Adaptation Artillery for High-Intensity Warfare Environments

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Agenda

1. Characteristics of Change on the Contemporary High-Intensity Battlefield
2. Evolution of the Modern Battlefield in High-Intensity Conflict:
   Artillery and Drones – A Comparative Analysis
3. Tactical Adaptations and Survivability Measures:
   Lessons from Ukraine and High-Intensity Operations

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Characteristics of Change on the Contemporary High-Intensity Battlefield

NEW REALITY

SATURATION OF THE BATTLEFIELD WITH VARIOUS UNMANNED SYSTEMS



INTENSIVE EMPLOYMENT OF STRIKE UAVs TO DELIVER FIRE EFFECTS



CONTINUOUS REAL-TIME RECONNAISSANCE ACROSS SIGNIFICANT DEPTH BEYOND THE LINE OF CONTACT

PERSISTENT SURVEILLANCE

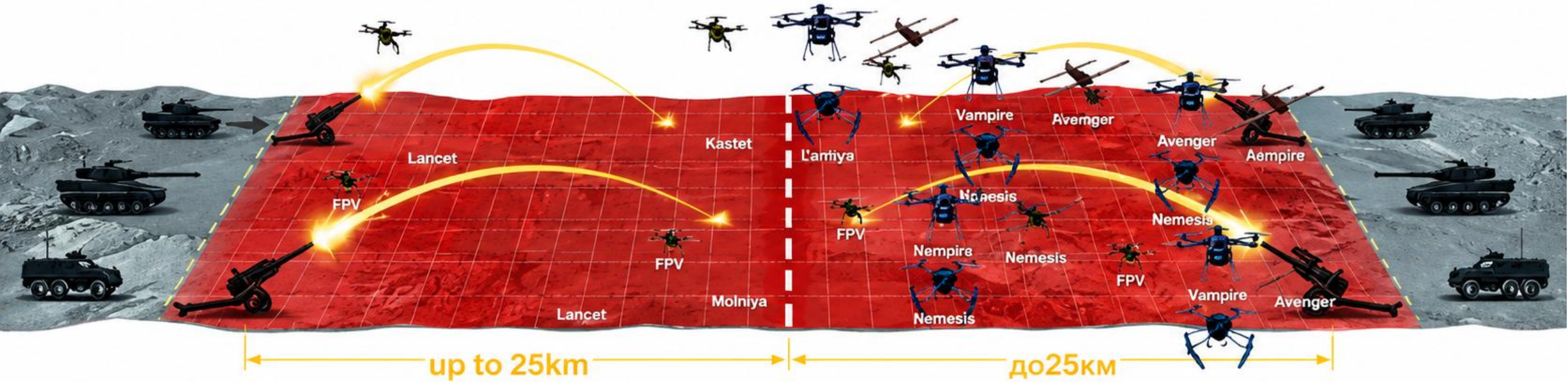
REAL-TIME INFORMATION

DEEP & BEYOND THE LINE OF CONTACT



Kill Zones

Mass employment of UAVs has created continuous engagement zones up to 25 km deep



Effects on the battlefield:

- Immediate engagement of detected targets
- Forced dispersion of artillery assets
- Complicated covert movement of units
- Increased requirements for engineering preparation of firing positions
- Use of unmanned systems for logistical support tasks

TRANSPARENT, SENSOR-SATURATED BATTLEFIELD

The Russo-Ukrainian War demonstrates the modern high-intensity battlefield

UAVs



Persistent aerial observation (day & night)

COMMERCIAL SATELLITES



Wide-area imagery & change detection

RADARS



Detection of movement, positions & trajectories

ACOUSTIC SENSORS



Detection of fire, movement & engines

ELECTRONIC INTELLIGENCE (ELINT)



Signals interception, communications & emissions geolocation

INTEGRATED DATA FUSION & REAL-TIME SHARING

Common operational picture accessible across echelons and effectors

DETECTED & TRACKED

DETECTED & TRACKED

DETECTED & TRACKED

DETECTED & TRACKED

DETECTED & TRACKED

SHARPLY REDUCED ABILITY TO REMAIN CONCEALED
for large formations and firing units

COMPRESSION OF THE SENSOR-TO-SHOOTER CYCLE

Speed of information → Decisive advantage

1. SENSORS / UAVs



- Persistent surveillance
- Target acquisition
- Fire correction
- Battle-damage assessment (BDA)

2. TARGET DETECTION



Detection of enemy positions / assets

3. DIGITAL C2 / DATA FUSION



Accelerated information flow

Verification → Prioritisation → Target data transfer

4. DECISION



Decentralised decision-making

5. AVAILABLE EFFECTOR



Artillery / Precision Fires / Strike UAV

6. TARGET ENGAGEMENT



7. UAV BDA & FIRE CORRECTION



Immediate BDA & fire correction

The decisive variable is no longer the maximum technical range of a weapon, but the SPEED with which information is verified, prioritised and converted into a fire mission.

