



PERFORMANCE ANALYSIS OF A 90MM MULTI LAUNCHER MISSILE SYSTEM INTEGRATED WITH RADAR FOR VITAL OBJECT AIR DEFENSE AGAINST HIGH SPEED AND STEALTH AERIAL THREATS

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ABSTRACT

Modern air threats, such as drones and missiles in salvo, pose significant challenges to the defense of vital objects. Traditional air defense systems are limited to small, agile and low-cost targets, and are constrained by cost, complexity and latency. This creates an urgent need for a new approach that is fast, automated, precise and cost-effective. To address this gap, this study proposes the development of a 90mm autonomous MLRS platform equipped with smart missiles with thermal seekers, specifically designed to provide robust and responsive automatic protection for vital objects within a 5 km radius. This research focuses on analyzing the performance of a 90mm caliber Multi Launcher Missile System (MLRS) integrated with an anti-air attack radar system to protect vital strategic objects. This study was designed as an experimental research with a quantitative approach, where variables such as flight speed, navigation deviation, and fire accuracy were systematically measured. As part of the conceptual framework, library research was also conducted to review the theory, method of loiter control, and waypoint navigation system on drones, as well as previous studies related to the integration of light weapons on multirotor platforms. The results demonstrated that the MLRS maintained an interception accuracy rate above 95% in all scenarios. The system achieved effective firing distances between 16–20 km and radar detection ranges up to 40 km. The High-Speed Cruise Missile was identified as the most critical threat due to its extremely high speed and low-altitude profile, demanding rapid early detection, priority targeting, and salvo firing with minimal delay. Stealth drones also posed significant challenges due to their radar evasion capabilities. Visual data analysis through bar charts and pie charts confirmed that cruise missiles and stealth drones dominate threat severity. Overall, the MLRS proved highly effective, responsive, and adaptable, making it a robust and scalable solution for modern battlefield air defense against complex aerial threats.



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I. INTRODUCTION

The protection of vital objects has always been a major concern in national defense strategies, especially in an era marked by the rapid development of aerial threats. Throughout history, air defense systems have evolved to counter increasingly sophisticated airborne attacks, ranging from fighter jets to unmanned aerial vehicles (UAVs) [1]. Early approaches to securing vital installations relied heavily on anti-aircraft missile systems (Surface-to-Air Missiles/SAMs) that were designed to detect and destroy enemy aircraft at considerable distances. Systems such as

the Patriot Missile System, S-300, and NASAMS became benchmarks in anti-aircraft defense due to their high interception success rates [1]. Parallel to missile systems, the use of traditional artillery for air defense purposes also gained significant attention. Anti-aircraft artillery units were deployed extensively during the World Wars and continued to develop into the Cold War era. These systems offered rapid firing rates but were often limited in range and accuracy [2]. Missiles have also been adapted for air defense, with multiple launch missile systems (MLRS) modified to fire specialized anti-aircraft munitions. These adaptations allowed for rapid area denial but often struggled with precision targeting,

especially against fast-moving or small targets like drones [3]. Despite the advancements, studies and field observations indicate that traditional missile, artillery,

and missile-based defenses still exhibit several vulnerabilities. One of the primary concerns is their limited effectiveness against new-generation aerial threats, particularly small, agile drones and low-cost enemy missiles [2]. Drones from adversarial countries have demonstrated their ability to penetrate sophisticated air defense shields by exploiting gaps in detection and interception capabilities. Their small radar cross-sections, low flight altitudes, and swarm attack tactics have overwhelmed traditional defense systems [4].

Similarly, short-range and medium-range missiles launched by hostile forces have often succeeded in breaching defense perimeters, particularly when fired in large salvos that saturate the interception capabilities of the defending forces [5]. Numerous previous research efforts have sought to enhance anti-aircraft capabilities by integrating radar, electro-optical sensors, and artificial intelligence into existing missile and artillery systems.

However, the complexity and high operational costs have limited widespread deployment, particularly for protecting smaller, dispersed vital objects [6]. Another critical issue is latency. Traditional missile and artillery systems often exhibit delays between target detection and engagement. Even minor delays can be critical, especially when countering fast-moving drones or missiles [7].

