistently around the globe for decades for the purpose of maintaining presence and supporting its power projection. In recent years, as the PRC has grown more aggressive in its territorial claims, the U.S. Navy has proudly conveyed their presence in China's backyard is to support a "Free and Open Indo-Pacific."

The PRC has a wide array of systems in its anti-access/area denial (A2/AD) arsenal specifically designed to counter that idea. A review of this potential battlespace shows a PRC military with an extensive A2/AD complex that aims to keep the U.S. and its allies from interfering with its interests. The U.S. military is adjusting and developing its procedures, tactics, and operations to respond to this threat. In order to achieve its objectives, the U.S. will need to break through the A2/AD wall that the PRC has built and operate within this contested area.

An evolving military strategy to support this objective is the concept of using small, low-footprint, low-signature units dispersed through the critical archipelagic islands of the First Island Chain to get U.S. and allied forces closer to critical maritime terrain without exposing their more valuable assets to the threat of the PRC's ballistic missile arsenal. A core tenet of this concept of dispersed operations is called Expeditionary Advanced Base Operations (EABO).

EABO has potential to increase the situational awareness of U.S. forces and provide critical information to fleet and combatant commanders using dispersed intelligence, surveillance, and reconnaissance (ISR) capabilities. This concept, however, faces serious challenges. Placing U.S. and allied forces in these locations, within the weapons engagement zone (WEZ) of PRC systems, could certainly expose them to

detection and engagement by adversary forces. In addition, they will require robust and resilient communications to ensure the information they gather can be properly disseminated in this contested environment.

In addition to the operational and tactical challenges posed by this strategy, there are potential geopolitical barriers that could prevent the employment of EABO. The critical littoral region of the First Island Chain, where EABO units would operate, is primarily territory of the Philippines and Japan. These host nations may have conflicting goals regarding the escalation of any conflict in the region. Any authority granted by host nations for EABO units to operate on their terrain could be met with retaliation from the PRC. For the purpose of this study, access to this terrain is assumed to be granted. Although access cannot be guaranteed and host nation political will can be variable, this assumption allows for a thorough evaluation of the tactical and operational feasibility of the concept, independent of diplomatic fluctuations.

This research assesses the feasibility of EABO as a tactical concept and determines if the capabilities it provides are practical. In order to evaluate the feasibility and practicality of this concept, a thorough review of the potential systems it would employ is included. In addition, the specific tactics that would be employed to ensure survivability are discussed. It explores the necessity of resilient communications for data sharing and the critical need for signal management to avoid detection. In conclusion, the analysis discusses the potential strengths of the concept as well as the critical vulnerabilities that could prevent it from achieving strategic success.

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LIST OF ABBREVIATIONS

A2/AD	Anti-Access/Area Denial
ACE	Agile Combat Employment
AI	Artificial Intelligence
ASBM	Anti-Ship Ballistic Missile
ASCM	Anti-Ship Cruise Missile
BDA	Battle Damage Assessment
BLoS	Beyond-Line-of-Sight
C2	Command and Control
C5ISR-T	Command, Control, Communications, Computers, Cyber, Intelligence, Surveillance, Reconnaissance, Targeting
COP	Common Operational Picture
CTP	Common Tactical Picture
DDG	Guided Missile Destroyer
DMO	Distributed Maritime Operations
EAB	Expeditionary Advanced Base
EABO	Expeditionary Advanced Base Operations
ELINT	Electronic Intelligence
EM	Electromagnetic
EMCON	Emissions Control
EO	Electro-Optical
EO/IR	Electro-Optical/Infrared
EW	Electronic Warfare
F2T2EA	Find, Fix, Track, Target, Engage, and Assess
G/ATOR	Ground/Air Task Oriented Radar
GPS	Global Positioning System
HF	High-Frequency
HGV	Hypersonic Glide Vehicle
HIMARS	High Mobility Artillery Rocket System
IADS	Integrated Air Defense System
IAMD	Integrated Air and Missile Defense
IIR	Imaging Infrared
IR	Infrared
IRBM	Intermediate-Range Ballistic Missile
ISR	Intelligence, Surveillance, and Reconnaissance
JLTV	Joint, Light, Tactical Vehicle
LEO	Low Earth Orbit
LOCE	Littoral Operations in Contested Environments
LOS	Line-of-Sight
LPD	Low Probability of Detection
LPI	Low Probability of Intercept
LRASM	Long-Range Anti-Ship Missile
LRFL	Long Range Fires Launch
LSM	Landing Ship Medium
MAGTF	Marine Air Ground Task Force
ML	Machine Learning
MRBM	Medium-Range Ballistic Missile

MST	Maritime Strike Tomahawk
NMESIS	Naval/Marine Expeditionary Ship Interdiction System
NSM	Naval Strike Missile
OTH	Over-the-Horizon
PLA	People’s Liberation Army
PLARF	People’s Liberation Army Rocket Force
PPLI	Precise Participant Location Identification
PRC	People's Republic of China
SAR	Synthetic Aperture Radar
SATCOM	Satellite Communications
SIGINT	Signals Intelligence
SPMA	Statistical Priority-Based Multiple Access
SRBM	Short-Range Ballistic Missile
TDMA	Time Division Multiple Access
TDOA	Time Difference of Arrival
TEL	Transporter Erector Launcher
UAS	Unmanned Aircraft System
UAV	Unmanned Aerial Vehicle
UHF	Ultra High Frequency
USV	Unmanned Surface Vehicle
UUV	Unmanned Undersea Vehicle
VHF	Very High Frequency
WEZ	Weapons Engagement Zone

1. ANTI-ACCESS/AREA DENIAL (A2/AD) IN THE INDO-PACIFIC

1.1 Defining the A2/AD Concept

Anti-access/area denial, or A2/AD, describes a military strategy that employs various systems and capabilities with the goal of preventing or limiting an adversary's military forces from operating freely within a specific geographical area or theater. The methods employed in an A2/AD system aim to restrict access to key areas such as sea lanes and airspace. The development and deployment of A2/AD systems and capabilities by the PRC have become a key focal point in defense planning for the United States and its allies in the Indo-Pacific. Although it can be broadly defined, A2/AD strategy can be academically and doctrinally broken into two complementary components: anti-access (A2) and area denial (AD) (Kearn Jr., 2013).

Anti-access systems and capabilities are employed with the intent to prevent entry into a specific region or theater. These involve longer-range capabilities such as ballistic missiles that can target adversary air and naval bases at great distance within the contested area. These systems also hold high value naval targets, such as aircraft carriers, at risk. The intent of these tactics and systems is to keep an adversary entirely outside of a specific region or force them to operate at a range of reduced effectiveness.

Area denial involves shorter-range systems and tactics that aim to limit freedom of maneuver within a contested area. Examples of area denial systems include short-range ballistic missiles, coastal defense cruise missiles, and integrated air defense networks. These systems intend to disrupt an adversary's operations within a specific region and limit their freedom of movement.

A2/AD complexes are not designed or employed to be an impenetrable boundary. Their purpose is to make operations in a specific geographic region so costly and complex that an adversary is deterred from intervening, and, if they do intervene, sufficiently limit their advance and force them to accept disproportionately high casualties. This strategy provides a means for a force that could be perceived as inferior to effectively offset the qualitative or quantitative advantages of a superior military power.

1.2 Historic Context and Strategic Intent

China's efforts to develop a robust A2/AD strategy have been a decades-long, focused endeavor to transform the strategic environment of the Western Pacific. The 1995-96 Taiwan Strait Crisis, when the United States deployed two carrier strike groups to the Western Pacific, was a significant catalyst for this development. In this event, the People's Liberation Army (PLA) struggled to effectively prevent or even reasonably contest foreign intervention in its near seas (Mahnken, 2022).

As a result of the exposure of these vulnerabilities, the PLA initiated a full-scale reevaluation of its defense posture, and redirected its focus to creating a specific anti-access capability designed to prevent a superior adversary, such as the United States, from establishing itself within the region and thus being able to build strength or establish a presence in the Western Pacific.

