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The Use of Emerging Disruptive Technologies by the Russian Armed Forces in the Ukrainian War

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The Russian Ministry of Defence, on 18 March 2022, reported that Russian forces had used Kinzhal hypersonic missiles[1] and destroyed an underground depot for missiles and aviation ammunition in the village of Delyatina in Western Ukraine. US officials also confirmed the use of hypersonic missiles[2]. According to US officials, the launch aimed to test weapons and send a message to the West about Russia's military capabilities.

This article discusses available Russian hypersonic missiles and reviews other Russian military capabilities used in military operations in Ukraine that potentially use emerging disruptive technologies.

1. Russian hypersonic missiles

First of all, it should be mentioned that hypersonic weapons are considered one of the disruptive technologies used in warfare, alongside such technologies as artificial intelligence, autonomous systems, big data, quantum technology, biotechnology, and novel materials[3].

Hypersonic missiles fly at a speed of at least Mach 5 or five times the speed of sound. There are two categories of hypersonic weapons: the first, when the rocket carrier carries the hypersonic glider and detaches from the carrier during flight, and the second when the rocket itself is hypersonic and is driven by high-speed engines throughout flight. Unlike ballistic missiles, hypersonic weapons do not follow a parabolic ballistic trajectory and fly at hypersonic speeds. They can manoeuvre freely en route to the target, making them more challenging to detect and destroy in flight[4].

Russia currently has two types of hypersonic missiles in use today and is developing a third type of hypersonic weapon to carry nuclear warheads: the Avangard, Kinzhal, and 3M22 Zircon. The Avangard is a hypersonic glider launched from a ballistic missile, such as the SS-19 Stileto, SS-9 Scarp, and SS-X-29 Sarmat. According to Russian news sources, Avangard began combat duty in December 2019. The Russian army's arsenal was supplemented by the air-launched hypersonic rocket Kinzhal in December 2017. The Kinzhal can be launched from the TU-22 bomber or the MIG-31 fighter.

Zircon, meanwhile, is a hypersonic cruise missile that is currently undergoing testing and should be operational in 2023[5].

The Kinzhal missile can also be used to destroy satellites in low earth orbit. It is estimated that the Kinzhal missile flies up to 2,000 km in distance and can reach altitudes up to 1,500 km. After intensive testing and the acceptance of the Kinzhal missile into the arsenal of the Russian army in 2017, it was used twice: in the Arctic region in 2019 and Syria in 2021. In both cases, the missiles were launched from the MIG-31 fighter jet. The total number of Kinzhal missiles produced is unknown.

 [6]

A MiG-31 with a Kinzhal hypersonic missile payload being flown over Moscow during the 2018 Moscow Victory Day Parades, 9 May 2018.

It should be noted that not every Russian MIG-31 fighter can carry a Kinzhal missile. A specialized version of the MIG-31K has been developed for this purpose[7]. The Russian Air Force is estimated to have up to 10 modernized fighter jets dedicated exclusively to this task[8]. The TU-22M3 bomber can carry four Kinzhal missiles. However, it is believed that no tests have been carried out from this platform[9].

The Russian army has a vast arsenal of non-hypersonic air-to-ground missiles, so the use of the Kinzhal missile in the war in Ukraine had more symbolic than practical significance. Russia likely uses both the Avangard hypersonic missile and the ship-launched hypersonic cruise missile Cirkon to boost the word about the effectiveness of its hypersonic weapons.

2. Use of other military capabilities in the Ukrainian war that have disruptive technologies

Russia has made significant progress in artificial intelligence and autonomous weapons systems, where several Russian institutes and military industries specialize[10]. However,

a detailed analysis of the military equipment used by the Russian military in Ukraine reveals that only a small part of created and tested concepts that were presented publicly are used in practice. Even systems, prior widely used in Syria, are not intensively used in Ukraine. These disruptive technologies are not numerous and have not reached the required level of maturity.

