

DEVELOPMENT OF AUTOMATED ARTILLERY FIRE CONTROL SYSTEMS

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The development of Automated Artillery Fire Control Systems (AAFCS) is currently at the leading edge of military-technical progress. The transition from "paper" maps and voice commands to digital ecosystems is defining the character of modern conflict. In the context of contemporary counter-battery warfare, the time from target detection to the first shot has been reduced from tens of minutes to mere seconds. An AAFCS is a complex of hardware and software tools that provides automation for reconnaissance, firing data preparation, and unit fire control.

When examining the evolution of these systems, they can be conventionally divided into three generations:

Generation I (1970s–80s): The era of the first electronic computers. Partial automation of calculations was introduced (e.g., the Soviet Mashina complex, the American TACFIRE).

Generation II (1990s–2000s): Integration of GLONASS/GPS, laser rangefinders, and digital radio stations into hardware and software suites (e.g., Kapustnik-B, AFATDS).

Generation III. There is a fundamental shift toward network-centric systems. An artillery battery is no longer viewed as an isolated unit, but as a node within a shared network that receives data from any available reconnaissance asset. Full integration with UAVs (Unmanned Aerial Vehicles) is occurring. Drones have become the "eyes" of the system, transmitting coordinates in real time via data link protocols such as Link 16 and specialized AWS (Automated Workstations).

The implementation of Artificial Intelligence (AI) allows for:

Target prioritization and automated pattern/object recognition.

Dynamic fire mission distribution among guns to achieve maximum operational effect.

Furthermore, high-precision 3D terrain models are widely used to account for topography during trajectory calculations. The systems also provide real-time automated tracking of barrel wear, propellant temperature, and atmospheric parameters.

The use of Artificial Intelligence (AI) in modern AAFCS transforms artillery from a means of "area suppression" into a tool of "surgical precision." This represents a transition from simple computational automation to intelligent decision support.

Traditional systems require the operator to manually identify targets via the UAV video feed; however, AI (computer vision neural networks) performs this automatically.

Algorithms can isolate camouflaged hardware against backgrounds of dense vegetation or urban development. The system instantaneously distinguishes a tank from a truck or a decoy, assigning a strike priority to the object based on pre-programmed doctrine. Furthermore, it automatically maintains a target lock even during maneuvers or brief periods when the target is obscured from view.

In high-intensity combat conditions, there may be dozens of targets but only a few batteries. AI solves the "target prioritization and weapon assignment problem" in real-time. The system evaluates which gun has the best firing angle, a sufficient supply of the required ammunition type, and the lowest risk of receiving counter-fire. AI can distribute targets across different types of assets—for example, assigning some targets to MLRS (Multiple Launch Rocket Systems), others to howitzers, and the remainder to FPV drones—to achieve maximum damage with minimum ammunition consumption.

AI is capable of accounting for non-linear dependencies that are difficult to describe using classical firing tables. The system analyzes the deviation of each previous shot (miss-based correction) and introduces micro-adjustments into subsequent ones, factoring in instantaneous changes in air density or the barrel wear of a specific gun. It cross-references data from various sensors across the battlefield to construct a dynamic wind map at different altitudes of the projectile's trajectory.

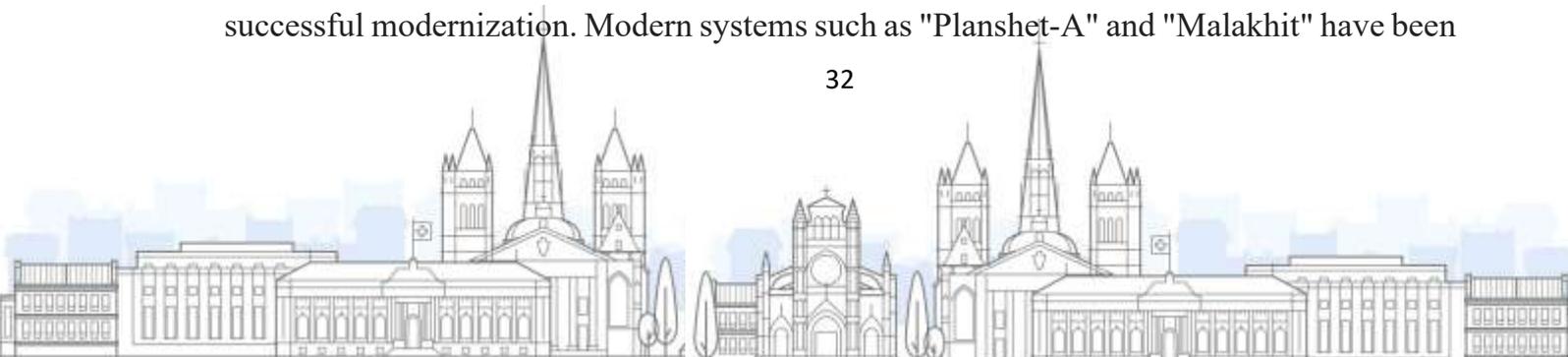
At the same time, the reaction speed of AI is critical for unit survivability. Upon receiving data from acoustic sensors or counter-battery radars, the AI calculates the coordinates of the enemy's position within milliseconds and generates a flight mission for a retaliatory strike. The system calculates the optimal withdrawal route for self-propelled artillery units immediately after completing a fire mission, minimizing time spent at the firing position.