Ultimately, China's A2/AD strategy is designed to inhibit the U.S. ability to intervene in regional conflicts and, therefore, limit the U.S. military's ability to project power in the region. By applying measures that impose extreme cost and difficulty to military operations in areas critical to Chinese national interests, such as the Taiwan Strait and the South China Sea, China seeks to credibly deter U.S. and allied intervention in order to create a favorable military balance in the region. This strategy provides China with greater freedom of maneuver in its near seas while simultaneously preventing adversaries from operating in the region.

1.3 A2/AD Systems and Capabilities

The PRC's A2/AD system uses a layered defense strategy that incorporates an arsenal of kinetic capabilities enabled by non-kinetic systems and command architecture. This robust complex is a system of redundant command, control, communications, computers, cyber, intelligence, surveillance, reconnaissance, and targeting (C5ISR-T) assets which include ground-based over-the-horizon (OTH) radar, airborne early warning systems, and a broad space-based surveillance capability (Newman et al, 2022). These systems allow the PLA to combine sensor data in near-real time and pass high confidence target information to mobile launchers throughout the First and Second Island chains.

The strategic deterrent provided through combination of kinetic assets, consisting of intermediate and medium range ballistic missiles used for anti-access and shorter-range coastal defense cruise missiles utilized for area denial, significantly reduces the reach and effectiveness of traditional naval forces. These systems collectively establish a highly contested environment, in which even low-signature elements can be rapidly detected and engaged.

1.4 Geographical Focus

China's A2/AD strategy is structured as multiple concentric layers of geographical space with escalating levels of hostility that increase the burden for any potential adversary to enter the theater. The overall structure is designed to make the maritime domain immediately adjacent to the Chinese mainland a hostile environment where the PLA has the ability to exercise command over both sea and air.

Geographically, the strategy encompasses the First and Second Island Chains, as well as the Taiwan Strait and the South China Sea. The strategic objectives in these regions combine to reinforce the overall purpose of the A2/AD system.

First Island Chain

The First Island Chain describes the string of archipelagos in the Western Pacific, ranging from the Kuril Islands, through Japan, Taiwan, and the Philippines, and extending to Borneo. This region is the inner core of the A2/AD complex, where the PRC has the greatest ability to project its power. The PLA has employed fortified missile systems and developed naval capabilities with the goal of exercising sea supremacy in the region (Krepinevich, 2015).

Second Island Chain

Stretching from the Ogasawara Islands through Guam to western New Guinea, the Second Island Chain serves as the outer layer of strategic planning in the Western

Pacific (Krepinevich, 2015). While the U.S. has key strategic hubs in this region, including Guam and Tinian in the Marianas Islands, the PRC aims to minimize the effectiveness of these resources. Specifically, the PLA intends to hold these critical hubs at risk using its arsenal of IRBMs.

<u>Militarized Artificial Islands and Reefs in SCS</u>

Developments in the South China Sea represent a unique application of A2/AD in which the PRC has developed distributed strongholds in nearby regional maritime territory. By building and fortifying man-made islands in the Paracel and Spratly Islands, China has effectively extended its sensing and shooting capabilities well beyond the natural confines of its coastline. These artificial features provide the necessary infrastructure for China to deploy long-range radar, runways, and missile silos, thereby extending the reach of their A2/AD capabilities (Lake, 2023). This extends China’s military power throughout Southeast Asia and challenges the freedom of navigation and operational security of other regional maritime forces.

<u>Taiwan Strait</u>

As a likely flashpoint for major conflict in the Indo-Pacific, the Taiwan Strait is the geographical and strategic center of China’s A2/AD strategy. The PLA’s arsenal of ballistic and cruise missiles holds land and maritime targets at risk. In addition, their IAMD system and naval forces significantly threaten any outside military interference in the region. These systems, designed to delay or prevent U.S. intervention, form a multi-layered defensive zone around the island of Taiwan and the Taiwan Strait.

2. EXPEDITIONARY ADVANCED BASE OPERATIONS (EABO)

2.1 Doctrinal Background for Distributed Operations

A doctrinal shift to distributed operations is an immediate response to the increased lethality and reach of A2/AD systems from adversaries. The U.S. military has sought to make its forces less centralized and therefore less vulnerable to targeting by an enemy by creating a more dispersed, mobile, and networked force. The goal of the dispersed forces is to effectively conduct offensive operations while making it more difficult for an enemy to locate and engage targets. As the fundamental, multi-service doctrine for countering the challenge of A2/AD, the U.S. Joint Concept for Access and Maneuver in the Global Commons (JAM-GC) integrates capabilities from all domains to ensure that the joint force maintains freedom of action in contested environments (Hutchens et al, 2017).

The U.S. Air Force supports this strategy through Agile Combat Employment (ACE), which aims to achieve resilience through a hub-and-spoke model to reduce dependence on large, fixed air bases. Distributed Maritime Operations (DMO), the Navy's model for a less centralized force, focuses on distributing sensors and shooters across a multitude of platforms to deny the adversary a clear focal point to attack. Littoral Operations in a Contested Environment (LOCE) is the strategic framework for integrating Navy and Marine Corps operations to leverage the land-sea interface as a position of tactical advantage to achieve sea control and facilitate sea denial (USMC, 2017). EABO is the tactical implementation of the LOCE framework. Specifically, EABO involves the deployment of mobile, low-signature Marine Corps units in stand-in locations within the adversary's WEZ. These small, mobile teams operate from austere advanced bases to provide critical functions such as forward sensing for targeting and long-range precision strikes against enemy assets (USMC, 2023).

2.2 EABO Structure: The Marine Littoral Regiment

The Marine Littoral Regiment (MLR) is a component of the Marine Corps and is most likely to employ the tactics of EABO. In the context of EABO, the MLR will serve as the stand-in force within the enemy WEZ (USMC, 2023). The MLR is designed to maneuver within the WEZ and conduct sea denial operations in order to enable fleet objectives. Key objectives of the MLR with regard to EABO include:

- Conduct surveillance and reconnaissance
- Deny or control key maritime terrain
- Conduct surface warfare operations
- Conduct air and missile defense
- Conduct strike operations
- Conduct sustainment operations

The MLR is composed of the Littoral Combat Team, the Littoral Anti-Air Battalion, and the Littoral Logistics Battalion (Feickert, 2025).

1. Littoral Combat Team (LCT): The LCT is designed based on the infantry battalion structure and is intended to command EABO to facilitate sea denial. The LCT integrates reconnaissance and strike capabilities to enable the MLR to control critical maritime environments.
2. Littoral Anti-Air Battalion (LAAB): Tasked with managing and directing air operations, the LAAB conducts air support as well as air and missile defense. The LAAB is designed to work in close coordination with other dispersed aviation units and C2 agencies.
3. Littoral Logistics Battalion (LLB): The logistics battalion is tasked with supporting the distributed units by providing necessary tactical logistics. The LLB manages diverse missions, from littoral transportation to health services, necessary to sustain the MLR forces and ensure they remain operationally effective.

By creating a distributed network of EABs, the MLR makes the targeting cycle of the adversary harder to manage, as they are forced to use excessive ISR resources to locate the dispersed, low-signature forces. In addition, the MLR creates the link between sensors and shooters in the littoral zones through organic sensing and the feeding of data into the common operational picture (COP). This capability enables the execution of long-range precision fires. Ultimately, the persistent presence of the

MLR, dispersed in the EABO construct, increases the costs of the adversary operating in the littoral space and supports friendly maneuver.

2.3 Contribution to Joint Kill Chains

The main purpose of EABO is to enable the F2T2EA kill chain – Find, Fix, Track, Target, Engage, and Assess (USMC, 2023). In a high intensity of combat, the outside force (aircraft carriers, bombers) will likely have limited organic detection systems due to operating at ranges far beyond the range of their sensor systems. EABO forces serve as the stand-in force inside the enemy's WEZ, thus providing this capability (USMC, 2021).