2.1. Use of unmanned aerial vehicles (UAVs)

Russia currently uses a small number of UAVs in Ukraine due to several factors. Firstly, Russia's planned military operation was to last three days, and no high resistance was expected, so the deployment of the UAVs was minimally planned due to the very high pace of the operation. Secondly, the demonstration of the successful air defence of Ukraine and electronic warfare (EW) against UAVs influenced the choice of the commanders of the Russian army. Also, the targets attacked by Russia are located throughout the entire territory of Ukraine, so the technical characteristics of the available UAVs do not allow them to support the operations at such depth and frequency. Russia's use of UAVs will likely intensify in the near future, as the war is slowly becoming static. The importance of these systems in combating positional warfare has been repeatedly demonstrated.

The Russian-made kamikaze UAV KUB-BLA was used in hostilities in Ukraine near Kyiv[11]. The operation of KUB-BLA is based on artificial intelligence algorithms, so it can autonomously identify the target and destroy it. The KUB-BLA has also been tested in Syria, where it has carried out many successful operations. The KUB-BLA is a hard-to-detect UAV that can fly up to 40 km, has a flight speed of up to 130 km / h, and can carry an explosive charge that weights up to one kilogram[12]. UAVs could be used to destroy unarmed or lightly armoured targets and create a surprise effect.

There were multiple reports and pieces of evidence that the Russian army in Ukraine uses UAV Orlan-10 and Inokhodets (Orian) intensively which also have disruptive technologies.

The Orlan-10 entered service in the Russian army in 2010. The UAV is modular, equipped with multiple cameras and other sensors. In 2020 Orlan-10 was upgraded with a laser designator. The Orlan-10 is often used with Russian long-range artillery and is also fit for ISR missions; it is a small UAV, with a wingspan of 1.8 m., it can fly up to 18 hours at 70-150 km / h. There has been a total of 14 Orlan-10 destroyed in the conflict so far[13]. Furthermore, the modules could be composed of a day-light camera, a thermal imaging camera, a video camera, and a radio transmitter in a gyro-stabilised camera pod that is fitted under the fuselage. The cameras provide real-time intelligence, 3D maps, surveillance, and aerial reconnaissance of ground-based targets. The imagery, video, and other sensor data collected by the payloads are transmitted to the ground control station in real-time, through a data link using 3G/4G cellular network. Optionally, the Orlan-10 is fitted with EW capability and can differentiate between friendly and enemy means of transmitting the information. It can mount interference transmitters and set up zones for cellular jamming[14].

 [15]

A Russian soldier prepares the Orlan-10 for launch during the Russian invasion of Ukraine, 30 March 2022.

Meanwhile, the Inokhodets is a medium altitude and long-range (MALE) tactical UAV. So far only one has been lost by the Russian army in Ukraine. The Inokhodets' maximum payload weight is 200 kg., it can fly at an altitude of 7.5 km, for a maximum of 24 hours with a speed of up to 200 km / h. The Inokhodets UAV is fitted with radar mounted at the rear. It also has an electro-optical, laser target finder, and infrared camera. The UAV is used for ISR and combat missions. The Inokhodets can be fitted with the 9M133 Kornet (AT-14 Spriggan), the second-generation man-portable anti-tank guided missile, which is used to destroy armoured vehicles and tanks. The UAV is capable to detect targets at a maximum range of 96 km and can fire a missile at a range of 4 km from the target[16].

 [17]

Russia's Orion UAV (also known as Inokhodets) on display, 29 August 2020.

As the war enters its second phase, meaning the Russian forces start focusing only on the Donetsk and Luhansk Regions, the usage of UAVs will intensify. Most likely we will see Altius, Forpost, and Volk-18 UAVs that are using artificial intelligence for ISR missions to detect and recognize targets and conduct autonomous operations.

