

# **Simulating Infantry Squad Counter Unmanned Aerial System Technologies to Increase Combat Effectiveness**

**John An, Sam Arnold, Ned Brady, Ty Bliss, Jack Louis, and Stephen Gillespie**

Department of Systems Engineering, United States Military Academy, West Point, New York 10996

Corresponding author's Email: [stephen.gillespie@westpoint.edu](mailto:stephen.gillespie@westpoint.edu)

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**Abstract:** US Army light infantry formations are ill-equipped to counter advanced small unmanned aerial systems (sUAS). This project analyzes 5 potential counter-sUAS (C-sUAS) systems originally scheduled for the All-Arms Maneuver Concept-Focused Warfighting Experiment (CFWE-M) using a systems-based process to evaluate their effectiveness and recommend how they might be best employed at the squad-level. The analysis utilizes the Infantry Warrior Simulation (IWARS) to model and evaluate the impact of the chosen C-sUAS technologies on squad survivability and squad lethality. Results indicate that minimizing detectability and emphasizing signature management increases unit survivability against enemy drones. We recommend employing the Detect Track Identity (DTI) system to identify potential drone threats in the area and Multispectral Camouflage Textile ponchos to hide from sUAS detection. If the unit is not willing to sacrifice maneuverability to avoid detection, we recommend attaching an autonomous C-sUAS unmanned ground vehicle to accompany the unit.

*Keywords:* Small Unmanned Aerial System (sUAS), counter-sUAS (C-sUAS), Infantry Warrior Simulation (IWARS)

## **1. Introduction**

### **1.1 Background**

Recent conflicts have demonstrated the operational effectiveness of small unmanned aerial systems (sUAS) (Sausser et al., 2025). sUAS capabilities are integrated across all warfighting functions, supporting intelligence, surveillance, and reconnaissance (ISR), logistics, and delivering direct lethal effects on armored and dismounted forces. Additionally, the Chinese People's Liberation Army's (PLA) doctrinal emphasis on manned-unmanned teaming (MUM-T) and swarm-enabled operations is relevant to US forces operating in the Indo-Pacific (Chen and Stewart, 2025). Accordingly, our research project maintains relevance to both the contemporary operational environment and the anticipated future battlefield.

### **1.2 Methodology**

The methodology used for this research closely followed the classic systems engineering "V". The systems engineering V starts with high-level concepts and requirements before moving into deep engineering design and development. Once the system is designed, it is tested and evaluated against criteria created during earlier concept design stages (Kossiakoff et al., 2020). We initially oriented our research to assist the Maneuver Future Capabilities Directorate (MFCD) plan and execute their 2026 All-Arms Maneuver Concept-Focused Warfighting Experiment (CFWE-M). We picked five technologies either originally planned for testing at the CFWE-M or already in service and modeled them using the Infantry Warrior Simulation (IWARS). Initial stakeholder engagement yielded system and sub-system requirements for our chosen technologies and allowed us to build a system validation plan and sub-system verification plans. After implementing our chosen technologies individually in simulation, we verified them against stakeholder data. We then combined our technologies into our final simulation and verified and validated it against our system requirements. Finally, we gathered data through simulation batch runs and analyzed that data to provide recommendations to our stakeholders. For our analysis, we utilized a 2<sup>5</sup> experimental design with 40 replicates per treatment combination for 1280 total runs. Forty replicates provided a robust dataset while

remaining computationally feasible. Given the significant effects of the Poncho technology, we conducted sensitivity analysis on its detectability parameter in the model. Halfway through our research, our stakeholders underwent major organizational change with the merger of US Army Training and Doctrine Command and Army Futures Command into Transformation and Training Command (T2COM), and the CFWE-M was cancelled. Given that our simulated technology will likely be involved in future Army experimentation efforts, we continued our research with no change.

Key constraints include requirements for the project to be conducted in IWARS and at the controlled unclassified information (CUI) level. Simplifying assumptions for our IWARS parameters are as follows: fixed number of infantry personnel, fixed friendly force positions, fixed engagement lines, fixed enemy sUAS capability.

Key stakeholders for this project include our sponsors at the MITRE Corporation, Futures and Concepts Command (FCC), T2COM, the Maneuver Future Capabilities Directorate (MFCD), technology vendor companies, and potential users of our tested C-sUAS systems. We interfaced with our MITRE, FCC, and MFCD stakeholders throughout the project to ensure our product met their needs, and we interfaced with technology vendor companies to ensure our simulation correctly modeled their real-life products.