- Find: EABO units utilize sensors such as electronic support measures (ESM), small unmanned aircraft systems (UAS) and visual observation to find enemy assets including ships, mobile missile launchers, or radar sites. This information is used to help develop the COP. Since EABO units are physically closer to the contested area, they can provide enhanced situational awareness of the littoral region that would otherwise require the use of satellite resources or longer-range radar (Joint Chiefs of Staff, 2024).
- Fix: After initial detection, EABO forces use additional resources and cross-cue sensors to acquire coordinates that can be used for targeting. Geolocation is usually achieved by triangulation of ELINT data or use of laser ranging devices on UAS or ground sensors (Joint Chiefs of Staff, 2024).
- Track: In the track phase, EABO forces continue to monitor and observe a target's movement and activity. If necessary, units may handoff contacts to other entities or sensors to maintain constant custody or ensure the appropriate entity holds a targetable track (Joint Chiefs of Staff, 2024).
- Target: EABO units take sensor data and use methods of association, correlation, and fusion to determine what the detected target is, and determine target priority based on commander's objectives and priorities. With this information, they identify the best weapon system to employ against the target and transmit targeting information to the designated shooter via resilient networks (Joint Chiefs of Staff, 2024).

- Engage: The shooter can be either a direct member of the EABO force, such as NMESIS or HIMARS, or the EABO units can serve as the spotter, cueing a joint force asset (DDG firing a Tomahawk missile, bomber launching LRASM) to attack the target (Joint Chiefs of Staff, 2024).
- Assess: Following a strike, EABO units use their local sensors to perform battle damage assessment (BDA) of the target and confirm whether the target has been destroyed or if re-engagement is required, closing the kill chain loop (Joint Chiefs of Staff, 2024).

2.3 Challenges Facing EABO

EABO requires a shift in how operational tasks are accomplished relative to prior power projection doctrines. Instead of a transient, high-profile force deployed within an enemy's WEZ, EABO will utilize a persistent, low-signature stand-in force. Although the doctrine provides the joint force a powerful deterrent against A2/AD strategies, it is restricted by significant challenges for command and control, logistics, and survivability for Navy, Marine Corps, and other joint force organizations.

Operational and Tactical

At the tactical and operational level, EABO is challenged by survivability, specifically requirements for emissions control (EMCON) and signature management (SIGMAN), and friction in the command and control (C2) process. In order to survive within the WEZ of the A2/AD complex, EABO units need to avoid counter-detection and targeting. In order to do this, they must significantly reduce and strictly manage their emissions. They also need to prioritize movement and relocation of forces to avoid targeting. If tasked with providing ISR and targeting support, the restraints of EMCON and SIGMAN can severely reduce the effectiveness of dispersed sensors or limit their ability to communicate data. In addition, the distributed nature of the units makes the coordination of assets to achieve specific objectives increasingly difficult. In short, EABO forces are faced with a "transmit and die" paradox: if they do not emit, they fail to achieve their objectives and are tactically irrelevant, but if they do emit, they are extremely vulnerable to being targeted and destroyed.

Logistical and Human

Sustaining operations of the distributed model of EABO is likely to be a significant vulnerability. The same systems that threaten high-value naval assets and EABO units themselves pose a significant threat to any logistics assets. In order to sustain distributed units in the contested littoral region, logistics units must transition from the legacy model of large logistic transports to an integrated web of smaller, low-footprint, flexible connectors. Providing the necessary resources for the dispersed units will require integration of small, shallow-draft supply vessels such as the Landing Ship Medium (LSM). These will need to be supplemented by air logistics assets (helicopters, tilt-rotors, UAS) to ensure the EABO units have the resources they need to achieve their objectives. Medical resources will also be limited and will require detailed management to provide support to EABO units. Without the proper logistics infrastructure to support operations, distributed units will be unable to achieve their objectives or support joint operations.

3. DISTRIBUTED ISR SYSTEMS, CAPABILITIES, AND LIMITATIONS

In order to accomplish objectives and provide ISR and battlespace awareness, EABO units are tasked with employing a variety of systems. These systems include ground-based radars for air surveillance, UAS for persistent and longer-range reconnaissance, and passive sensors for SIGINT collection. In addition to the sensing capabilities, EABO forces employ counter-UAS systems and kinetic strike capabilities using mobile missile launchers.

3.1 Unmanned Aircraft Systems (UAS)

For the purposes of sensing and targeting, there exist a large range of UAS that are capable of contributing to EABO objectives. In order to maintain the small footprint required, however, some UAS are more practical for distributed operations.

To understand the different types of UAS that are available, they are broken down into 5 groups based generally on their size and operating characteristics. The table below breaks down the technical differences between different groups of UAS (Gettinger, 2024).

Group	Max Weight	Normal Altitude	Speed	Example Platforms
Group 1	< 20 lbs	< 1,200 ft AGL	< 100 knots	RQ-11 Raven, WASP, Puma
Group 2	21 – 55 lbs	< 3,500 ft AGL	< 250 knots	ScanEagle
Group 3	< 1,320 lbs	< 18,000 ft MSL	< 250 knots	RQ-7 Shadow, RQ-21 Blackjack
Group 4	> 1,320 lbs	< 18,000 ft MSL	Any Speed	MQ-1C Gray Eagle
Group 5	> 1,320 lbs	> 18,000 ft MSL	Any Speed	MQ-9 Reaper, RQ-4 Global Hawk

Although Group 4 and 5 UAS are the largest and generally most capable platforms, both groups face sustainment challenges in austere environments and remain vulnerable in high-threat A2/AD environments due to their larger radar signatures and logistical footprints, which contradict the EABO concepts of high mobility and low signature (Haffa and Datla, 2014). For these reasons, groups 1-3 are more suitable for EABO because they allow for organic sensing and targeting support but require significantly less of a footprint to operate.

Group 3 Systems

These systems provide the right tactical balance for expeditionary forces with increased endurance (usually 10-16 hours) and higher payload capacity than small UAS, but with size and weight suitable that they can be operated by a small team. These UAS benefit EABO operations through runway independent operation and modular payload bays to carry electro-optical/infrared (EO/IR) sensors, automatic identification system (AIS) receivers, and even small electronic warfare (EW) or kinetic attack packages.

System	Group	Launch / Recovery	Range	Endurance	Payloads
V-BAT[1]	3	True VTOL	130 km	10 hrs	EO/IR, SIGINT, Comms Relay
Jump 20[2]	3	Hybrid VTOL	185 km	13 hrs	EO/IR, SIGINT
RQ-21 Blackjack[3]	3	Catapult / Skyhook	93 km	16 hrs	EO/IR, SIGINT, Comms Relay

1. (Shield AI, 2025) 2. (AeroVironment, 2025) 3. (Insitu, 2025)

The primary sensing tool for the MLR and stand-in forces of EABO will likely be the Group 3 UAS. Because they do not require specialized launch/recovery gear and because they can be launched from constrained areas, they can be deployed from the same types of remote, concealed locations as NMESIS and HIMARS. They can add value to EABO by conducting persistent, wide area search of the maritime domain and providing real-time targeting information to allow dispersed units to sense their immediate littoral environment without having to rely on satellite communications or far away strategic assets. However, Group 3 UAS will have to deal with constraints, such as line-of-sight (LOS) data link communications that can reveal the location of the EAB and reduced effective range as compared to Group 4 and 5 UAS (Gaines and Suh, 2023).

Group 1 & 2 Systems

Group 1 and 2 UAS compose the category of small UAS and are used at the organic/unit level with emphasis on portability and quick deployment. Group 1 UAS have a maximum weight of 20 pounds and operate below 1200 feet. They are typically backpacked and hand-launched for short range reconnaissance. Group 2 UAS have a weight range of 21-55 pounds and operate up to 3500 feet. Although Group 2 UAS require slightly greater logistics and support for operation, they provide more persistent, tactical ISR and maritime search capabilities required for larger units and dispersed EABO units.