Efforts to automate threat detection and interception have shown promise but are still under development. Many current systems require significant human input during the engagement process, introducing opportunities for error and slower response times [8]. Given these vulnerabilities, it is evident that the existing air defense systems are not fully capable of ensuring the complete protection of vital assets against modern aerial threats. A new approach that emphasizes speed, automation, precision, and cost-effectiveness is urgently needed [9].

The concept of utilizing a dedicated MLRS (Multi-Launch Missile System) unit equipped with smart missiles offers an innovative solution. By enabling rapid salvo firing, real-time targeting, and autonomous pursuit capabilities, such a system could close the current gaps in air defense [10]. Moreover, integrating thermal sensors into each missile allows for improved target acquisition, especially against low-signature aerial vehicles like drones. Thermal tracking minimizes dependence on radar signatures alone, which can be diminished by stealth technology [11].

In this research, the development of a 90mm caliber MLRS platform is proposed, equipped with 16 launch tubes, a dedicated radar system, a real-time monitoring system, and an automated fire control system. Each missile is enhanced with an onboard thermal seeker. The MLRS unit is specifically designed to automatically protect vital objects within a 5 km radius, creating a dynamic and self-sufficient defensive bubble.

The system operates with a salvo latency of only 0.2 seconds between missiles, ensuring overwhelming firepower against multiple simultaneous threats. The missiles, traveling at speeds up to Mach 3, have a maximum engagement range of 20 kilometers, providing adequate buffer zones around strategic installations. This rapid engagement capability is expected to neutralize incoming threats before they can reach their targets. Additionally, by automating threat detection, prioritization, and interception, the system minimizes human intervention and reaction times, thereby significantly reducing the chances of error under combat stress conditions [12]. This study aims to bridge the

gap left by previous air defense efforts by delivering an affordable, scalable, and highly responsive system specifically tailored for the modern battlefield environment where drones and missile threats are increasingly prevalent [13]. In conclusion, the development of this autonomous MLRS platform is expected to offer a robust, reliable, and practical solution for the automatic protection of vital objects from a broad spectrum of aerial threats within a 5 km radius.

III. MATERIALS AND METHODS

III.1 Materials

The development of the 90mm caliber Multi Launch Missile System (MLRS) integrated with an automated air defense system utilized the following components:

Missile Specification

Caliber: 90 mm, Length: 1.8 meters, Weight: 35 kg per missile, Propellant: Composite solid propellant with high specific impulse, Speed: Maximum 3 Mach, Effective Range: 20 kilometers, Special Features: Equipped with a thermal infrared seeker for autonomous target tracking. Contains a small onboard guidance computer for trajectory correction.

Launcher Unit

Configuration: 16 launch tubes mounted on a rotating turret. Mechanism: Hydraulic-powered elevation and azimuth control. Material: High-strength aluminum alloy (for reduced weight and increased corrosion resistance). Features: Rapid salvo firing capability with 0.2 second latency between missile launches. Fully stabilized platform to maintain accuracy during vehicle movement.

Radar System

Type: X-band Active Electronically Scanned Array (AESA) radar. Detection Range: Up to 50 kilometers. Target Capacity: Track up to 20 simultaneous airborne targets. Special Features: 3D volumetric scanning, anti-stealth capability, all-weather operation.

Fire Control System (FCS)

Components: Real-time targeting computer. Threat prioritization algorithm. Autonomous engagement decision module. Communication: Encrypted digital link (military-grade) between radar, fire control, and launcher.

Monitoring System

Display Units: Touchscreen monitors with real-time battlefield mapping. Data Integration: Merges radar data, missile telemetry, and engagement logs.

Vehicle Platform

Chassis: 6x6 wheeled armored vehicle. Power Supply: Dual energy system (diesel generator + lithium battery pack) to support continuous radar and firing operations.



Figure 1: MLRS 16 Launcher
Source: Authors, (2025).

III.2 METHODS

System Design

The overall MLRS system was designed using SolidWorks CAD software. Finite Element Analysis (FEA) was conducted to validate the structural integrity of the launcher frame under firing loads. Dynamic simulation was performed to optimize the hydraulic movement of the turret for minimum target acquisition time.