KEY LESSONS

SPEED OVER RANGE

Rapid information processing and short sensor-to-shooter cycle provide a decisive advantage.

FEDERATED C2

Modular, federated systems integrate heterogeneous sensors and weapons within one network.

RESILIENCE & DECENTRALISATION

Systems must operate under degraded connectivity and support decentralised decision-making.

SURVIVABILITY AND DISPERSION

Key to Artillery Effectiveness on the Modern Battlefield

THE PROBLEM: HIGH VISIBILITY = HIGH RISK

CONCENTRATED GUN LINES



Easy to detect and target

PROLONGED OCCUPATION OF FIRING POSITIONS



Increases exposure time

PREDICTABLE AMMUNITION POINTS



Create signatures that can be detected and engaged

FIRE – DISPLACE CYCLE



THE ADAPTATION: SURVIVE – SHOOT – DISPLACE

DISPERSED EMPLOYMENT

Artillery used individually or in small, dispersed groups from prepared and concealed positions



SHORTER FIRE MISSIONS

Fire missions are shortened to reduce exposure



AMMUNITION MANAGEMENT

Ammunition stored away from the weapon



DISPLACEMENT / RESUPPLY AFTER CHECKS

Displacement or resupply only after checking local UAV and EW situation



UNMANNED GROUND VEHICLES

Support last-mile ammunition delivery, reducing personnel exposure and logistics signature



MOBILITY, SIGNATURE MANAGEMENT AND RAPID FIRE-AND-DISPLACE ARE AS IMPORTANT AS RANGE AND RATE OF FIRE

MOBILITY

Move quickly, stay unpredictable

SIGNATURE MANAGEMENT

Reduce detection, control your signature

RAPID FIRE-AND-DISPLACE

Shoot, move, and survive

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Evolution of the Modern Battlefield in High-Intensity Conflict: Artillery and Drones – A Comparative Analysis

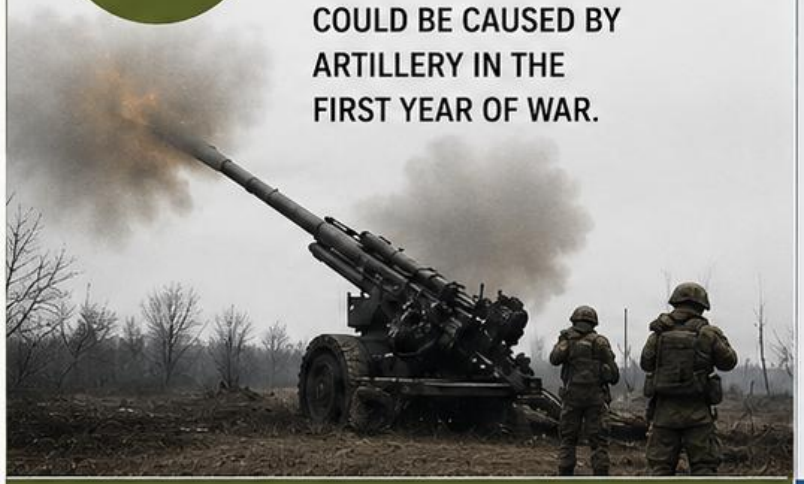
EVOLUTION OF THE BATTLEFIELD

DURING A HIGH-INTENSITY CONFLICT

2022–2023

UP TO 90%

LOSSES ON BOTH SIDES COULD BE CAUSED BY ARTILLERY IN THE FIRST YEAR OF WAR.



SOURCE:
Mertens, F., Heer de, B., Sweijs, T., Hooft van, P., Bekkers, F. (2023), Lessons from land warfare: One year of war in Ukraine, The Hague Centre for Strategic Studies. https://hcss.nl/report/lessons-from-land-warfare-one-year-of-war-in-ukraine/ Google Scholar

2024–2025

75%

OF LOSSES ON THE RUSSIAN SIDE ARE NOW CAUSED BY UKRAINIAN STRIKE DRONES, SIGNIFICANTLY MORE THAN ARTILLERY.