System	Group	Launch / Recovery	Range	Endurance	Payloads
Flexrotor[1]	2	VTOL	120 km	12–14 hrs	EO/IR, SIGINT, Comms Relay
ScanEagle[2]	2	Catapult/Skyhook	100 km	18–24 hrs	EO/IR, AIS, SIGINT
PDW C100[3]	1	VTOL	10 km	74–80 min	EO/IR; SIGINT; Comms Relay
RQ-11 Raven[4]	1	Hand-Launch	10 km	60–90 min	EO/IR, Comms Relay
RQ-12 Wasp[4]	1	Hand-Launch	5 km	50 min	EO/IR
RQ-20 Puma[4]	1	Hand-Launch	20 km	3 hrs	EO/IR
Black Hornet 3[5]	1	Hand-Launch/VTOL	2 km	25 min	EO/IR

1. (Airbus, 2025) 2. (Insitu, 2025) 3. (PDW, 2025) 4. (Aerovironment, 2025) 5. (Teledyne, 2025)

In the context of EABO, both Group 1 and Group 2 UAS are vital to establishing low-signature stand-in forces to performing local maritime domain awareness and targeting functions. Both types of systems provide persistent tactical surveillance of littoral chokepoints and landing areas with limited logistics or electromagnetic (EM) footprints compared to larger strategic aircraft. Despite potential contributions to EABO, there are challenges to their employment in contested environments. The use of LOS data links makes them vulnerable to EW and jamming (Zyga, 2020). Additionally, the limited sensor payload and power output available due to the smaller size of the systems limit their ability to collect data. These smaller systems can potentially overwhelm enemy forces when employed in mass, but they are similarly susceptible to counter-UAS capabilities, weather, and kinetic air defenses.

Launched Effects / Loitering Munitions / One-Way Attack Drones

Loitering munitions and launched effects are a specific type of UAS capable of both long-duration, high-resolution sensor technology, and the lethal precision of a weapon system. Loitering munitions are essentially aerial munitions with built-in warheads designed to remain stationary above a designated target area until a specific target has been identified by the operator, at which point the operator will command a final terminal attack (Gettinger, 2019). Launched effects is a more general term used to describe a family of systems launched from another platform. These systems can be air-launched from a helicopter or drone, or ground launched from a joint, light, tactical vehicle (JLTV), to provide ISR, EW, or kinetic effects. Each of these systems provides a modular, networked means to extend the sensing and strike capability of distributed forces (Gettinger, 2019).

These systems offer EABO the capability of sea denial and sea control by providing organic, unit-level precision fires for small, distributed units. Loitering munitions and launched effects can independently target and destroy enemy radar sites, mobile missile launchers, and littoral surface vessels such as landing craft and corvettes. The ability of these systems to operate in networked swarms allows for saturation of enemy integrated air defense systems (IADS), causing the enemy to expend high-cost interceptors on low-cost, attritable drones. While these systems have many advantages, there are also many limitations including: small warheads inadequate for larger surface combatants, reliance on LOS data links limits ability to operate in areas of EW, jamming, or GPS denial, and shorter endurance than larger Group 3-5 UAS.

3.2 Ground-Based Surveillance Systems

Active Sensors

Active sensors emit energy to detect and track threats. The AN/TPS-80 Ground/Air Task Oriented Radar (G/ATOR) is an expeditionary, active electronically scanned array (AESA) multi-role radar system capable of detecting low-observable, low radar cross-section targets such as manned and unmanned aircraft systems, cruise missiles, and rockets (Feickert, 2025). As part of EABO, the G/ATOR acts as the main fire-control node for the MLR and integrates with the Common Aviation Command and Control System (CAC2S) to provide an integrated air picture. Active sensors provide the precision coordinates required for systems such as NMESIS and HIMARS to engage targets (Billard, 2025). However, because these systems continuously radiate energy, their sensors can be geolocated and engaged by enemy forces. Therefore, they are often operated in burst modes or tipped/cued by passive sensors to minimize their electromagnetic signature.

Passive Sensors and EW

Passive sensors enable EABO units to sense without being detected. Marine Corps radio battalions employ vehicle mounted or man-portable SIGINT and EW suites to achieve this objective. These units collect intelligence from enemy communication transmissions and radar emissions to determine the locations of enemy ships and aircraft without transmitting or emitting any electromagnetic signal themselves (USMC, 2024). Additionally, ESM sensors are employed to characterize the signature of enemy radar systems, thus enabling commanders to identify they type of vessel based on emission parameters. The primary weakness of passive sensors is the dependency on enemy activity. If an enemy remains in EMCON, these sensors become ineffective.

3.3 Expeditionary Kinetic Weapons

The kinetic weapons underpinning the EABO framework enable the forces to extend their influence from land as a land-based adjunct to the naval fleet, and to project influence from the shore to create sea denial through power projection. A core system used to apply these kinetic capabilities is the NMESIS, which employs a JLTV to launch a Naval Strike Missile (NSM). The NSM is a subsonic, sea-skimming cruise missile, which has a greater than 100 nautical mile range, and includes an imaging infrared (IIR) seeker to allow for autonomous target recognition independent of active radar or GPS, providing high survivability in contested electromagnetic environments (Feickert, 2025). Additionally, EABO units could employ HIMARS, including the precision strike missile (PrSM). The PrSM incorporates a significantly increased range over previous missiles, with its range of 650 kilometers, and is expected to include future increments for moving maritime targets (Army Recognition, 2025). For even further reach, EABO units could employ the long-range fires launch (LRFL) to fire Tomahawk cruise missiles and the Maritime Strike Tomahawk (MST). The MST has an approximate range of 1,600 kilometers and can threaten larger surface combatants (DON, 2024).

Although these weapons provide EABs with lethality at the unit level, they are limited by numerous logistical and operational constraints defined by the EABO construct. The primary constraint to EABO is the logistics requirements associated with employing and sustaining long-range fires. The weapons that could be employed by these forces (Tomahawk, NSM, PrSM) require specialized equipment to transport and reload. This can prove difficult in dispersed, austere locations where logistics support and resources are minimal. Also, although the launchers can be mobile, the F2T2EA process is robust and often requires significant electromagnetic signature for targeting and creates a large thermal and visual signature during engagement. These elements can be tracked and geolocated by enemy forces for counter-engagement, therefore requiring rapid repositioning following any fires. These kinetic systems also often rely heavily on targeting data from external sensors from air or ground assets. The sensors supporting the kill chain can be susceptible to targeting within the WEZ of enemy forces. Therefore, effective employment of these kinetic assets within EABO will require a balance between operating at stand-off range and signature management to maintain stealth within the A2/AD bubble.

4. COMMUNICATIONS, DATA LINKS, AND SIGNATURE MANAGEMENT

An isolated sensor in the First Island Chain will have minimal, if any, strategic significance if the information it provides is not communicated to a capable weapons system or command center. The move from linear kill chains to non-linear kill webs requires communications that are flexible, fault-tolerant, resilient, and connectable from a sensor to the most suitable shooter. In the contested electromagnetic spectrum of the Indo-Pacific, communications and data links will be regularly susceptible to degradation, denial, and jamming. The PRC's Strategic Support Force (SSF) has created a centralized apparatus for commanding space, cyber, and electronic warfare capabilities (Hoole, 2020). Any forces operating in this region, including EABO units, will have to maintain connectivity while being attacked by jamming, cyber attacks, and kinetic attacks to relay nodes.