**Problem Statement:** Current C-sUAS methods leave light infantry platoons vulnerable to detection and targeting. We will simulate new technology and tactics, techniques, and procedures (TTPs) originally scheduled for testing at the CFWE-M, ultimately providing testable hypotheses on how to best employ new equipment.

## 2. Simulation

The Infantry Warrior Simulation (IWARS) is an agent-based combat simulation designed to model infantry combat operations. The platform enables users to represent tactical actions and decision-making processes while incorporating weapon system characteristics, equipment performance data, and environmental variables such as terrain and weather effects. Originally developed for use by multiple U.S Army laboratories and analysis centers, IWARS provides analytical capabilities suitable for assessing infantry unit responses to emerging threats, including unmanned aerial systems, through the testing of varying tactics, techniques, and equipment configurations (Natick Soldier TD&E Center & Army Materiel Systems Analysis Activity, 2014). We selected IWARS for this project due to its accessibility and the research team’s existing proficiency with the platform.

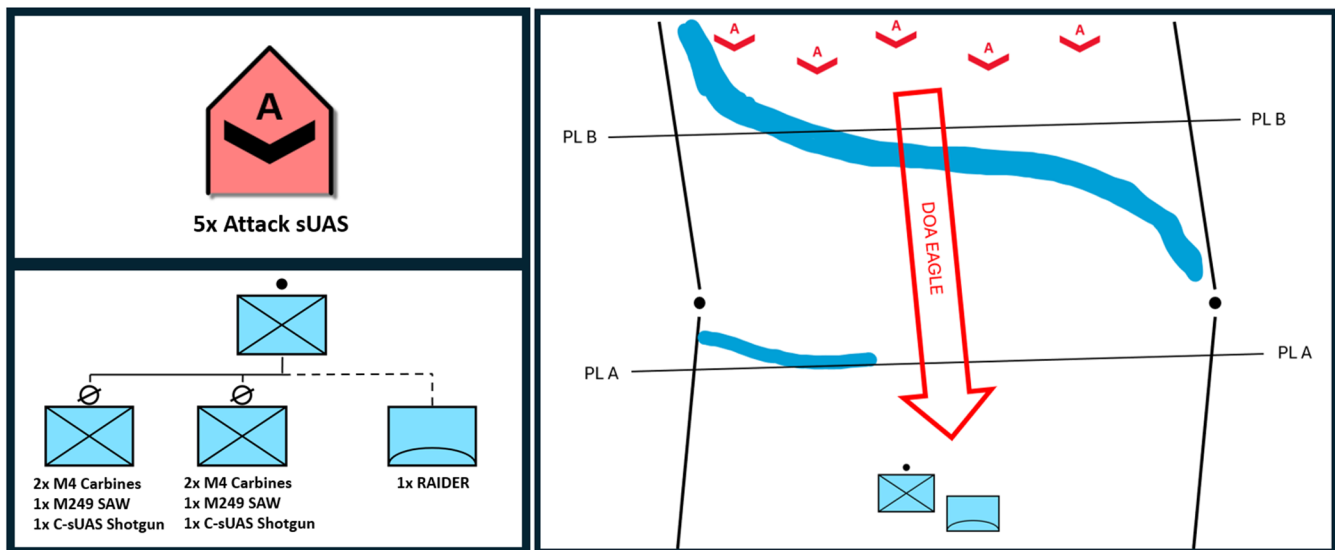


Figure 1: Simulation Situation

### 2.1 Simulation Scenario

Within IWARS, we developed a simulation depicting an organic infantry squad position in a stationary, modified column wedge formation. As shown above in Figure 1, a swarm of five fixed-wing one-way attack sUAS, representative of those used in the Russo-Ukrainian War, were assigned unique flight paths to pass directly over the squad’s position. Upon

detecting the formation, the drones autonomously maneuvered to close with the identified combatants and executed a kamikaze style engagement. An infantry squad, rather than a platoon sized element, was selected for simulation to reflect observable trends in modern conflict, particularly in Ukraine, where units increasingly operate in smaller, dispersed formations to reduce vulnerability to aerial surveillance and drone-enabled precision strikes (Sauser et al., 2025, p. 55). Modeling squad-level operations therefore provide a more realistic representation of contemporary battlefield survivability and tactical adaptation under persistent sUAS threat conditions.

## 2.2 Counter sUAS Platforms

To determine C-sUAS solutions for analysis, we selected C-sUAS technologies that were originally scheduled for testing at the 2026 CFWE-M in addition to current C-sUAS solutions in use by the US military. For each of the technologies, we assessed how a platoon performed with and without it. Our selection is not exhaustive, and future sUAS threats may require different C-sUAS solutions.