~21%
ARTILLERY

4%
INFANTRY WEAPONS

SOURCE:
Col. Andrianyk Hasparian, Development Department of Missile Forces and Artillery, Armed Forces of Ukraine, "Adaptation Under Fire: Trends And Challenges, Future Artillery Forum, London, 2025

2025

UP TO 80%

LOSSES ON THE BATTLEFIELD ARE NOW CAUSED BY DRONES – DOMINATION OF DRONES ON THE FRONT LINE. FPV DRONES ARE DISPLACING TRADITIONAL WEAPON SYSTEMS.



SOURCE:
Death from above: Drones upend rules of war in Ukraine, https://theweek.com/politics/death-drones-upend-rules-war-ukraine (published 14 July 2025)

Artillery vs. Drone – 2025

Criterion	Conventional HE Artillery Ammunition	UAS (One-Way Attack / Strike / FPV)
Susceptibility to Detection	LOW	HIGH
Susceptibility to Enemy Countermeasures	LOW	HIGH – vulnerable to electronic warfare (EW) and kinetic countermeasures
Precision	LOW	HIGH
Unit Cost	MEDIUM – approx. USD 4,000 per 155 mm HE projectile	LOW – approx. USD 300–700 per FPV kamikaze drone
Dependence on Weather Conditions	LOW	HIGH
Time to Achieve Operational Readiness	SHORT	MEDIUM
Capability to Engage Moving Targets	LOW	HIGH
Provision of Intelligence, Surveillance and Reconnaissance (ISR)	NO	YES
Potential for Technical Modification	LOW	HIGH
Technology Development Cycle	LONG	SHORT
Access to Components, Equipment and Technology	LIMITED	WIDELY AND READILY AVAILABLE
In-Flight Conditions	Chamber pressure up to 413 MPa; spin rate up to 20,000 rpm; velocity up to 1,000 m/s	Free, low-speed, controlled flight; speed up to approx. 80 m/s

Functional comparison of conventional artillery ammunition and principal UAV variants

Criterion	Conventional HE artillery ammunition	ISR / target-acquisition UAV	FPV / one-way attack UAV	Bomber UAV / loitering munition
Primary function	Massed fire, suppression and destruction	Detection, identification, correction and BDA	Exact precision engagement of point or moving targets	Persistent strike, repeated drops or area interdiction
Effect and payload	High-explosive effect; scalable through volume of fire	Normally non-kinetic; enables other effectors	Small, target-specific payload	Larger or multiple payloads; longer endurance than FPV
Latency	Very low after receipt of fire data	Reduces latency for the entire fire system	Low when operator and relay network are available	Low to medium; depends on search and loiter time
Precision / moving targets	Limited without guided ammunition and correction	Enables correction but does not itself create kinetic effect	High potential, including against moving targets	High against detected targets; varies with guidance mode
EW dependence	Low after firing; digital preparation may still be disrupted	High dependence on navigation, data links and spectrum access	High for radio-controlled variants; lower for fibre-optic or terminally autonomous variants	Medium to high; autonomy and alternative navigation increase resilience

Functional comparison of conventional artillery ammunition and principal UAV variants

Criterion	Conventional HE artillery ammunition	ISR / target-acquisition UAV	FPV / one-way attack UAV	Bomber UAV / loitering munition
Weather sensitivity	Relatively low	Medium to high	High	Medium; platform- and sensor-dependent
Persistence and ISR	None after firing	High; core mission	Limited but can confirm terminal effect	Medium to high; supports search, tracking and BDA
Signature and risk	Gun flash, sound, radar trajectory and logistics create counterfire risk	Control station and emissions can reveal operators	Operators and relay nodes are vulnerable to detection	Launch, control and recovery elements require dispersion
Logistics and scalability	Heavy ammunition, barrels and transport; industrial-scale supply required	High attrition; batteries, sensors and trained crews required	Low unit cost but very high consumption and component dependence	Higher cost and support demand than FPV; reusable and expendable variants
Best employment	Shock, suppression, adverse weather and sustained high-volume fires	Building the common operating picture and cueing artillery/UAV strikes	Economical precision against exposed or mobile targets	Interdiction, repeated attacks and engagement beyond the immediate line of contact

Not Competitors – but Allies

UAVs provide:

- Target acquisition and fire adjustment.
- Increased effectiveness of fire missions and reduced ammunition expenditure.
- Laser designation for precision guided munitions.