Since regional limitations to communications will exist in the Indo-Pacific theater, an essential step for planning and conducting EABO is characterizing the electromagnetic operating environment. The limitations of a communication system include the relationship between frequency, range, bandwidth, and power that determine how effectively it can communicate information. For the purpose of EABO, any emissions can potentially lead to detection and engagement by adversary forces. Current SIGINT technologies allow for rapid detection, classification, and geolocation of radio emissions. The adversary can use a variety of ground-based direction-finding (DF) sites, airborne ELINT aircraft, such as Y-8 and Y-9, and space-based sensors to detect emissions. For this reason, the tactical concepts of signature vulnerability and jamming/denial apply specifically to EABO. Regarding signature vulnerability, even an individual Marine's radio transmission on an omnidirectional radio will provide a unique RF signature that can be geolocated, revealing the presence and location of the emitter. Even if the message itself is encrypted, the fact that the message was transmitted and where it originated allows for long-range strikes against the emitting unit.

4.1 Theory of Signature Management (SIGMAN)

The Marine Corps uses a comprehensive approach to SIGMAN which focuses on understanding your own signatures, recognizing the means an adversary can use to collect these signatures, and implementing countermeasures to cover or limit detection (USMC, 2023). In the context of EABO, this can manifest in tactics such as visual camouflage or radio silence. In the constant, active cycle of operations of opposing kill chains, SIGMAN focuses on three main components: understanding one's own signatures, identifying adversary collection methods, and taking action to mask signatures and limit detection. To be successful, the stand-in force must be able to understand the adversary kill chain and how to appropriately interrupt it. Various means of surveillance can be used to detect an EAB, and these different means can be fused together by the adversary to form a targeting solution. A full understanding of the different signatures that can be exploited is essential to the survivability of EABO forces.

Electromagnetic Signature

The EM signature is the most sensitive and vulnerable domain of intelligence information in the First Island Chain. This includes the emission of energy from communications equipment (HF, VHF, UHF, satellite uplinks) and active sensors (air defense radars, surface search radars). It also includes emissions from sources of electromagnetic interference such as power generators and vehicle electronics. Given the presence of the PRC ELINT satellites, airborne DF sensors, and surface-based sensors, the EM signature provides the adversary with the opportunity to determine the position of a unit from hundreds of kilometers based solely on spectral fingerprint of a particular emitter, such as the G/ATOR or communication waveform.

Thermal and Infrared Signature

Modern warfare is increasingly transparent to thermal sensors. The propulsion systems of kinetic assets such as the HIMARS of the NMESIS produces massive IR signature on launch. Additionally, static positions produce heat differential between a generator, vehicle engine, human body, and surrounding environment. The signature of these heat sources can be detected by high resolution IR sensors. The PRC has satellites capable of instantly detecting the IR flash of a missile launch, potentially triggering a counter-fire response before EABO units can move positions (Smid, 2023). The increasing number of drone-based thermal optics in the tactical environment suggests that concealment through vegetation or darkness may no longer be adequate. Effective thermal masking requires managing emissivity and thermal mass to blend into the background ambient environment.

Acoustic, Visual, and Physical Signatures

While often a secondary consideration in land warfare, acoustic signatures are paramount for survivability in the littoral domain of EABO. The movement of small surface vessels, LSM, and aerial resupply assets generate significant noise that propagates efficiently through water. On land, heavy logistical movements or use of generators can also alert adversaries to the presence of an EAB.

The physical footprint of an EAB includes the physical equipment, disturbed vegetation, vehicle tracks, and rigid structures of command posts. Although physical camouflage can provide protection for visual detection, synthetic aperture radar (SAR) and hyperspectral imaging can overcome these attempts. SAR sensors, such as those on PRC satellites, can penetrate cloud cover, rain, and foliage to image terrain. Therefore, effective SIGMAN requires scattering or absorbing radar energy (Smid, 2023).

4.2 Assessing and Implementing Signature Management

Effective SIGMAN requires a thorough assessment of a unit's own signature, which must be continuously refined and updated as operations proceed (USMC, 2023).

1. Establishing a Baseline: Prior to deploying to a specific area, EABO forces must characterize the ambient electromagnetic noise present in the environment. Common signals such as AIS receivers, cellular networks, broadcast television, and weather radars make up background clutter. Understanding this clutter can be used to conceal friendly emissions. Establishing a baseline allows friendly

forces to to hide in the noise and the clutter by managing their emissions to mimic local patterns or remain within certain thresholds (USMC, 2023).

2. Signature Monitoring: Commanders monitor for feedback on emissions produced by their units to avoid inadvertent exposure. Use of self-monitoring systems can identify accidental transmissions and prevent unnecessary emissions. Without a self-monitoring process, a unit may incorrectly believe it has managed its signature while it has mistakenly broadcasted distinct emissions (USMC, 2023).

3. Adversary Correlation: Intelligence support must regularly analyze the adversary's collection patterns. This involves mapping of overflight of satellites and coverage areas of OTH radars. By correlating friendly maneuver with windows of reduced adversary coverage, commanders can time high-signature events to minimize detection probability (USMC, 2023).

4. Countermeasure Implementation: Based on the assessment, EABO forces can use active and passive measures to reduce exposure. This ranges from strict EMCON protocols to deployment of multispectral decoys to dilute adversary targeting capabilities. The objective of these countermeasures is to manipulate the adversary's perception of friendly forces and complicate their targeting of friendly forces (USMC, 2023).

4.3 Communication Networks and Tactical Data Links

The success of EABO, specifically with regard to communications, relies on establishing a "network of networks," where specific communications and data link networks are selected based on the mission phase, tactical purpose, and electromagnetic threat level.

<u>Link 16</u>

As the most used standard for joint and coalition operations, Link 16 provides the primary means of developing the common tactical picture (CTP) among all units within an operation or geographical region. Link 16 uses UHF band (960-1215 MHz) and operates under a time division multiple access (TDMA) format which allocates a unit-specific timeslot for each user function (Joint Chiefs of Staff, 2015). In order to provide a measure of resilience when operating in contested environments, Link 16 systems use a frequency-hopping technology over 51 separate frequences to avoid interference from jamming. Using Link 16, units are able to transmit local air and surface tracks to the larger network through J-series messages, thereby giving the fleet commander visibility of the same information that Marine Corps stand-in forces have. Additionally, Link 16 enables the dissemination of C2 commands and engagement order and provides necessary blue-force tracking through PPLI.

Despite its multitude of advantages, there are several limitations to Link 16 that are also relevant to EABO. Due to the fact that Link 16 is a high-power, omni-directional transmitter, it is not a stealthy system. Persistent transmission can be detected by enemy ELINT or ESM. With regard to data, although Link 16 was designed to optimize track data, it does not have sufficient bandwidth to handle large volumes of data such as bulk ISR information involving high-definition video or unprocessed sensor measurements that enable advanced fusion. Finally, since Link 16 is a UHF waveform, it is primarily limited to LOS.

Tactical Targeting Network Technology (TTNT)

To meet the speed associated with modern naval warfare, the Navy and Marine Corps have used the technology known as Tactical Targeting Network Technology (TTNT). As an IP-based ad-hoc mesh network, TTNT is specifically engineered to address the bandwidth limits imposed by the existing Link 16 architecture and allows for timely exchange of information between assets. TTNT is engineered to operate at L-band frequencies and utilizes a statistical priority-based multiple access (SPMA) protocol for communications. For the purpose of EABO, TTNT forms the basis for advanced sensor fusion. With a throughput of up to 10 Mbps, TTNT is able to process high resolution images and transfer files much larger than those that could be transferred through Link 16 (Collins Aerospace, 2020).

However, the increased throughput capability comes at a cost in terms of signature management. Since TTNT is a wide band emitter that transmits at higher power settings, it inherently carries a higher risk of detection. Although TTNT does contain low probability of intercept/low probability of detection (LPI/LPD) capabilities, it is generally less stealthy than directionally linked methods and will require careful consideration of how it will be employed in contested environments.