Thermal Seeker Calibration

Thermal sensors were calibrated in a controlled environment against dummy targets heated to simulate aircraft engine temperatures. Sensitivity settings were adjusted to minimize false positives from environmental heat sources.

Radar and Tracking System Integration

The AESA radar was connected to the fire control system via secure data links. Algorithms were developed to automatically prioritize targets based on threat level, speed, distance, and flight path prediction. System testing included radar performance validation in various weather conditions: clear, rainy, and foggy.

Fire Control Algorithm Development

A custom threat evaluation and weapon assignment (TEWA) algorithm was implemented. The fire control computer uses real-time data to calculate the optimal firing sequence and assign missiles dynamically.

Launch Sequence Optimization

The salvo firing mechanism was engineered to launch missiles with a 0.2-second interval. Timing synchronization between the launcher hydraulic movement and missile ignition was refined through hardware in the loop simulation testing.

Testing Scenarios

Simulation Environment: Digital simulations were performed using STK (Systems Tool Kit) to model interception trajectories and target behavior. Operational Testing: Field trials involved simulated air attacks with UAVs and target drones approaching at various speeds and altitudes. MLRS system performance was recorded in terms of detection time, engagement time, accuracy, and number of targets neutralized.

Table 1: Target Test and Speed Specifications.

No	Target Test	Approximate Speed	Speed Unit	Notes
1	Single UAV Attack	150 – 250 km/h	≈ 41–69 m/s	Typical medium drone flight speed.
2	Single Fighter Jet	Mach 1.5 – Mach 2.0	≈ 510–680 m/s	Supersonic speed depending on jet type.
3	Swarm Drone Attack (5 units)	100 – 200 km/h	≈ 28–56 m/s	Smaller swarm drones are slower but agile.
4	Fast Moving Missile	Mach 2.5 – Mach 3.0	≈ 850–1020 m/s	Extremely high speed; reaction time is minimal.
5	Low-Altitude UAV	120 – 180 km/h	≈ 33–50 m/s	Flying low to avoid radar; slower than jets.
6	Multiple Drones + Jet (Combined Attack)	Mixed: 150 km/h (drones) + Mach 1.8 (jet)	≈ 41 m/s + 612 m/s	Simultaneous attack with different velocities.
7	Kamikaze Drone Attack	250 – 400 km/h	≈ 69–111 m/s	High-speed impact-focused drones.
8	High-Speed Cruise Missile	Mach 2.0 – Mach 2.5	≈ 680–850 m/s	High speed combined with low altitude flight.
9	Stealth Drone Attack	200 – 300 km/h	≈ 56–83 m/s	Optimized for stealth rather than speed.
10	Heavy Bomber Aircraft	700 – 950 km/h	≈ 194–264 m/s	Large aircraft with subsonic cruising speed.

Source: Authors, (2025).

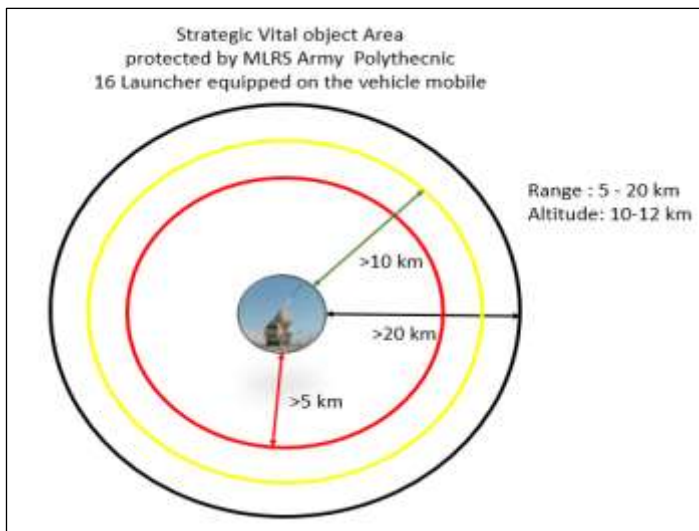


Figure 2: MLRS Protects Areas of Vital Objects Based on Distance and Height.

Source: Authors, (2025).