A unified fire system



Artillery provides:

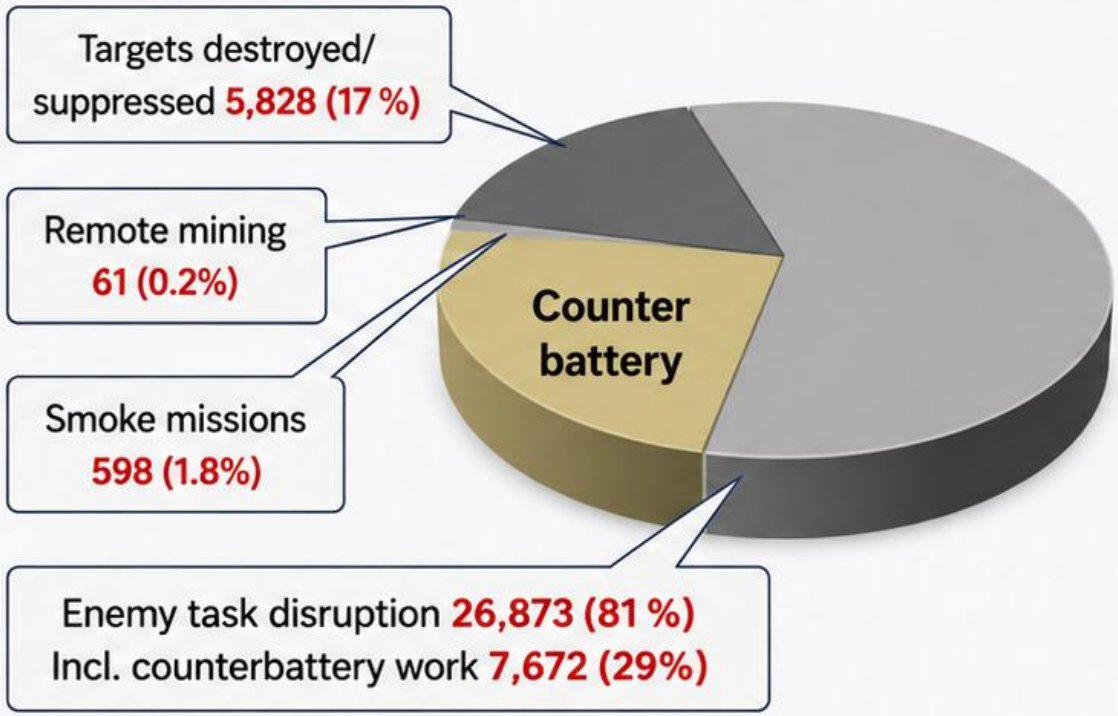
- Target engagement regardless of weather.
- Operation under heavy enemy electronic warfare.
- Execution of special tasks (remote mining, smoke, illumination).

Integrated employment of UAVs and artillery creates synergistic effects, enhances combat effectiveness and maximizes operational outcomes.

