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PRESENTATION OF THE USE OF MODERN FIRE CONTROL SYSTEMS AND THEIR IMPLEMENTATION IN INFANTRY UNITS

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Abstract: *The implementation of fire control systems in infantry units represents a significant step towards modernizing and enhancing military operations. Integrating these systems enables infantry units to precisely and efficiently coordinate fire support from air, land, and sea, thereby reducing reaction time and increasing the accuracy of attacks. This paper presents the technology, training, and tactical procedures required for the successful integration of modern fire control systems into the infantry units of the Serbian Armed Forces. The focus is on contemporary tools such as laser rangefinders, advanced radio devices, and GPS systems that allow fire control operators to identify targets and direct fire with minimal collateral damage. Additionally, the paper examines the challenges in implementation, including the need for comprehensive training of infantry units. This study provides guidelines and recommendations for the optimal use of modern tools and fire control systems in operations, emphasizing the importance of technological advancement and coordination within the military system.*

Keywords: *Fire control Systems, JTAC (Joint Terminal Attack Controller), GPS, UAV, Infantry*

1. INTRODUCTION

Modern warfare has evolved due to intensive technology integration through all military systems. High precision ammunition, guided by complex navigation systems and integrated into unique command and control (C2) structure had a pivotal role in operational success, force protection and force support in critical moments.

Systems for fire control through last 20 years were developed with increased pace. Their use in operations enabled units to deploy high precision strikes, reducing collateral damage and optimizing costs of operation. Their effectiveness has been proven countless times in operations through Middle East, Africa, Ukraine [1] and Nagorno-Karabakh.

Complexity of these systems arises from their elements which include: observation equipment – land devices (optical, color camera, passive or thermal) or air systems (drones, aircrafts, helicopters, etc.) [2], communication equipment (radio systems), software with user interface (UI) to quickly gather, prepare, send data to command element and to distribute target package to fire support unit, fire support assets - artillery or close air-support (CAS) and human element – high performer in tactical thinking and accurate equipment usage.

Through this study, all of above mention elements will be presented in order to structure existing equipment in unique fire support system that will unite the actions of company forward observers (FO), tactical air control parties (TACP) and joint terminal attack controllers (JTAC).

Additionally, this paper will analyze data required to standardize forms for requesting fire support in order to reduce time needed to analyze target, prepare and deploy fires. This standardization makes troop training easier, enables quick reaction, less time spent in radio transition and reduces risk of human-made mistakes.

Paper will present in-use equipment capabilities, how to integrate it in infantry tactics based on premium military experiences. Starting point will be targeting cycle and its implementation in military operations and units' organization. Literature analyzed represent both domestic and foreign academic researches on similar topics, foreign field manuals, tactical procedures and technical overviews, equipment user manuals and on-field usage analytical reviews. This comprehensive approach will offer insights into optimizing fire support systems for future military operations. The goal is to enhance the efficiency and effectiveness of military operations by leveraging advanced technology and standardized procedures. Ultimately, this study aims to contribute to the ongoing development and refinement of modern warfare tactics.

2. TARGETING PROCESS

A target is an entity or object that performs a function for the adversary, considered for possible engagement or other action [3]. Targeting is the process that matches the target with an adequate response to achieve desired effects. In an operational context, fire may be placed to

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deceive, defeat, degrade, delay, deny, destroy, destruct, disrupt, divert, exploit, interdict, neutralize, or suppress a target. The targeting process includes a series of activities as shown in Figure 1.