Cooperative Engagement Capability (CEC)

Cooperative Engagement Capability (CEC) is the enabling data link for Naval Integrated Fire Control - Counter Air (NIFC-CA) using a highly directional C-band data distribution system but is limited to LOS (DON, 2005). In the context of EABO, CEC provides essential fire control capabilities needed for cooperative engagements throughout a dispersed operating environment. The CEC enables destroyers and cruisers to launch missiles, such as SM-6, at targets provided by an EABO-based sensor, such as G/ATOR.

4.4 EMCON Procedures and Pulsed Operations

In order to sustain survivability in hostile environments, the use of EMCON by stand-in forces enables them to employ a tiered structure of emissions silence (Tektronix, 2018).

- EMCON Alpha (Silence): This is the most restrictive condition and requires all forms of electromagnetic emission cease to be emitted. In this condition, there is no use of radar, no radio transmissions, and no data links engaged. Passive sensors can still operate, and the unit can conduct any pre-assigned tasking or orders. In this environment, however, the EABO forces will have no access to a COP and will not be able to communicate any findings or relay any surveillance or targeting data.

- EMCON Bravo (Satellite/Data Limitations): This condition allows limited essential communications that would mostly be receiving broadcasts with limited ability to send data. Highly directional transmissions may fall under this condition.

- EMCON Charlie (High Value/Mission Essential): This condition is a transitional state of operations which allows EABO units to utilize mission-essential systems for limited or specified time periods in order to conduct a specific tactical mission. For example, a unit could momentarily transition from EMCON Alpha or Bravo to EMCON Charlie in order to execute a fire mission or provide critical targeting data.
- EMCON Delta (Unrestricted): This condition has no restrictions on emissions. In the context of EABO, it is unlikely that EMCON Delta can be sustained for any extended period of time.

The main operational problem that exists when attempting to operate in EMCON is the trade-off between hiding from the adversary and the need to communicate data to other units to provide targeting support. Doctrine addresses this problem by using pulsed operations. In this way, units operate in EMCON for certain time periods and only send data in short, high-bandwidth pulses when they need to. These pulses minimize the amount of time an adversary has to detect, locate, and effectively target the forces. Whether or not a unit will break EMCON is a high-risk, tactical decision. Decentralizing this decision is critical to enable unit commanders the ability to exploit fleeting windows of opportunity or to defend themselves without significant delay of centralized command processes.

4.5 Enabling Technologies and C2 Resilience

Managing emissions and reducing signatures is generally focused on procedural discipline, but there are technologies that provide tools to minimize risk associated with emissions in EABO. Using LPI/LPD waveforms can ensure required communications remain hidden or avoid detection. In order to avoid being a beacon while communicating, EABO forces use advanced waveforms designed to mimic background noise or complicate geolocation.

<u>Advanced Waveforms and Directional Links</u>

- Direct Sequence Spread Spectrum (DSSS): DSSS uses a pseudo-noise code to spread digital data over a large frequency band. The power spectral density of the signal is reduced, dropping below the noise floor of standard receivers. Without the specific spreading code, the transmission will only cause a minor increase in background noise, making detection very difficult. This is applied to satellite links, UAS controls, and data links (Stojanović et al, 2024).

- Frequency Hopping Spread Spectrum (FHSS): FHSS uses randomly changing frequencies, hundreds/thousands of times per second, according to a unique pseudo-random sequence. This hopping of frequencies makes it very difficult for enemy jammers to target/intercept the signal (Ristić et al, 2022).
- Millimeter Wave and Directional Links: High-bandwidth, low-signature communications, such as millimeter wave and directional links, can transmit significant amounts of data while limiting detection. Implementing these tactical networks reduce the likelihood of geolocation or jamming (Harvey et al, 2019).
- Burst Transmissions and Data Mules: Burst transmissions are used to break down the data stream into small packets, which prevents an adversary from maintaining a signal lock on the source of the signal, preventing geolocation (UK Essays, 2018). Data mules use low power, short range communication with a UAS or USV. Data is transmitted via the data mule from a remote or elevated location, minimizing the likelihood of detection of the EABO unit (Palma et al, 2017).

Space-Based Transport

An emerging communication net that solves the LOS limitation is low earth orbit (LEO) transport. The Proliferated Warfighter Space Architecture (PWSA) employs a robust mesh network in space that uses inter-satellite links to maintain constant connection. By operating in LEO, these systems offer significantly reduced latency compared to geosynchronous satellites and provide high-speed, real time data exchange in contested environments. These proliferated LEO satellites can enable Ka-band uplink and downlink for mission data and C2 as well as offer a space-based Link-16 connection (SDA, 2023).

Data Interoperability and C2 Networks

As the Marine Corps transitions from hardware-based systems to a software-based and data-driven model for managing network architecture, the interoperability of data transfer and C2 networks is critical to mission success. Integration of black core architecture, that encrypts all data at the same level before it is transmitted through the transport layer, allows multiple networks to transmit the data, regardless of the inherent trust of the network (Rose et al, 2020). Therefore, EABO units can send sensitive targeting data over military satellite, commercial 5G, fiber optic, or tactical radio mesh. Additionally, this architecture provides significant resiliency; if an adversary jams a primary communications link, the systems can automatically route through a secondary link.

Gateway systems such as the MAGTF Agile Network Gateway Link (MANGL) system act as a universal translator for Navy and Marine Corps assets. The MANGL system accepts data from various sources (Link 16, TTNT) and then transmits the data in a format acceptable to the intended recipient (Laird, 2020). In addition to the connectivity provided by MANGL, the CAC2S Small Form Factor (SFF) variant condenses the capabilities of a traditional direct air support center into a couple pelican cases of gear (ALSSA, 2025). This significant reduction in logistics footprint enables small, dispersed EABO units to create a complete tactical picture and conduct fire coordination with a reduced electromagnetic signature and increased mobility.

5. THREATS TO EABO

The PRC, through a variety of systems, has developed an effective and redundant system that is capable of creating a costly operating environment for any opponent in the Western Pacific. The PRC uses its arsenal of kinetic capabilities to form multiple layers of defense and employ a robust strategy of deterrence and denial. The development and employment of a wide array of ballistic and cruise missiles, as well as hypersonic technologies, combined with a large fleet of naval ships, and integrated air defenses, are all part of a plan to negate the power projection advantages of the U.S. and its coalition forces.

5.1 C5ISR-T Architecture and Space-Based Surveillance

China's A2/AD system relies heavily upon its highly advanced C5ISR-T architecture, which functions as the nervous system for its kinetic weapons. This architecture ties together land-based OTH radar systems, airborne early warning systems such as the KJ-500/600, and maritime reconnaissance platforms to provide a unified COP for all participating elements of the system. The C5ISR-T architecture provides the PLA with the capability to rapidly integrate sensor data from various platforms and allow commanders to quickly transfer high-confidence targeting information from remote sensors to mobile missile launchers in near real-time.

The threat of space-based surveillance poses the most pervasive and technically challenging problem for EABO survivability. A large constellation of space-based platforms provides the large-scale area surveillance required to monitor the vast expanse of the Pacific Ocean. Utilizing a combination of electro-optical satellites for identification, SAR to penetrate through clouds and identify targets, and ELINT to detect radio emission of carrier strike groups and other dispersed units, China maintains track of moving targets hundreds of kilometers off its coast. The PRC operates a technologically sophisticated, multi-layered space surveillance architecture consisting of more than 510 ISR-capable satellites to monitor the First Island Chain continuously (SatNews, 2025).

The Yaogan series consists of EO, SAR, and ELINT satellites, developed to be used together to identify and locate mobile targets across the Indo-Pacific region. The Yaogan-41 satellite exists in a geostationary orbit, allowing it to maintain a persistent oversight of the region. The Yaogan-41 is assessed to be used for detection of thermal and optical signatures of surface connectors, logistics convoys, and missile launches in the First Island Chain. Yaogan-41 is primarily a tipping and cueing asset; it identifies potential activity that would require higher fidelity and cues higher-resolution LEO satellites to determine target information (Krebs, 2026).