Effectiveness of Artillery and Strike UAV Units

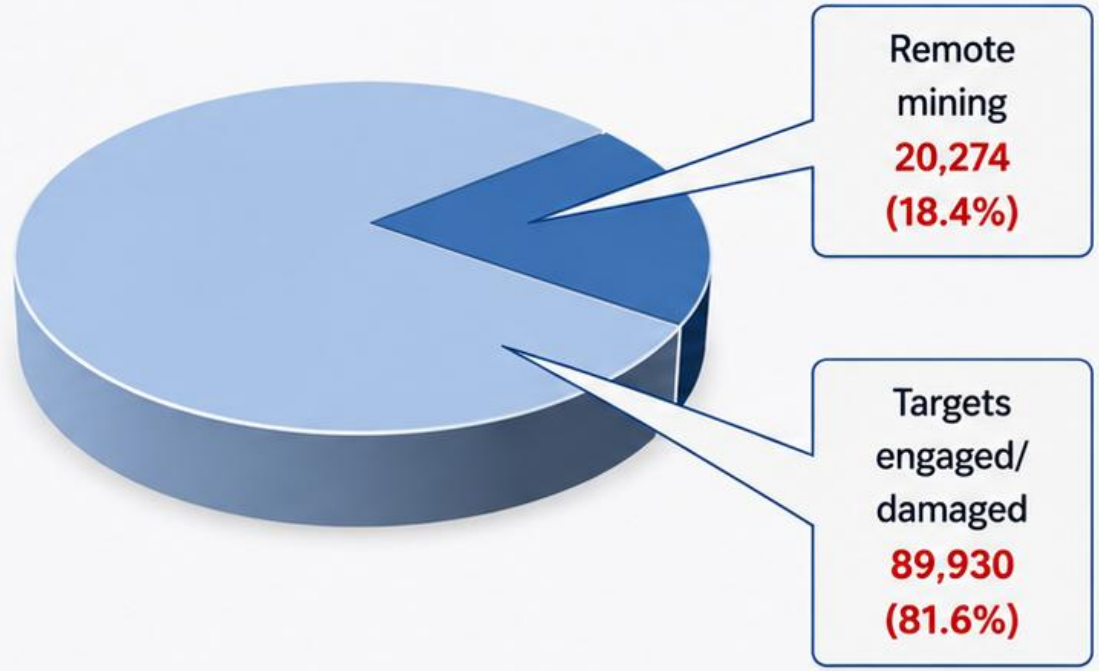
ARTILLERY

- Total fire missions: 95,300
- Effectiveness: 35%
- Confirmed target hit: 33,360



STRIKE UAV

- Total fire missions: 326,231
- Effectiveness: 34%
- Confirmed target hit: 110,204



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Tactical Adaptations and Survivability Measures: Lessons from Ukraine and High-Intensity Operations

TACTICAL SHIFT

TRADITIONAL EMPLOYMENT







ADAPTED / DISPERSED EMPLOYMENT





FASTER FIRE MISSION EXECUTION

Reduced time from target acquisition to first round.



< 5 min

(vs. 15–20 min traditionally)

INCREASED RANGE

Ability to engage targets at greater distances.