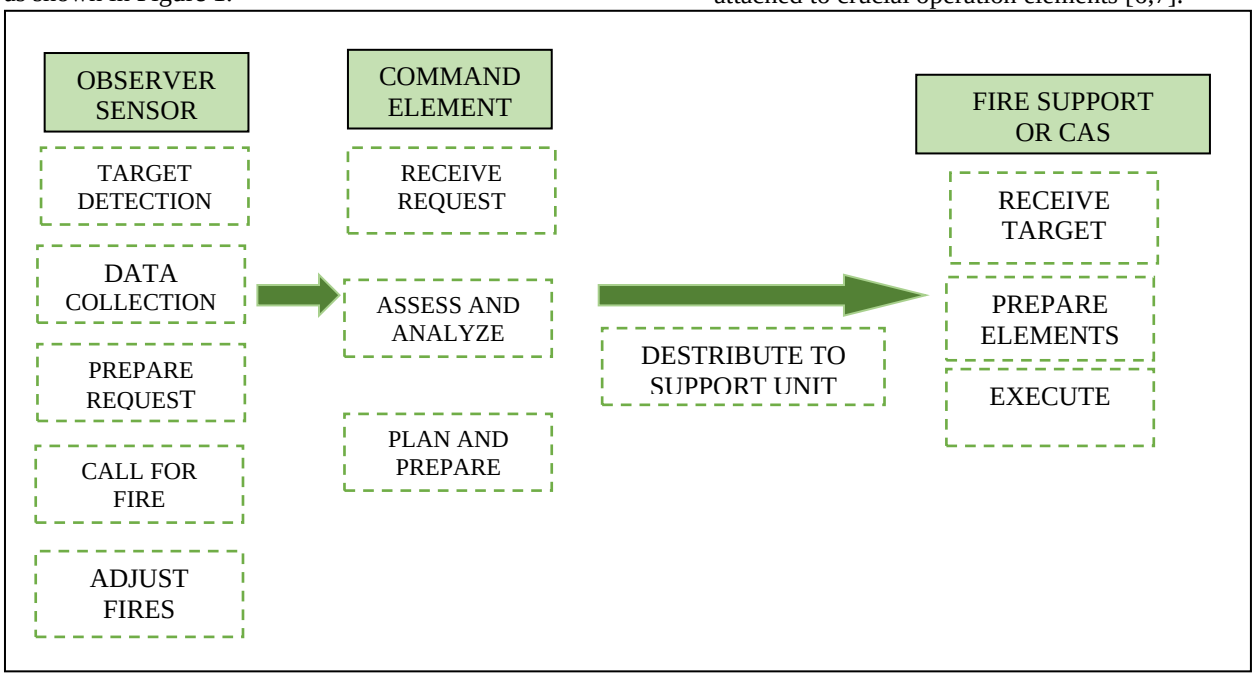

Figure 1. Targeting process

The first step for a unit in contact is to detect the target. The detection method depends on the tactics and equipment used, which can vary widely. Sensors used for detection can be either human or technical, each having its own advantages and limitations. Human sensors rely on trained personnel such as forward observers, TACPs, and JTACs, who use their skills and experience to identify and verify targets. Technical sensors, on the other hand, include a range of equipment such as optical instruments, camera systems, drones, and other reconnaissance technologies. These devices enhance the detection capabilities by providing real-time data and broader surveillance coverage. Effective detection is critical, as it sets the foundation for subsequent steps in the targeting process, including identification, tracking, and engagement of the target. The integration of both human and technical sensors ensures a comprehensive approach to targeting, enhancing accuracy and effectiveness in various combat scenarios.

3. OBSERVER ELEMENT

Human sensors are experts who completed extensive training in classic infantry tactics, weapons, observation equipment, fire support navigation tactics, communication systems, etc. Depending on asset they are guiding, these soldiers may be:

- Forward Observers – usually one on platoon or company level trained to guide fire support assets up to brigade level [4],
- Tactical Air Control Parties (TACP) – Airforce experts in navigating and guiding Close Air Support (CAS). They are usually attached to decisive operation battalion or brigade [5].
- Joint Terminal Attack Controllers (JTAC) – experts in navigating both ground and air support. They are usually within special forces community and are attached to crucial operation elements [6,7].

Technical sensors include following:

- Optical instruments (binoculars, spotters, etc.),
- Camera systems (color, thermal, passive),
- Various radars and
- Drone carried sensors for aerial air reconnaissance[8,9].

Besides listed, following equipment may be used for target data collection:

- Laser pointers (LP),
- Laser range finders (LRF) and
- Navigation systems (GPS, GLONAS, Bei Dou).

Additionally, target or own position marking can be done to distinct enemy and friendly units and setting fire limits and danger zones for Close Air Support with following gear:

- GPS devices,
- Active or IR markers (IR strobes, flashlights, etc.),
- Smoke grenades or
- Other improvised markers.

4. CALL FOR FIRE

Depending on target, call for fire can be planned or emergency. Well planned call is usually done after deliberate reconnaissance of area with purpose to display planned effect on target. It can be done through radio request or through software that supports data transition through sensor – computer – radio – Tactical Operations Center (TOC) [10].

On the other hand, emergency calls are usually made when unit is faced with danger that can cause mass

casualties (MASCAL) and can be put out of battle. These calls are made on moment, usually through standardized forms and protocols via radio communications.

Call for fire support form should minimally include:
– Observer location,
– Target location and
– Fire control measures.

Besides that, standard cards should enable giving as much details as possible about own position, target position, fire mission details in the fastest way possible. Analyzing forms for indirect fire support or close air support of foreign armies on one hand, and having in mind capabilities and procedures of Serbian Armed Forces (SAF) on the other hand, fire call form given below can be used when calling for fire in SAF.