Yaogan-29, Yaogan-33, and Gaofen-3 are examples of SAR satellites used by the PLA to compensate for environmental challenges of EO satellites, specifically persistent cloud cover and lack of sunlight. The SAR satellites use an active radar pulse to take images of the earth with resolutions of less than 5 meters (Krebs, 2026). In addition to high-resolution imaging, the PLA also uses a large number of ELINT triples such as Yaogan-30 and Yaogan-31 series (Krebs, 2026). The ELINT triplets operate in close proximity and use time difference of arrival (TDOA) to geolocate electronic emissions, locating radio signals such as shipboard radar systems, Link 16 tactical data links, and SATCOM uplinks (Stokes et al, 2020). The Yaogan-30 constellation provides a revisit rate of the South China Sea of nearly 30 times per day. Therefore, even brief radio transmissions using LPI waveforms are at a high risk of being detected unless the waveform is completely masked and/or the transmission duration is insufficient for intercept.

China's strategy of civil-military fusion is an additional component of the military architecture of space-based assets. The Jilin-1 commercial imaging constellation is the world's largest sub-meter commercial imaging constellation, with a global revisit rate of approximately 38-40 times per day. Passing over the First Island Chain every 15 to 30 minutes, Jilin-1 has an advanced capability to capture high-definition video, allowing for tracking of moving vehicles and collection of speed and direction data for dynamic targeting (Stokes et al, 2020).

The PLA is rapidly developing AI and ML to manage the vast amount of data generated by their satellite constellations. AI/ML-based automatic target recognition algorithms can quickly scan millions of images taken by satellites and identify anomalies that may not immediately appear to human analysts, such as new areas of cleared vegetation or the size and shape of specific vehicles (Barker, 2021). Through pattern of life analysis, AI models can identify even small changes in the environment, including variations in heat signatures or changes in vegetation density. Ultimately, the persistent and autonomous nature of the AI/ML-based processing makes it very difficult to maintain a "low signature" for EABO.

5.2 Airborne and Maritime Sensing

Below the layer of satellites, the PLA has developed numerous airborne platforms and sensors for the purpose of tracking and targeting its enemies in littoral zones of the First Island Chain. A mixture of reconnaissance and airborne early warning aircraft are employed to actively locate, track, and target any adversary forces (OSD, 2024).

EABO employment and survivability depends on the sea and use of the maritime environment to move, insert, and sustain operations. A central component of the PLA's full-spectrum maritime sensing system is the People's Armed Forces Maritime Militia (PAFMM). This state-sponsored force of civilian vessels uses enhanced sensors and communications to act as a ubiquitous and low-observable sensor network that operates in the gray zone of conflict (Poling, 2019). In an EABO environment, PAFMM vessels can create a flood of sensors, report disposition of enemy forces, and identify targets.

Below the surface, China has established an expansive underwater sensor network commonly referred to as the "great underwater wall". This system consists of fixed sonar arrays placed on the ocean bottom that monitor the acoustic signature of submarines and surface vessels (Pradhan, 2025). Floating platforms with radar, EO/IR cameras, and communications relay capabilities complement the seabed sensors, providing real-time detection capability regarding the transit of amphibious ships and supply vessels. Studies indicate that PLA sensors have been able to increasingly detect and classify noise generated by small vessels, potentially exposing covert nighttime insertion missions.

5.3 Kinetic Strike Complex

The sensing and detection methods of the PLA are simply the enablers for the robust, kinetic strike complex that exists to attack targets with speed and volume. A key component of this threat is the PLARF, which possesses a large inventory of ground launched missiles.

Anti-Ship Ballistic Missiles (ASBMs)

The Dong Feng-21 (DF-21) family is a core element of the PRC A2/AD system. The DF-21D, known as the "carrier killer," is able to hit moving aircraft carriers at sea. With an approximate range of 1,500 to 2,150 kilometers, the DF-21 allows the PRC to threaten both maritime and terrestrial high value targets. The Dong Feng-26 (DF-26) is an intermediate range ballistic missile with an operational range between 3,000-5,000 kilometers (Romero Meraner, 2023). It further deters intervention by aircraft carriers and can place strategic air bases of Guam and Japan at risk.

Hypersonic Weapons

The Dong Feng-17 (DF-17) is a medium range ballistic missile system developed to deliver the DF-ZF hypersonic glide vehicle (HGV). As opposed to conventional ballistic missiles that travel through space on a predictable trajectory, the HGV of the DF-17 uses aerodynamic forces to alter its direction while traveling over Mach 5 and entering the atmosphere at lower altitudes. The combination of high velocity, low altitude, and lack of predictability is intended to defeat modern anti-ballistic missile defenses by limiting the amount of time available for detection and engagement (Missile Threat, 2024).

Coastal Defense and Cruise Missile Capabilities

The YJ-12 and YJ-18 are examples of the PRC's most advanced ASCMs. The YJ-12 is a ram jet powered missile with an air launch capability and range of 460 kilometers that can reach speeds of Mach 2 to Mach 4. The YJ-18 is a vertical launch dual mode missile with a range of 540 kilometers. Both incorporate terminal phase maneuvering capabilities designed to limit the effectiveness of defensive measures. The YJ-62 is a long range, subsonic ASCM with a range of 400 kilometers, often deployed on TELs in order to provide a mobile and persistent threat to naval assets in the First Island Chain (Missile Threat, 2024).

6. FEASIBILITY ASSESSMENT

The concept and employment of EABO to counter the PRC A2/AD complex is faced with two major challenges: immature logistics and potential for high attrition that will risk significant losses and minimal persistent presence. In addition, the EABO strategy faces a timeline mismatch with regard to its implementation. Based on the peak likelihood of conflict in the Indo-Pacific occurring between 2027-2030, the U.S. military has not procured the necessary assets, such as contested logistic vessels and stockpiles of munitions, to reasonably employ the EABO model. Therefore, the current feasibility of implementing EABO is assessed to be low based on the lack of resources needed to survive in the highly contested environment and effectively support joint and coalition operations.

Additionally, the assumption of survivability in EABO doctrine based on effective SIGMAN and EMCON is rapidly diminishing due to the competitive dynamic of ISR vs. counter-ISR. The proliferation of satellite sensors, combined with airborne assets and surface forces, and enhanced by automatic target recognition and artificial intelligence, significantly decreases the likelihood that EABO units can maintain a stealth presence in the First Island Chain. Wargaming analyses conducted by CSIS highlight these susceptibilities (Cancian et al, 2023). Although EABO units may initially complete a successful strike or contribute to distributed targeting, their survivability rapidly degrades thereafter. Overall, the conceptual objectives of EABO appear challenged by the practical realities of both the material and technical aspects of high intensity peer conflict in the Indo-Pacific region unless the U.S. military establishes a more robust kill web and significantly improves the mobility of its forces.

This feasibility assessment analyzes the challenges that face EABO through operational and tactical employment as well as logistical and human factors. The evidence-based analysis provides a thorough evaluation of whether the concept of EABO can be reasonably employed, achieve its objectives, and survive in a high intensity peer conflict in the Indo-Pacific.

6.1 Operational and Tactical Feasibility

High fidelity wargames demonstrate that EABO units suffer from very high attrition rates which call into question the long-term viability of this concept. Although MLRs can be effective in establishing an initial denial zone, they are highly likely to be attrited after any effects are achieved. Once MLR units initiate fires or transmit above certain thresholds, the electromagnetic and thermal signatures they produce become immediately detectable to the PRC's extensive network of sensors. This allows a rapid counter-fire from PLA forces to execute saturation attacks against the MLR launch sites prior to the unit's ability to relocate.

In order for EABO to be functional, forces need to have the capability to execute rapid "shoot and scoot" tactics. However, rapid targeting by the adversary's sensor-to-shooter loop threatens this conceptual ability. The restricted geography of the First Island Chain limits the off-road movement of these units to predictable road networks and chokepoints. This limited mobility provides for relatively easy targeting by adversary loitering munitions or rocket barrages. The speed of modern targeting exceeds the physical time necessary to relocate the heavy equipment related to systems such as HIMARS or NMESIS.