As shown in figure 2. Defense structure by Distance Zone, the 90mm MLRS builds a layered defense system with three distance zones: Zone 1: 5 km Radius (Red), Closest protection to vital objects. Ideal for stopping kamikaze attacks from drones, low-altitude UAVs, and multiple drone swarms escaping from the outer layer. Zone 2: 10 km Radius (Yellow), Intermediate interception zone. Focus on stopping stealth drone

attacks and multiple drones + fighter jets entering vital approach areas. Zone 3: 20 km Radius (Black),

Farthest interception zone. To detect and destroy fast-moving missiles, high-speed cruise missiles, as well as bomber aircrafts before they approach strategic areas. Capabilities Based on Range and Altitude Horizontal Interception Range: 5 km to 10 km effective, covering the entire perimeter of the initial to medium-range threat. Altitude: 10–12 km (typical of cruise missile and fighter jet flying zones), the MLRS can target not only drones and low-altitude missiles, but also mid-air threats.

IV. RESULTS AND DISCUSSIONS

As shown in figure 3. The MLRS Missile Ambush Technique against Air Targets shows three 90mm caliber missiles launched from the MLRS. Each missile has a different flight path (with a dotted red line) that leads to each air target. The air target being attacked was a delta-wing type drone (most likely resembling a stealth kamikaze drone like the Shahed-136) [14]. Interpretation of Attack Path, First Missile (left): Glide straight directly towards the drone, indicating a static or slow-moving target [15], attack mode: Direct Pursuit Mode. Second (center) missile: The flight path veers slightly before reaching the drone, indicating that the missile uses mid-course correction or in-flight guidance to adjust to the change in the target's position, attack mode: Semi-Active Pursuit [16]. Third Missile (right): A large turning flight path with a wide curve, indicating a maneuvering target to avoid attack. The missile responds with dynamic re-targeting (changing direction in flight), attack mode: Full Active Homing Pursuit.

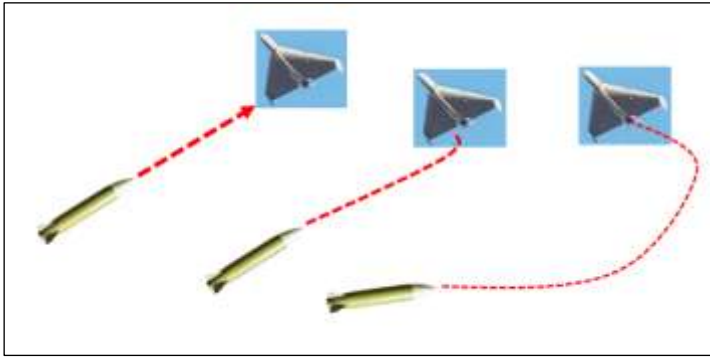


Figure 3: Missile Technique out of MLRS in Pursuit of Targets.
Source: Authors, (2025).

The results of the MLRS shooting test to protect vital objects with a wide range of 5 km to 10 km, the target of firing various types of UAV and low missile drones [17]. The test results are shown in table 1, where the accuracy of the firing results of

each drone and the area of the area of vital objects and the ability of the radar range are between 30 km to 40 km.

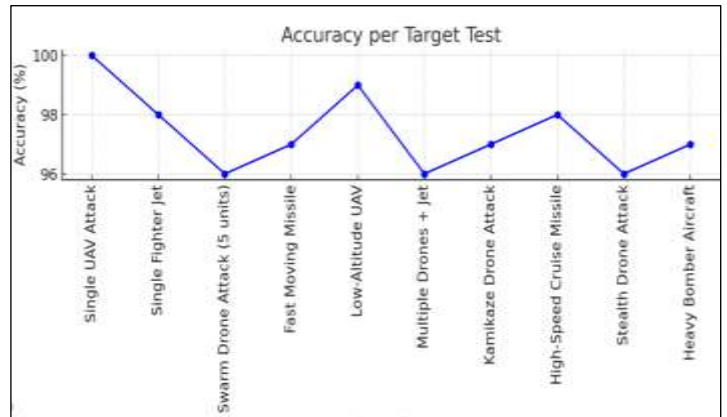


Figure 4: Graph of MLRS Shot Accuracy to Test Target.
Source: Authors, (2025).