Table 1. Fire support form

"**Command call sign** this is **Observer call sign**, FIRE MISSION – BREAK!"		
My location coordinates	a) MGRS b) POLAR c) OBJECTIVE CODE NAME	"BREAK!"
My position marked with	a) STROBE LIGHT b) IR LIGHT c) SMOKE d) REFLECTIVE PANEL e) NONE	"BREAK!"
Target coordinates	a) MGRS b) POLAR c) OBJECTIVE CODE NAME d) FRONT (LEFT COORDINATE, RIGHT COORDINATE)	"BREAK!"
Target description	a) PERSONEL b) VEHICLE c) OBJECT d) FORTIFIED	"BREAK!"
Target marked with	a) STROBE LIGHT b) IR LASER c) SMOKE d) TRACER ROUND e) NONE	"BREAK!"
Fire control measures	a) ON MY CALL b) ASAP c) CIVIL CLOSE d) DANGER CLOSE	"OVER" or "BREAK!"
Adjust fires	a) PROJECTILE COORDINATES b) VERTICAL DEVIATION (+-) c) HORIZONTAL DEVIATION (left-right) d) REPEAT e) HIT - STOP	"OVER" or "BREAK!"
"**OVER**!"		

This 9 – line form enables both calling for fires and adjusting fires. For example, call can be made like in example below:
"1. **Star** this is **Chamber,** fire mission – BREAK!"
"2. C) ALPHA 15, BREAK!"
"3. A) BREAK!"
"4. D) 34TDQ242344235, 34TDQ242344250 BREAK!"
"5. A) BREAK!"
"6. B) BREAK!"
"7.B) BREAK!"

Adjusting fires can be one like in example:
"1. **Star** this is **Chamber,** fire mission – BREAK!"
"8. b) +30, c) L 20, d) BREAK!"
After adjusting fire, if target was destroyed, call will be made like in example:
"1. **Star** this is **Chamber,** fire mission – BREAK!"
"8. e) OVER!"

5. COMPARATIVE ANALYSIS OF COMMON INFANTRY TARGET ACQUISITION EQUIPMENT

The following table provides a comparative analysis of common infantry target acquisition equipment, focusing on three widely used systems: Vectronix Moskito, Sagem JIM, and DJI Matrice 30T. Each of these devices offers unique capabilities and features suited for different operational needs. This analysis aims to highlight the strengths and limitations of each system, providing a comprehensive overview for military personnel to make informed decisions regarding their deployment and use in various combat scenarios.

Table 2. Comparative analysis of common infantry target acquisition equipment

	VECTRONIX MOSKITO	SAGEM JIM	DJI MATRICE 30T
Platform	land	land	UAV
Operators number	1	1 regular, 2 for RC	2
Observation method	optical, passive NVG	day camera, thermal	day camera, thermal
Thermal capabilities	-	IR	IR
LRF	<4000 m	not restricted	not restricted
LP	no	yes	yes
Navigation	GPS	GPS	GPS, GLONAS, Bei Dou
Digital compass	64-00 360°	64-00 360°	360°
Zoom	none	x2, x4	5-16x optical
Resolution	-	standard and high	up to 8K
Memory	none	300 img with	adaptable to user needs

		standard resolution	
AI integration	none	none	flight assistance, tracking
Remote control	not available	available with RC station	operated from distance
Data transfer capabilities	none	RS 422 to RC-PC-radio	RC-PC-radio
Jamming resilience	resilient	resilient	high risk of jamming
Versatilities	not restricted	not restricted	open space required for takeoff and landing
Mobility	compact, easily carried	low restriction	need vehicle transport

Criteria given above are related to tactical requirements of infantry units. Additionally, few criteria can be added and considered, but should not be crucial. Those are:

– Ease of use,
– Training duration and
– Purchase and maintenance price.

These criteria are important, but compared to systems capabilities and their effect on operational success are minor.

All systems require technical knowledge. User interfaces of all three systems given in analysis are friendly oriented, easy to navigate and comprehensive. Users should not have any trouble navigating through menu and options in each one of them. Functions are well displayed, and user manuals are simple.

According to that, technical training should not be long, theoretical, but more practical oriented, short and intensive with hands-on principle.
Having in mind complexity of the system, its functions and capabilities, training should be recommended as following:

– SAFRAN VECTRONIX Moskito: up to 2 days,
– SAGEM JIM: up to 4 days and
– DJI MATRICE 30T: up to 7 days.

These recommendations are long enough to cover basic theoretical knowledge needed to display technical understanding of device on one hand and cover and rehearse all device functions on the other hand. It is important to emphasize that these recommendations are technology – wise, meaning that they not include tactics and system integration training, which are equally crucial for operational effectiveness and require additional dedicated training programs.

Complete training program for FOs (troop), TACPs (air force) and JTACs (special operations) usually vary from 5 days for FOs, up to 6 months for special operation forces JTACs [11].

Costs of given systems are divided into procurement costs and maintenance costs.