At the same time, such complexes have their own drawbacks. Among these are the vulnerability of digital control channels to hacking and interception, as well as the necessity for systems to function under conditions of total satellite navigation and radio communication suppression. An adversary may utilize "adversarial attacks" against neural networks, providing visual interference that forces the AI to erroneously classify a civilian object as a military one.

A difficulty arises in verifying exactly why the AI made a specific decision in a combat environment. Furthermore, there are increasing requirements for the technical literacy of the crews operating such systems and complexes.

Nevertheless, the world's leading militaries continue to expand and refine their hardware and software capabilities in this field.

In the Russian Federation, the 1V12 and 1V17 control complexes have undergone successful modernization. Modern systems such as "Planshet-A" and "Malakhit" have been



developed, with their distinguishing features being high electronic counter-countermeasures (ECCM) and the ability to operate under total GPS suppression.

Within NATO forces, the American AFATDS (Advanced Field Artillery Tactical Data System) and the German ADLER have been deployed. Their primary emphasis is on interoperability within the framework of NATO standards.

When examining the characteristics and operations of various AAFCS, one can highlight the difference in approaches: ranging from deep integration into a digital battlefield (NATO) to a focus on jam-resistance and mobility (Russia).

Characteristic	AFATDS (USA)	Planshet-A / 1V198 (RF)	ADLER III (Germany)	TOPAZ (Poland)
Developer	Raytheon	VNII Signal	ESG	WB Electronics
Command Level	Battery to Corps	Individual gun to Battalion	Platoon to Battalion	Individual gun to Regiment
Reaction Time (sec)	30–60 (Networked)	30–40 (via UAV)	~45	20–30
UAV Integration	Full (MQ-1, RQ-7)	Full (Orlan, Eleron)	Integrated with KZO/Aladin	Deep integration (FlyEye)
Transmission Channels	Satellite, Link 16, VHF	Secured HF/VHF, Satellite	NATO Data Bus	Radmor Radio Stations
Key Features	Interoperability with all NATO members	EW-resilient, portable man-pack version	Automated ammunition logistics	Modularity, intuitive interface

Based on the analysis of the table, the following conclusions can be drawn:

Optimized Response Time: Modern systems, such as the Polish TOPAZ, demonstrate minimal reaction times. This is achieved through a narrow specialization in digital data exchange protocols directly between the commander and each individual gun crew.

Autonomous Resilience: The Russian "Planshet-A" system stands out for its ability to operate in a fully autonomous mode on individual tablets. This capability is critical when central communication nodes are suppressed by Electronic Warfare (EW) assets.

Integration Depth: The American AFATDS remains the benchmark for integration depth. It enables artillery units to receive target designations directly from Joint Terminal

Attack Controllers (JTACs) or naval platforms, bypassing intermediate headquarters and significantly shortening the "sensor-to-shooter" link.

REFERENCES

1. Military-Technical Doctrine of the Russian Federation (pertaining to the development of Rocket Forces and Artillery).
2. Babichev, V. V., & Kobylin, V. V. "Prospects for the Development of Automated Artillery Fire Control Systems." Army Collection (Armeysky Sbornik) Journal, No. 4, 2021.
3. Ivanov, S. A. Network-Centric Warfare: Principles, Technologies, Examples. Monograph, Moscow: Voenizdat, 2019.
4. U.S. Army Field Manual FM 3-09 "Fire Support and Field Artillery Operations." Washington, D.C.: Department of the Army.
5. Technical Manual for AFATDS (Advanced Field Artillery Tactical Data System) – Declassified reports from the RAND Corporation research center.
6. Articles and reviews from the "Fatherland's Arsenal" (Arsenal Otechestva) portal regarding the digitalization of battlefield management (2023–2025).