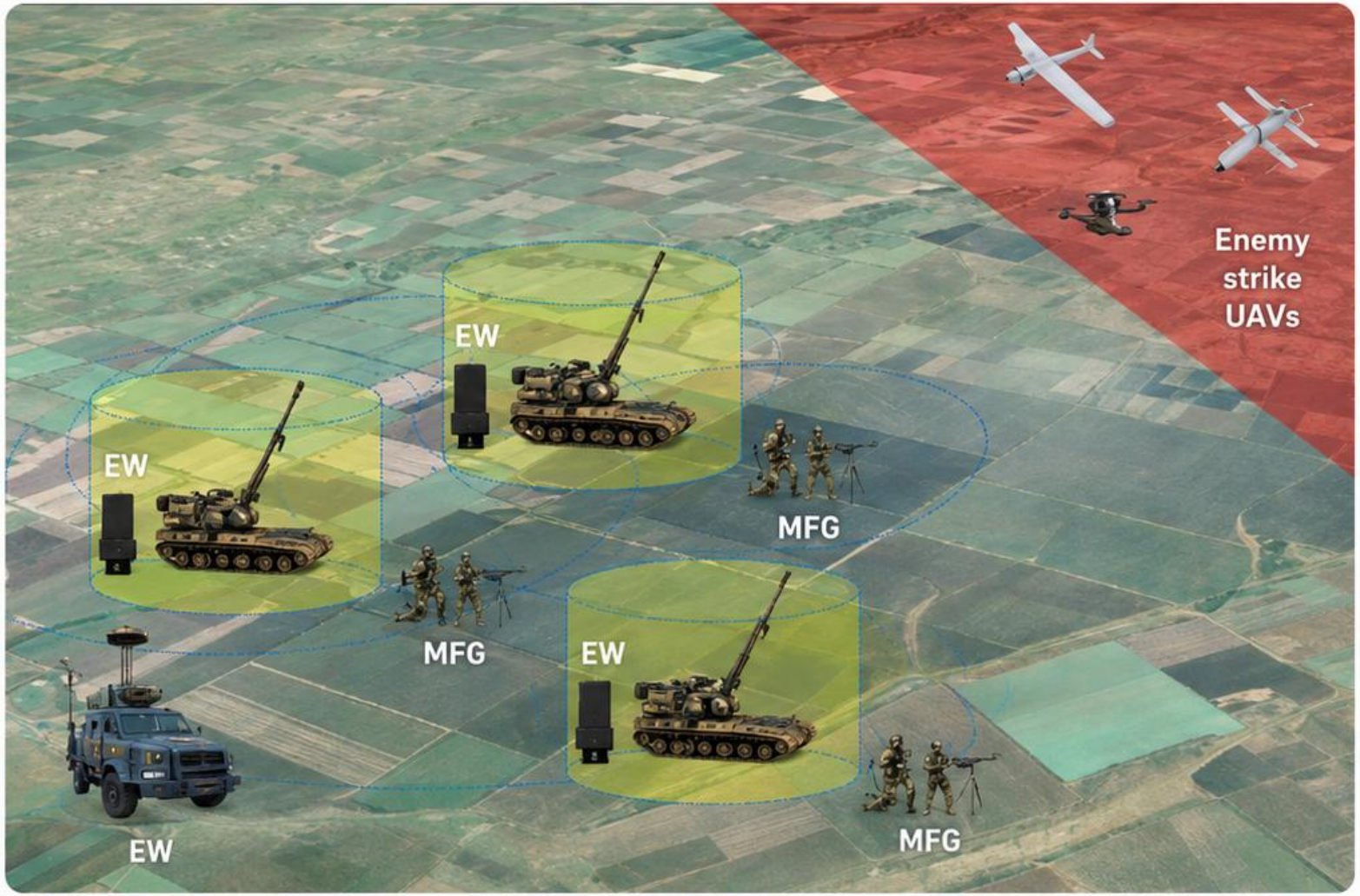
IMPROVED ACCURACY

Use of precision munitions and advanced targeting methods.



The tactical shift increases artillery survivability, reduces vulnerability to counter-battery fire, extends engagement range and improves overall operational effectiveness.

DEFENCE SYSTEM AGAINST ENEMY UAVS



THREATS

- **Reconnaissance UAVs** (Orlan-10, Supercam, ZALA, DJI Mavic, DJI Matrice)
- **Strike UAVs** (Privet-82, Molniya, VT-40, “Lancet Dron”)
- **Loitering munitions** (Lancet)

DEFENCE COMPONENTS

- **Electronic warfare systems** (omnidirectional & directional)
- **Mobile fire groups (2–3 pers.):**
  - Heavy machine gun
  - Shotgun
  - Small arms
  - Portable UAV detector

Layered defence: detection, electronic warfare suppression and mobile fire groups ensure protection of artillery assets against enemy UAV threats.