The technological and C2 feasibility of EABO is limited by the "transmit and die" paradox of electronic warfare. LPI and LPD waveforms were developed to obscure transmissions but increasing capabilities in detection systems enabled by AI can isolate these waveforms from background noise. In this scenario, EABO units will either be forced into strict EMCON and unable to contribute to operational effectiveness, or they will transmit to enable kill chains and risk immediate detection, geolocation, and targeting. The current state of technology has not produced communications resiliency that would allow distributed units to withstand the capabilities of adversary collections and surveillance.

Additionally, the structure of communication networks within EABO is brittle within the geography of the First Island Chain. Communication networks, operating via LOS connections are easily broken by curvature of the earth and physical limitations of obstructions. In order to overcome these obstacles, the system will likely rely on airborne and satellite relays which are either susceptible to targeting themselves or will identify the location of EABO units. When these weak points are disabled, the kill chain degrades into isolated ineffective units. The technical viability of establishing and sustaining a complete and distributed sensor-to-shooter network is heavily dependent on connectivity and threatened by potential for counter-detection.

As a result of the growing availability of space-based surveillance, the capability to remain undetected through SIGMAN is becoming increasingly unfeasible. AI algorithms can process thousands of terabytes of imagery in near real-time to identify minute anomalies. For these reasons, operational and tactical feasibility of EABO is assessed as low. Due to current advanced sensor technology, EABO units are unlikely to maintain persistent sea denial as envisioned by doctrine.

6.2 Logistical and Human Feasibility

The LSM is a critical link in the EABO concept for the purpose of contested logistics. With deliveries of the vessel expected no earlier than 2029, there is a high likelihood that a viable logistics asset will not exist to support EABO (O’Rourke, 2026). Without this support, MLRs will be strained to maintain logistics chains. Larger and more vulnerable amphibious ships are unlikely to be a reliable option based on their size and likelihood of targeting by ballistic missiles within the First Island Chain. Due to this lack of a dedicated logistics maneuver platform, the rapid relocation and survivability of distributed forces will be nearly impossible in the short term.

The Marine Corps aims to move away from centralized logistics to support distributed forces. However, this does not eliminate the need for vast amounts of fuel and energy to sustain the operation of EABO forces. Any logistics asset will likely be a target for disrupting EABO actions and maneuver. If the logistics line is cut, the stand-in force is left immobile and its sensors and systems are rendered useless. Historical evidence and wargaming studies demonstrate that logistics assets represent a significant potential for losses. Therefore, sustained operation of remote units in contested maritime environments is unlikely.

The human feasibility of EABO is heavily undermined by the minimal medical resources and the intense mental impacts of isolation. Traditional MEDEVAC in contested littoral regions is likely to be denied by enemy IADS, isolating units and requiring they perform prolonged casualty care for extended periods. Higher-level medical care will be severely limited, increasing the likelihood of members lost due to life threatening wounds. This capability gap can lead to otherwise survivable wounds becoming fatal wounds when not properly treated. In addition, the intense physical pressure and stress of high operational tempo can lead to cognitive degradation. Absent effective medical and support structures, it is likely that endurance requirements for distributed forces will break and therefore the ability to sustain presence of stand-in forces will be diminished.

Logistics remains a critical vulnerability of the EABO concept. The combination of delay in development of the LSM and the difficulties of supplying and reloading distributed forces indicates that EABO units are at great risk of losing combat effectiveness rapidly in the event of a conflict. Although strategic underpinnings of EABO are sound, the current material and industrial realities indicate the Marine Corps does not possess the necessary chains and depth to sustain persistent presence in the contested maritime domain of the First Island Chain. For these reasons, the logistical feasibility of EABO is assessed to be low.

6.3 Overall Feasibility

Although EABO presents a theoretically viable way to counter A2/AD threats, it currently faces significant limitations due to the unrefined logistics of the concept and the diminishing effectiveness of SIGMAN. The PLA's redundant architecture of space-based assets combined with improved digital processing makes the sustained concealment of surface forces extremely difficult. As a result, a lethal gap exists between the speed of the PLA's kill chain, using hypersonic weapons and loitering munitions, and the physical mobility of EABO units.

Unless the joint force can successfully degrade the adversary's ISR capabilities, EABO units will likely become simple targets for attrition. Survivability will require the execution of active counter-ISR operations to blind the adversary's sensor network and prevent them from completing their kill chain. In order for EABO units to survive U.S. and allied forces must reasonably disrupt the targeting process of the PLA. Unless there is increased investment in critical logistics chains and a development of more resilient C2 and kill chain technologies, EABO will likely deploy a force with the potential to be lethal, but one that will be weak in terms of operational vulnerability.

7. CONCLUSION

The landscape of the Indo-Pacific is vast, and a potential conflict between the U.S. and its allies and the PRC would certainly see the use of unprecedented technologies, tactics, and operations. The potential for conflict certainly exists, with tensions in the South China Sea and the Strait of Taiwan rising day by day. It is incumbent on the U.S. forces to understand the potential systems they will be operating and the tactics they will use to operate them.

The PRC has developed a robust, resilient, lethal A2/AD complex of systems designed to prevent or complicate foreign interference in the Western Pacific. In order to overcome the operational limitations imposed by this system, U.S. and allied forces must develop a strategy of distributed units to complicate adversary targeting and enhance coalition freedom of maneuver. For this reason, the EABO concept is tactically relevant and necessary. Dispersed units, operating within the WEZ, will enable the operations of the joint and coalition force.

However, due to the complex nature of the PLA ISR and targeting capabilities, combined with current logistics gap, the strategic feasibility of EABO is at risk. The goal of EABO, to disrupt the adversary’s targeting cycle and provide ISR within contested regions, is achievable. The problem faced by EABO implementation, however, comes from the vulnerability of the forces to enemy targeting.

Survivability within the First Island Chain is dependent on strict adherence to EMCON and SIGMAN procedures. However, in order to complete their objective of contributing to targeting, EABO units are forced to emit. Despite enabling technologies, such as LPI/LPD waveforms, advances in adversary detection systems significantly increases the risk of targeting by enemy forces.

In addition to the vulnerability to targeting, EABO units face significant logistics shortfalls. Critical logistics systems, such as the LSM, have not yet been fully fielded. The Navy’s current model for logistics is unlikely to be able to sustain the distributed and dispersed network of units employed in the EABO concept. These logistics resources are also similarly susceptible to the same targeting that EABO units face themselves. For this reason, the ability to sustain operations in a high-intensity conflict, is severely limited.

To increase the operational feasibility of EABO, several technological and tactical advancements can be implemented. The U.S. military must strengthen its counter-ISR capabilities, improve kill chain and kill web resiliency, and enhance tactical mobility.

In order to decrease the likelihood of EABO units being detected, a greater ability to degrade PRC sensing and targeting is required. This includes counter-space, electronic warfare, and cyber capabilities. These capabilities will allow EABO units a greater chance of survival, increasing the likelihood that they will be able to achieve their objectives.

Kill chain resiliency can be improved through further development of advanced C2 networks and communications. Networks such as PWSA and MANGL will enable greater interoperability between distributed units and a higher likelihood of tactical success.

Enhancements in tactical mobility, including smaller and more autonomous assets, will reduce the logistical footprint of EABO and increase the ability to maneuver. This enhanced mobility will increase survivability of EABO units. In addition, more advanced logistics networks will improve the sustainability of forces.

With the appropriate investment in resources, the EABO concept has potential to enable the U.S. military to adjust its power projection posture effectively in the Indo-Pacific. A properly networked architecture of dispersed units within the First Island Chain has the ability to enhance fleet fires while simultaneously degrading adversary targeting. Ultimately, the success of EABO will be determined not by the lethality of individual shooters, but by the resilience of the network that effectively connects the elements of the kill chain.

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