**Organic Infantry Weapons:** All soldiers not utilizing a shotgun utilized their standard-issue service weapon (either a M4 Carbine or an M249 Squad Automatic Weapon) (*ATP 3-21.8 Infantry Rifle Platoon and Squad*, 2024). All weapons fire a standard 5.56x45mm NATO cartridge. Base IWARs accuracy tables for standard-issue weapons were not changed.

**Shotguns:** The shotgun system developed by Brown, et al was retained for use in this study. Given its demonstrated effectiveness during prior experimentation, it was assessed as a relevant baseline capability for comparison against emerging counter-UAS technologies. Due to the reduced unit size modeled in this simulation, transitioning from a platoon- to squad-level element, the number of shotgun systems was scaled accordingly, with two shotguns assigned to the squad to reflect realistic task organization and equipment distribution at the small-unit level.

**Bispectral Obscurant Screening System (BOSS):** The BOSS grenade is an experimental, modified version of the already fielded M106 Bursting Obscuration Hand Grenade. Where a typical smoke grenade creates only visual obscuration, the BOSS grenade also blocks infrared sensing, capabilities that are not atypical for sUAS platforms (Carestia et al., 2014). The BOSS was designed to counter sniper systems with thermal and IR detection, though we hypothesized that countering sUAS by providing troops with a window to break contact could be a useful secondary use case for the BOSS (Close Combat Systems, n.d.).

**Remote Autonomous Integrated Defense and Engagement Rover (RAIDER):** The RAIDER is a mobile capability for detecting, identifying, tracking, classifying, and defeating small to medium UAS threats. It is an implementation of the Invariant Corporation's already-proven containerized weapons system on an unmanned ground vehicle. It utilizes both an anti-air missile system and a 30mm cannon (Maneuver Capabilities Development Integration Directorate [MCDID], 2025).

**Multispectral Camouflage Textiles:** The Ametrine Multispectral Poncho is a lightweight overgarment designed to reduce a soldier's detectability across multiple portions of the electromagnetic spectrum, including visual and infrared bands. Unlike traditional camouflage, it provides multispectral signature management, degrading the effectiveness of thermal imagers, night-vision devices, and UAS-mounted sensors. The poncho's effects were simulated by modifying the detection parameters available to the drones, specifically adjusting the sensor profiles used for target acquisition depending on whether the multispectral poncho was enabled or disabled (MCDID, 2025).

**Detect Track Identity (DTI) System:** The DTI system is a wearable system that detects, tracks, and identifies group 1 and 2 UAS. It utilizes omnidirectional sensing (400MHz-6 GHz bandwidth, 7 km range), artificial intelligence-enabled identification, RF direction-finding, and integration with TAK displays. We simulated the DTI system by increasing the squad's dispersion and increasing their maximum engagement line when the DTI system was equipped to represent the behavior change the squad would experience with early detection (MCDID, 2025).

### 3. Simulation Results

#### 3.1 IWARS Outputs and Statistical Analysis

The simulation yielded the following observations that enable analysis of the relationship between the measures of performance (MOPs) and inclusion or exclusion of the five technologies. The primary MOPs are kills of sUAS and losses of soldiers.