In order to maintain listed devices, armed forces should provide adequate training for their maintenance personnel, purchase tools and reserve part needed to function the system.
Procurement costs are given in table below:

Table 3. Commercial device prices

		PRICE (EUR)
DEVICE	**Moskito GPS XR5**	25.000 €
	Sagem JIM	27.000 €
	MATRICE 30T	9.888 €

All prices are collected from commercial store websites. Although DJI Matrice 30T provides better quality reconnaissance, detection and acquisition capabilities, its price is significantly lower than other two devices because its commercial purpose. Sagem JIM and Safran Vectronix Moskito are military devices that provide better characteristics in terms of materials used, durability, survivability and resilience.

This analysis support statement that all mentioned devices have large capacity when it comes to operational employment. Their limitations and needs of infantry units are determinators of fact in which unit these systems should be deployed.

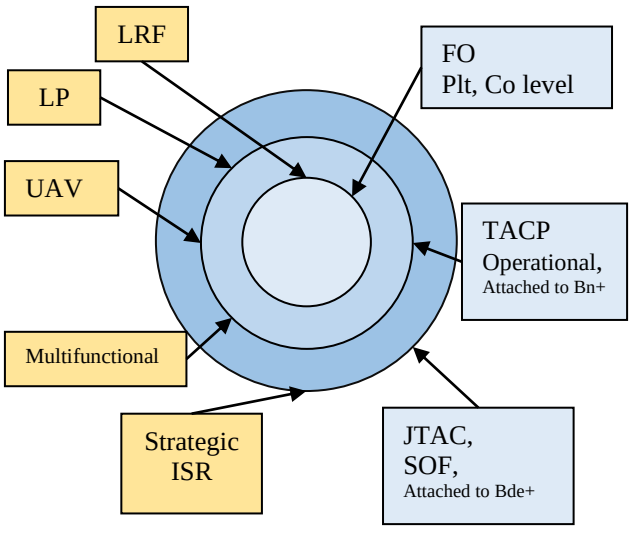

Figure 2. Fire control equipment deployment

As given in Figure 2, all platoon and company level fire observers should be equipped with at least GPS laser range finders. This provides them enough data to guide field indirect fires including mortar and artillery fires.

On battalion and above level, there should be at least one tactical air controller attached. Battalions that are conducting decisive operations should have at least 2 TACPs. If battalion is conducting shaping operations, and CAS is approved, at least one TACP should be attached to it. These airmen, among LRFs should be equipped with laser pointers to show enemy positions, strobes or other similar gear to mark own position in order to evade friendly fire.

JTACs are masters of all fire call disciplines and they are

proficient in guiding both indirect fires and CAS. These operators are attached to decisive operation brigade combat teams and similar operations, or they are just conducting special forces missions as guidance assets within their own teams. In support to their field activities, there should not be equipment restrictions.

When all of above fire control operators and equipment fail, strategic ISR assets should be deployed to deal with complexity of situation [12,13]. Additionally, incorporating real-time data analytics and machine learning algorithms could further enhance the accuracy and responsiveness of fire support operations, ensuring that units are better prepared to adapt to dynamic combat environments. This integration of advanced technologies will be crucial in maintaining a strategic edge in future conflicts.

Moreover, continuous training and adaptation to new technologies will be essential for maintaining operational readiness. Collaboration with technological industries to develop and refine these tools will also be a key factor in future advancements. Lastly, fostering interoperability between different branches of the military and allied forces can enhance the overall effectiveness and efficiency of fire support systems, leading to more coordinated and successful missions.

6. CONCLUSION

The evolution of modern warfare has been significantly influenced by the integration of advanced technology into military systems. Fire control as operational capability significantly contributes to the operational success. This paper highlights the fact that fire control as operational capability can be developed not only by using sophisticated equipment, but also necessarily by training professional operators to conduct various tasks related to targeting process.

A comparative analysis of common infantry target acquisition equipment highlighted the strengths and limitations of devices such as the Vectronix Moskito, Sagem JIM, and DJI Matrice 30T. Each system was evaluated based on tactical requirements, ease of use, training duration, procurement and maintenance costs. While commercial devices like the DJI Matrice 30T offer advanced capabilities at a lower cost, military-specific devices like the Moskito and JIM provide superior durability and resilience. All of presented systems have extensive potential in fire control missions when completed with precise tailored training.

Future research should focus on further refining of these systems in order to increase their resilience against jamming, improving the interoperability of different devices, and developing more intuitive user interfaces to cut training durations. Additionally, studies should explore the integration of emerging technologies such as artificial intelligence and machine learning to enhance the targeting process and decision-making capabilities of fire support units. Such advancements will ensure that military forces continue to maintain a strategic advantage in complex operational environments.

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