ENGINEERING PROTECTION OF ARTILLERY POSITIONS

Personnel shelters



> 50 m

< 10 m

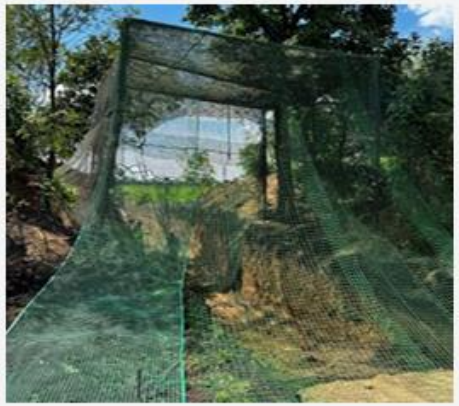


bunker for crew rest



dugout for crew protection

Gun shelters





Ammunition storage pits



< 30 m

< 5 m



ammunition storage



ready-use ammunition niche

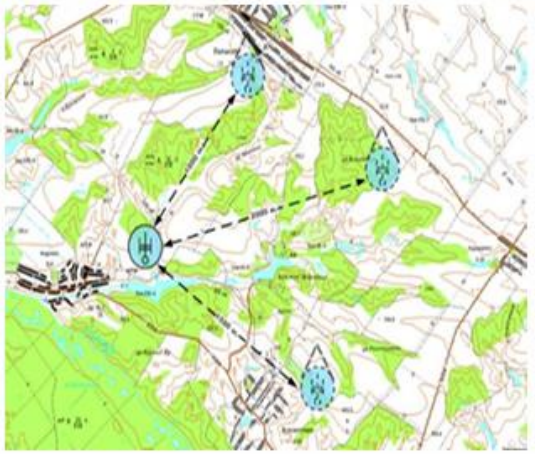
DECEPTION MEASURES

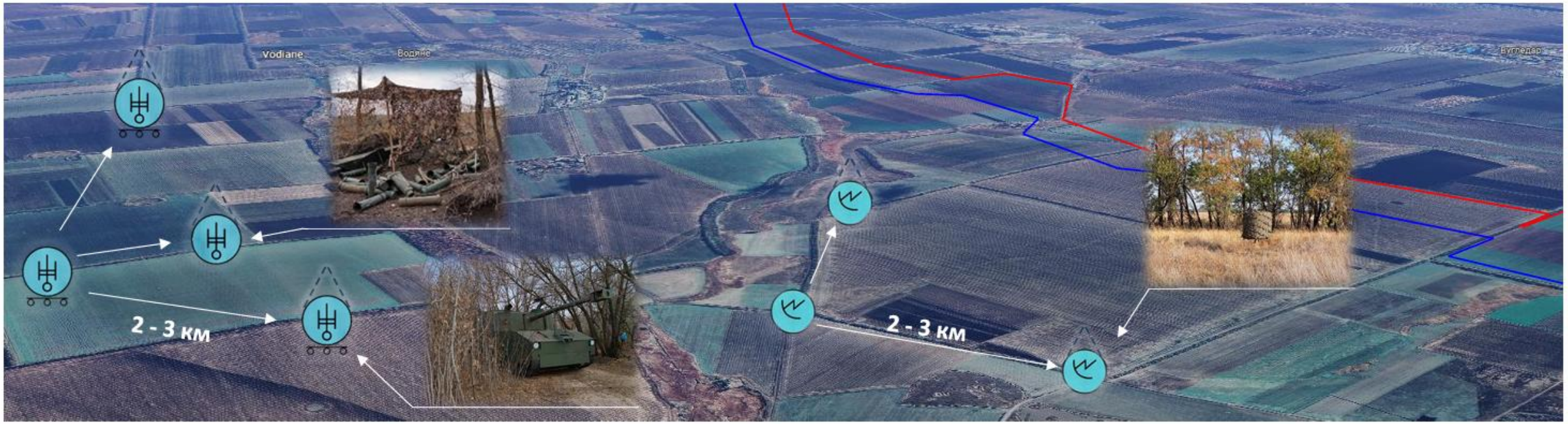
Tools

- Mock MLRS
- Mock SPH and towed artillery
- Mock mortars
- Mock artillery reconnaissance assets









SUSTAINING SURVIVABILITY IN OPEN BATTLEFIELD CONDITIONS

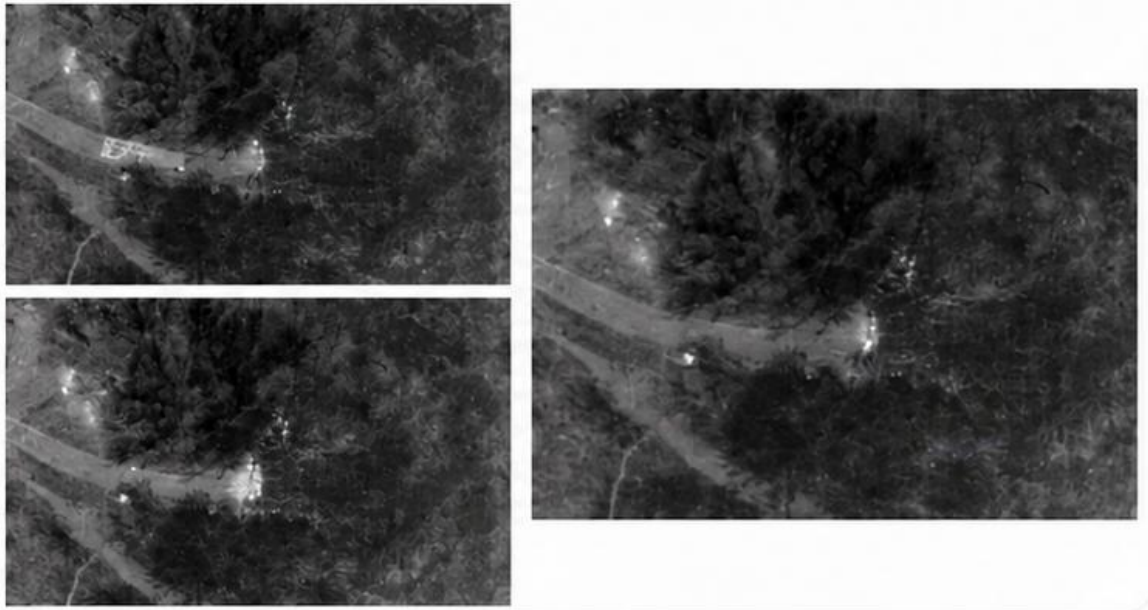
EARLY DETECTION AND SUPPRESSION

- Spectrum analyzers (e.g., “Tsukorok”) detect control and downlink channels of UAVs and FPV drones.
- This gives time to relocate, hide or deploy enhanced camouflage (physical contact with a drone).
- Local EW (electronic warfare) systems in technical positions of units block frequencies of FPV drones and copters with munitions.



RADIO AND THERMAL ISOLATION

- Compliance with radio silence: minimum use of phones, terminals and wireless networks.
- Light masking at night and signature control.
- Extensive use of smoke, screens, thermal blankets, thermal decoys, radio isolation of engines and exhausts, thermal blankets for equipment.



Continuous detection, signature control and isolation are key to reduce exposure, maintain concealment and increase survivability on the modern battlefield.