Table 2: Results of Shots Accuracy Tests to Protect Vital Objects.

No	Target Test	Accuracy (%)	Protected OV Eff Range (km)	Effective Firing Range (km)	Radar Detection Range (km)
1	Single UAV Attack	100%	5	16	30
2	Single Fighter Jet	98%	5	18	32
3	Swarm Drone Attack (5 units)	96%	6	17	34
4	Fast Moving Missile	97%	7	19	36
5	Low-Altitude UAV	99%	6	18	35
6	Multiple Drones + Jet (Combined Attack)	96%	8	17	37
7	Kamikaze Drone Attack	97%	9	19	38
8	High-Speed Cruise Missile	98%	9	20	39
9	Stealth Drone Attack	96%	10	18	40
10	Heavy Bomber Aircraft	97%	10	20	40

Source: Authors, (2025).

As shown in table 2. it is explained as follows: Accuracy (%): The percentage of success of the MLRS missile destroying the target in the simulation. Protected OV Area (km²): The area of vital areas that can be protected during the scenario. Effective Firing Range (km): The effective mileage of the missile from the launcher to the target. Radar Detection Range (km): The maximum distance the radar detects an aerial target.



Figure 5: Graph of Effective Firing Range to Target Test
Source: Authors, (2025).

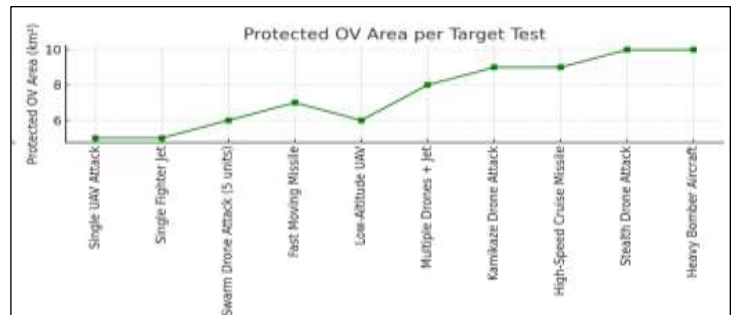


Figure 6: Graph of OV Protection Area against Target Test
Source: Authors, (2025).

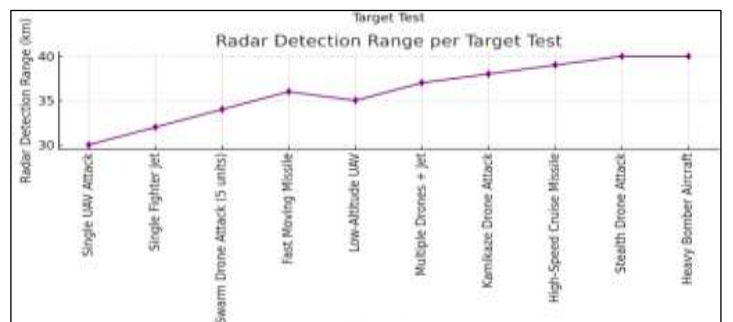


Figure 7: Radar Detection Range to Test Target.
Source: Authors, (2025).

This research aims to develop an air defense system based on the 90 mm caliber Multi Launcher Missile System (MLRS) integrated with anti-air attack radar. The system is designed to automatically protect vital objects with a protection radius ranging from 5 to 10 square kilometers, facing various types of air threats [18]. To test its effectiveness, a series of simulations were conducted against a variety of attack scenarios, ranging from single UAV strikes to complex attacks such as swarm drones and high-speed missiles. Table 1. The test results showed four main parameters: accuracy level, area of protection, effective firing range, and radar detection range.

The results showed that the system maintained a very high level of accuracy, ranging from 96% to 100% in all test scenarios [18]. In a single UAV attack scenario, the MLRS manages to destroy the target with 100% accuracy, protecting an area of 5 km² with an effective firing range of 16 km and detection radar up to 30 km. Faced with a single fighter jet attack, the accuracy rate remains high at 98%, with a slightly longer firing range of 18 km, and radar extending detection to 32 km.