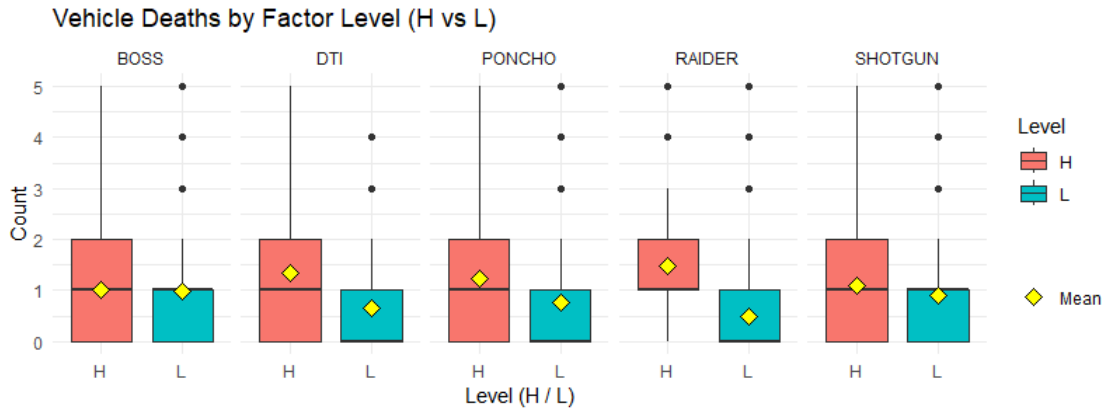


Figure 2: Drone Death Box Plot

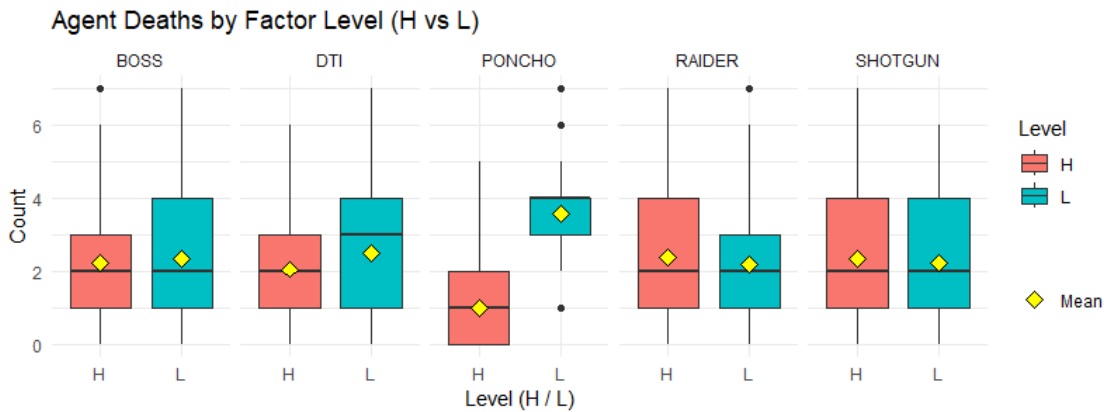


Figure 2: Soldier Death Box Plot

#### 3.2 Analysis

**Figure 2:** In figure 2 we can see increases in means and medians of friendly interceptions of drone in means and median across the RAIDER, Poncho, and DTI. However, little to no change occurred across the other technologies. It appears that the RAIDER had the most significant effect, equating to about 1 drone death increase across the model.

**Figure 3:** Looking at our blue survivability boxplot, we can see noticeable changes in quartiles and means across the Poncho and DTI systems. Poncho had the most significant changes here; it decreased blue KIA by over 2 soldiers on average. The DTI system had a larger standard deviation; a one-soldier difference in blue force deaths is the median of simulated effects, and the mean of effects is a slight decrease in blue force deaths. There was little to no difference among the other technologies in this visualization.

$$\widehat{Y}_{sUAS} = 2.515 - 1.10X_{DTI} - 1.381X_{Raider} - 0.181X_{Boss} - 0.338X_{Shotgun} - 0.731X_{Poncho} \quad (1)$$

*Equation 1: sUAS Death Multiple Linear Regression*

$$\widehat{Y}_{Soldier} = 1.087 + 0.409X_{DTI} + 0.042X_{Raider} - 0.139X_{Boss} - 0.439X_{Shotgun} + 2.023X_{Poncho} \quad (2)$$

*Equation 2: Soldier Death Multiple Linear Regression*

**Equation 1 (sUAS Death):** The sUAS death multilinear regression analysis is presented in equation 1. The results indicate that with all the modeled technologies, there is an average increase of 2.515 sUAS deaths. When removing different technologies into our simulation, the stand-alone technologies that were significant are shown below. We know these are significant because through our multilinear regression analysis, these held a p-value of below 0.05. We also conducted this analysis on the interaction effects of these technologies. Here we found the significant interactions (below 0.05 p-value) to be DTI-RAIDER, DTI-Shotgun, DTI-Poncho, and BOSS-RAIDER. As we can see when the DTI is paired with the RAIDER, Shotgun, or Poncho, this acts as an early warning system for the agents to either destroy or conceal themselves from the threats. And in terms of the BOSS and RAIDER interaction this can be explained by the BOSS concealing the RAIDER, thus giving it more time to engage as the drones would have a less clear target to take out the RAIDER.

- **DTI:** When taking away the DTI system out of our simulation we found that on average this destroyed 1.10 less drones, compared to having DTI. This decrease is explained by the agents having an early warning and being able to engage the drones for longer.
- **RAIDER:** When taking away the RAIDER system out of our simulation we found that on average this destroyed 1.381 less drones, compared to having the RAIDER. This decrease is explained by the RAIDER being a high round capacity drone killing system that when taken away removes a precise kinetic kill option.
- **Multispectral Poncho:** When taking away the Poncho system out of our simulation we found that on average this destroyed .731 less drones, compared to having the Poncho. This decrease is explained by the agents being able to be less detectable by the drones, thus having more of the element of surprise when they start engaging the drones. Sensitivity analysis of different Poncho detection levels found that sUAS death is not sensitive to Poncho detection levels as modelled.
- **Shotguns:** When taking away the Shotgun out of our simulation we found that on average this destroyed .338 less drones, compared to having Shotguns. This smaller decrease is explained by the agents ability to shoot these drones being only slightly better than their base weapon.