MEASURES TO ENHANCE SURVIVABILITY

2 “SHOOT & SCOOT” PRINCIPLE

Firing positions are detected and engaged by the enemy very quickly. A lower signature reduces the probability of detection and minimizes the time between firing and displacement.

TIME OF EXPOSURE = RISK OF DESTRUCTION.
Shoot little, accurately, and move fast.

1 CLOSED



Position occupied.
Detection – minimal.

2 OPEN



Short series of fire.
Minimum exposure time.

3 CLOSED AGAIN



After firing – immediate closure and concealment.

KEY TAKEAWAYS

- Reduce time in firing position to a minimum.
- Fire only what is necessary to achieve the effect.
- Move, close and conceal immediately after firing.

THE GOAL

Make the enemy’s decision cycle longer than ours.
Be harder to find and harder to destroy.

AUTOMATION OF THE FIRE MISSION CYCLE

1. TARGET DETECTION

Radar

Optical

UAVs

Sound

Detect and locate the target.

2. DATA COLLECTION AND PROCESSING

Data Collection

Processing

AI

Collect, process and validate data.

3. DECISION MAKING

Situation Assessment

Analysis of Intelligence

Ammunition

Weather Conditions

Integrate data and assess options to make the best decision.

4. ENGAGEMENT MEANS

Fire Support Systems

UAVs (Reconnaissance, Engagement)

AI

Execute the fire mission using the right means.

5. ASSESSMENT AND FEEDBACK

AI

Assess results and provide feedback for improvement.

KEY IDEA:

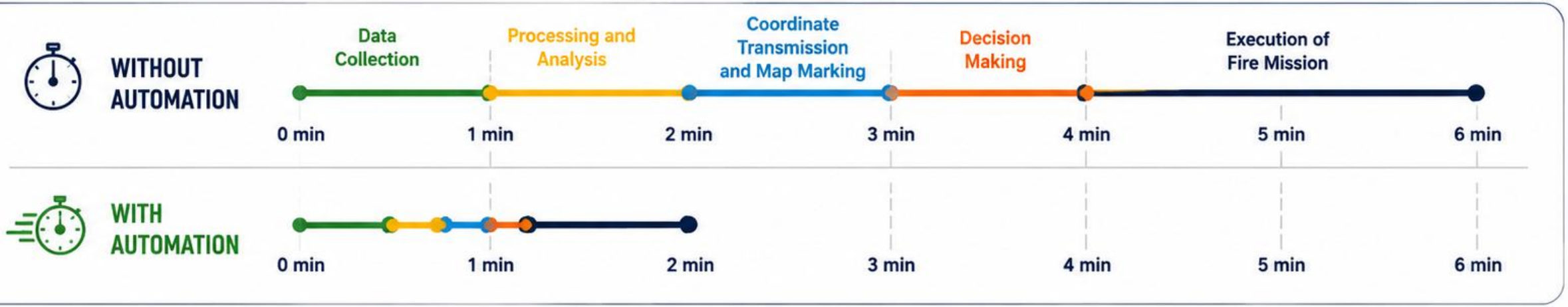
Automation shortens the time from detection to impact, increases accuracy, reduces workload and enables rapid adaptation to a dynamic battlefield.

BENEFITS:

- Faster cycle
- Higher accuracy
- Better coordination
- Resource efficiency
- Continuous improvement

INCREASING THE EFFECTIVENESS OF FIRE MISSIONS

PROCESS	WITHOUT AUTOMATION	WITH AUTOMATION	IMPROVEMENT
Data Collection	1 min ... 2 min	30 sec	3–4 times faster
Processing and Analysis	30 sec	1 ... 3 sec	10–30 times faster
Coordinate Transmission and Map Marking	1 min	1 ... 3 sec	20–60 times faster
Decision Making by Commander	20 sec	10 sec	2 times faster
Execution of Fire Mission	from 3 min	from 2 min	1.5 times faster
TOTAL TIME	from 5 min	from 2 min	**2 TIMES FASTER**



SHORTER TIME = FASTER ENGAGEMENT + LESS EXPOSURE + HIGHER EFFECTIVENESS

Automation shortens the fire mission cycle and increases both effectiveness and survivability.

KEY TAKEAWAYS:

"Artillery of the future is not just guns.
It is an integrated, protected,
autonomous system
that shapes the battlefield."

Commander of Missile Forces and Artillery
of the Armed Forces of Ukraine
Major General Andrii MALINOVSKYI

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THANK YOU FOR YOUR ATTENTION

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