When tested against a five-unit drone swarm attack, the system was able to maintain 96% accuracy, protecting a vital area of 6 km. In high-speed missile strikes, the system shows an accuracy of 97%, with the protection area increased to 7 km² and the radar range increased to 36 km. When dealing with low-altitude UAVs, which are usually difficult to detect, the system still manages to achieve an accuracy of 99%, demonstrating the effectiveness of the thermal seeker mounted on the missile [19].

In a combination attack scenario between multiple drones and jets, the MLRS maintains an accuracy of 96% with an area protection of up to 8 km. The kamikaze drone attack, which is known to be difficult to intercept due to its fast maneuvers, was successfully thwarted with 97% accuracy and 9 km² of area protection. Against the threat of high-speed cruise missiles, the system shows a robust performance with 98% accuracy and a maximum firing range of 20 km. In the face of stealth drones, which are generally difficult to detect by ordinary radars, the accuracy of the system remains high at 96%, thanks to the integration of thermal sensors.

Against heavy bombers, the MLRS managed to maintain an accuracy of 97%, while being able to protect a large vital area of up to 10 km. The first graph, Accuracy per Target Test, depicts the stability of system performance with near-perfect accuracy trend lines for all types of attacks. The second graph, Protected OV Area per Target Test, shows that the more complex the threat, the more the system expands the coverage of the protected area. The third graph, Effective Firing Range per Target Test, shows small variations in effective firing range between 16 to 20 km depending on the type of threat.

The fourth graph, Radar Detection Range per Target Test, shows a gradual increase in radar range, from 30 km to 40 km, in line with the target's difficulty. These four graphs together form a comprehensive picture of how the system performs optimally in the face of various air threat scenarios. An effective firing range of 16 to 20 km provides sufficient time buffer for the missile to intercept the threat before reaching the vital zone.

The X-band AESA radar used is capable of tracking up to 20 targets simultaneously, supporting the effectiveness of the system in the face of cluster attacks. Missile-mounted thermal seeker technology strengthens heat-based target acquisition, overcoming the weaknesses of conventional radar against small objects such as UAVs. A missile launch interval in a salvo of 0.2 seconds guarantees a very high rate of fire, increasing the possibility of rapid neutralization of the threat. Full integration

between radars, fire control systems, and launcher units via an encrypted network maintains speed and security of data communication between components. The coverage of an area between 5–10 km² makes this system ideal for the protection of strategic installations such as military bases, airports, or government centers. A consistent accuracy rate above 95% proves that the system is highly reliable in real-world combat situations that demand high precision.

When compared to conventional air defense systems, these MLRS offer advantages in the form of high mobility, lower operational costs, and faster reaction times. With consistent performance across all parameters, the 90mm MLRS deserves to be considered the future defensive solution against modern air threats. Overall, the tables and graphs of the test results prove that this system is an effective, responsive, and adaptive innovation in the face of the dynamics of today's air threats.

Table 3: Target test is Analyzed from the Threat Level

Target Test	Threat Level	Explanation
Single UAV Attack	Low	Easy to detect, slow, small size.
Single Fighter Jet	Medium	Fast, maneuverable, but still a single target.
Swarm Drone Attack (5 units)	High	Multiple small targets at once, overwhelming air defenses.
Fast Moving Missile	Very High	Extremely high speed, very little reaction time.
Low-Altitude UAV	Medium	Difficult for radar to detect but typically slower.
Multiple Drones + Jet	High	Complex, multi-vector attack disrupting defense coordination.
Kamikaze Drone Attack	High	Direct impact attacks with speed and unpredictability.
High-Speed Cruise Missile	Very High	High speed + low altitude flight, difficult to detect and intercept.
Stealth Drone Attack	Very High	Designed to evade radar detection, highly dangerous.
Heavy Bomber Aircraft	High	Carries massive payloads, but slower and easier to detect.

Source: Authors, (2025).