**Equation 2 (Survivability):** Regarding the equation for blue forces deaths, we did the same multilinear regression and found that the significant technologies were the DTI, RAIDER, Shotgun, and Poncho. This is based on the low p-values associated with each of these technologies. The low p-values show that these technologies have a significant effect on the increase or decrease in blue force deaths. When comparing all these coefficients, we scaled them based on the number of blue force deaths that occur with all the technology (Y-intercept), which is 1.087 deaths on average.

- **DTI:** When we take away the DTI from the sum of all the technologies, on average there is an increase of 0.409 blue force deaths. This can be explained by the fact that the infantry soldiers now lack the ability of early detection and have less of a chance to either conceal themselves or eliminate the drone threat.
- **RAIDER:** When taking the raider out of the sum of all the technologies, there is an average increase of 0.042 blue force deaths. This smaller increase can be attributed to the fact that the RAIDER potentially acts as another detectable target for the sUAS as well as its only ability is being able to eliminate drones and not defend infantry soldiers.
- **Multispectral Poncho:** Out of all the technologies, the Poncho clearly performed the best. When taken out of the sum of technologies, on average there were 2.023 more blue force deaths. This is likely due to 2 main factors. One, with obscured detection, agents are given more time to find and shoot drones. Two, in simulation, even if agents reveal themselves by shooting, the poncho obscurant effects are still present. While the poncho is clearly effective in simulation, it may not be perfectly reflective of real-world conditions where shooting at drones makes yourself a target and reveals your location. Sensitivity analysis of different Poncho detection levels found that survivability is sensitive to Poncho detection levels as modelled, with higher levels resulting in higher survivability.
- **Shotguns:** When we remove the Shotgun from the sum of all technologies, there is an average decrease of 0.439 of blue force deaths. The main reason for a decrease in soldier deaths is due to fratricide. As we found from last year's simulation, blue on blue deaths became a huge problem with the shotgun, and this is what we are seeing here in our simulation as well.

## 4. Conclusions

### 4.1 Recommendation

Regardless of the unit's mission and situation, we recommend light infantry squads be equipped with one DTI system and each soldier be equipped with a multi-spectral poncho in place of their standard-issue poncho. The swap between the standard issue and multi-spectral poncho adds no additional weight to soldier load. The DTI system adds approximately 6 pounds to soldier load. Both solutions caused significant increases in sUAS destruction and significant decreases in friendly force deaths. For greatest effect, the squad must be willing to sacrifice maneuverability to decrease detectability. When the squad detects a drone, they should cease movement, increase their dispersion, and conceal themselves completely with the poncho. Movement or incomplete poncho coverage will compromise the poncho's effectiveness. If the unit cannot afford to remain stationary, we recommend an autonomous C-sUAS unmanned ground vehicle (similar to the RAIDER) accompany patrols. The RAIDER was responsible for the greatest increase in drone destruction and can potentially draw sUAS attention away from the friendly unit. The size and weight of systems like the RAIDER will need to be accounted for when transporting units. Given elevated fratricide while the shotgun was equipped, we do not recommend equipping shotguns without significant C-sUAS shotgun training and engagement criteria. We do not recommend equipping the BOSS grenade – the loss in situational awareness is not worth a small potential gain in survivability.

### 4.2 Future Work

Future work should integrate new technologies as research continues into C-sUAS systems and update the simulation as unclassified data is published about the simulated technologies. IWARS imposes limitations on complexity in the simulation, so utilizing more complex software would facilitate the integration of varying terrain, fires, and units. Future research, regardless of simulation platform, should include complex terrain (hills and foliage) and C-sUAS operations while conducting a mission. While effective for squad and platoon level analysis, alternative simulation environments may provide expanded capabilities for future research efforts with broader scope. One example is Virtual Battlespace 4 (VBS4), a modern synthetic training and simulation environment developed by Bohemia Interactive Simulation. VBS4 provides enhanced graphics, improved physical modeling, large-scale terrain integration, and advanced joined and multi-domain operations, allowing for more detailed representation of complex operational environments. The most important future adaptation to the simulation will be representing the simulated technologies' capabilities as they emerge into the unclassified realm.

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