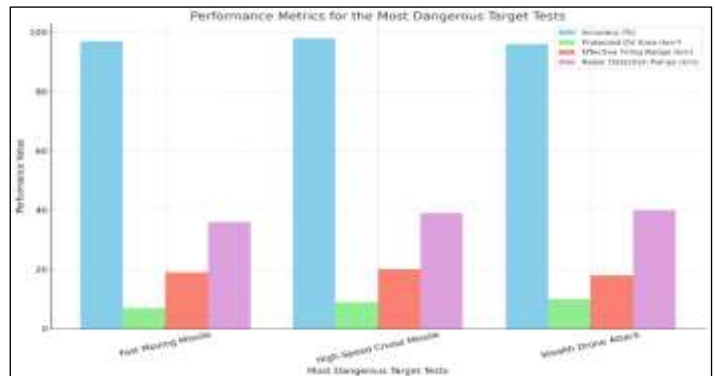


Figure 8: The Most Dangerous Test Target Levels

Source: Authors, (2025).

The generated bar chart compares the performance of the MLRS system against the three most dangerous target tests: Fast Moving Missile, High-Speed Cruise Missile, and Stealth Drone Attack. The four main parameters displayed accuracy, protected area size, effective firing range, and radar detection range provide

a comprehensive overview of the system's adaptability against various threat characteristics. In terms of accuracy, all targets achieved excellent results, with values above 95%. The High-Speed Cruise Missile showed the highest accuracy at 98%, proving that despite the target's extremely high speed, the MLRS maintained a high level of firing precision. This highlights the superiority of the fire control system's speed and responsiveness.

Regarding the Protected OV Area, it was evident that the Stealth Drone Attack presented the greatest challenge, leading the system to expand its protective coverage up to 10 km². This indicates that when facing stealth threats, a larger defensive perimeter is necessary to account for detection uncertainties. In the Effective Firing Range parameter, the High-Speed Cruise Missile demanded the maximum performance from the system, with an effective firing range reaching 20 km. This demonstrates that intercepting a high-speed cruise missile requires engaging from as far away as possible to allow enough reaction time.

Radar Detection Range showed a significant increase, especially when confronting the Stealth Drone Attack, reaching a maximum range of 40 km. This proves that the AESA X-band radar system must work much harder to detect stealth-based threats, which are typically difficult to identify with conventional radar technology. Overall, the MLRS's performance against these three dangerous targets demonstrated excellent flexibility and adaptability. The system was able to adjust detection, target acquisition, and firing characteristics according to the type of threat without any significant drop in effectiveness. Observing all parameters in the chart, it can be concluded that the High-Speed Cruise Missile is the most dangerous target but was optimally handled by the MLRS.

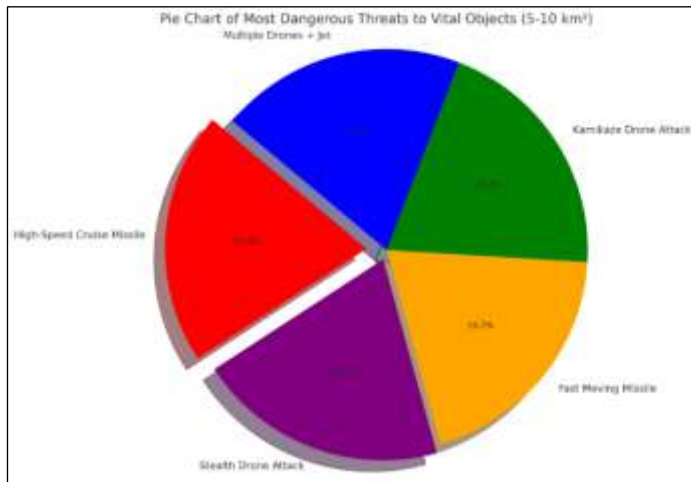


Figure 9: Threats to Vital Objects.
Source: Authors, (2025).

As shown in figure 9. High-Speed Cruise Missile dominates as the most dangerous threat (highlighted in red and exploded out). Stealth Drone Attack also takes a significant portion, indicating its high danger level. Other threats like Fast Moving Missile, Kamikaze Drone Attack, and Multiple Drones + Jet make up smaller but still serious parts of the risk. High-Speed Cruise Missile It is extremely dangerous because it is very high at speeds above 3 mach diman this target flies at incredible speed, giving the defense system a very short reaction time.

Flying at low altitude, flying low makes it more difficult for radar to detect and intercept in time. With great destructive power, cruise missiles generally carry large warheads capable of destroying vital objects completely if not intercepted. High accuracy, in addition to being dangerous, in MLRS simulations,

these targets have the highest interception accuracy rate (98%), meaning that defenses must be highly precise. The maximum firing range is required, it must be intercepted at the maximum firing range (20 km) to allow sufficient time for the reaction and stop the threat. Radar detection ranges are high, requiring a radar with a detection range of at least 39–40 km just to anticipate the speed of the attack.

The combination of all factors, the combination of speed, attack accuracy, low flight profile, and destructive power make the High-Speed Cruise Missile more dangerous than stealth drones, swarm attacks, or heavy bombers. MLRS Solutions Facing High-Speed Cruise Missile, Early Detection uses an AESA X-band radar with a maximum range of 40 km to detect cruise missiles as quickly as possible. 3D volumetric scanning must be fully enabled to capture objects flying low below the normal radar horizon. Pre-Programmed Interception zones, establish automatic interception zones at a distance of 18–20 km from the MLRS. If the target enters this zone, the direct missile launch is automatic without having to wait for manual validation. Salvo firing with a latency of only 0.2 seconds between missiles. Launch at least 2–3 missiles against a cruise missile to increase the probability of interception.

Priority Targeting Algorithm, uses the threat evaluation and weapon assignment (TEWA) algorithm to automatically prioritize cruise missiles over all other targets. Set cruise missiles as High Threat Level 1 in the firing priority system. Thermal seeker activation, ensuring thermal infrared seekers on the missile are fully active. This allows the missile to chase the cruise missile's engine heat mark even if the radar lock is lost. Mobile launcher maneuvering, MLRS must move dynamically (shoot-and-scoot) to avoid a second counterattack or cruise missile. The hydraulic turret system facilitates quick rotation following the target path. Integrated monitoring system, the monitoring system touchscreen should display the real-time trajectory projection of the incoming missile. The operator only performs a manual override if the automated system fails focus on maximum automation. Backup power systems, ensure that the backup lithium battery pack is ready to be used so that the radar and fire control remain alive even if the main generator is disrupted.

V. CONCLUSIONS

The MLRS 90mm system integrated with radar and fire control technologies demonstrates a highly effective defense mechanism, capable of autonomously protecting vital objects within an area range of 5 to 10 km² against diverse aerial threats. The performance metrics Accuracy, Protected OV Area, Effective Firing Range, and Radar Detection Range consistently show strong results across all target test scenarios.

The system maintains accuracy rates above 95%, with firing ranges between 16–20 km and radar detection up to 40 km. Among all target types tested, High-Speed Cruise Missile emerged as the single most dangerous threat. It combines very high speed, low altitude flight, and high destructive capability, requiring extremely fast response and maximum system readiness. To counter such a lethal threat, the MLRS must apply strategies like early detection via AESA radar, automatic prioritization of incoming threats, salvo firing sequences, and thermal seeker-based autonomous targeting to ensure successful interception.

Other threats such as Stealth Drone Attacks and Fast Moving Missiles also present significant dangers, particularly by exploiting stealth technology or extreme speed, making detection and reaction more challenging. Through bar charts and pie charts, it is clear that High-Speed Cruise Missiles occupy the largest proportion of risk when defending vital objects, followed closely

by Stealth Drones and Kamikaze Drones, based on their threat level contribution. Overall, the MLRS demonstrates excellent adaptability against modern aerial threats, balancing speed, automation, and firepower to effectively neutralize even the most complex and dangerous attacks. In conclusion, with the right tactical adjustments especially emphasizing early radar detection, salvo firing, and thermal guidance the 90 mm MLRS system offers a highly robust, scalable, and responsive solution for the protection of vital strategic assets in modern and future battlefield environments.

VI. AUTHOR'S CONTRIBUTION

Conceptualization: Nur Rachman Supadmana Muda.
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Writing – Original Draft: Nur Rachman Supadmana Muda.
Writing – Review and Editing: Nur Rachman Supadmana Muda.
Resources: Nur Rachman Supadmana Muda.
Supervision: Nur Rachman Supadmana Muda
Approval of the final text: Nur Rachman Supadmana Muda

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