So far, there are no signs that the Russian Navy is using its unmanned naval vessel Kadet-M, Intercontinental nuclear-powered nuclear-armed autonomous torpedo Poseidon, or unmanned underwater vehicle Galtel. Similarly, there are no indications from land forces that available unmanned ground vehicle Udar[18] is being used in the war. The Udar was developed on the basis of the BMP-3 infantry fighting vehicle, and the Marker, which was just recently upgraded with the ability to autonomously communicate with a group of ground robots[19].

It is likely, that unmanned ground and underwater systems are not being used at all because they are not fully developed and have limited interaction capabilities. Furthermore, legacy systems prove to be efficient at the current pace of war.

2.2. Other platforms with AI and autonomous capabilities

The Russian Federation aimed to supply the Navy with large patrol ships, capable of patrolling, monitoring, and protecting open and closed seas. So far, six ships were built under Project 22160, which was launched in 2014 aiming to reduce crew through automation and AI. The ship Vasily Bykov, one of three ships available in the Black Sea, participated in the attack on Snake Island on 24 February 2022 during the first day of the Russian invasion of Ukraine[20].

The T-14 Armata tank is another platform capable of autonomous combat operations which could be used as a testbed for unmanned tank technology. The tank features fully digitized equipment, an unmanned turret, and an isolated armoured capsule for the crew. So far, there is no evidence of T-14 Armata being used in Ukraine. Furthermore, there are already clear indicators that sanctions would hamper the production of T-14 Armata[21].

There were attempts to augment the on-board information management and target recognition of aircraft Su-35S and MiG-35 with AI. Only the Su-35S is engaged in the war. So far, one Su-35S was hit by Ukrainian air defence near Izium, in eastern Ukraine. The Su-35S aircraft featured thrust-vectoring, radar-absorbent paint, Irbis-E passive electronically scanned array radar, IRST (Infra-Red Search and Track), the Khibiny radar jamming system, the ultra-long range R-37M air-to-air missile, and a Kh-31 anti-radiation missile[22].

Additionally, the Russian army is using AI for the targeting automation artillery system. The MSTA-SM, manufactured by Rostex, has a new digital fire control system that allows increasing the rate of fire to 8-9 rpm. It has an improved land navigation computer that minimizes the time to input firing coordinates and therefore can open fire within 30 seconds from standby. The MSTA-SM has been used intensively in the war[23].

AI is also used in the anti-personnel mine POM-3 Medallion, which facilitates an autonomous target identification and activation. The POM-3 uses a seismic proximity fuse to detect human footsteps, based on vibrations proximate to the mine and comparing this data with seismic signatures in the munition's on-board catalogue. If the vibrations are similar enough to the correct seismic signatures in the landmine's memory and have sufficient and increasing amplitude (indicating movement towards the mine), the munition is triggered. The use of anti-personnel mine POM-3 by the Russian army in the Ukraine war has been confirmed in several locations[24].

[25]

A Russian POM-3 mine on display at an Army Exhibition, 23 August 2020.

2.3. Command and Control Elements

Similar to the USA joint all-domain command and control (JADC2) concept, Russia has its own national defence management centre (NDMC) system. The goal of NDMC is to move data seamlessly between air, land, maritime, space, and cyber forces in real time. The NDMC was designed to receive information from the lowest military unit levels, and, following analysis and evaluation, feed the data directly to those at the strategic level. The outcomes of the first phase of the Ukraine war indicate that data from the lowest military unit was not processed within NDMC and the outputs were not brought at the strategic level[26].

Furthermore, there were no indications that the following systems utilizing AI were used at war: AquaHranitel developed by Formosa System, enabling oversight of Maritime domain; ACS of the Russian Military, developed by Ministry of Defence to be used as a system of systems for managing battlefield information; Aircraft management system Kasatka, developed by RadarMMS, for greater autonomy in aircraft, helicopters, and drones[27].

In terms of EW, besides the legacy and the updated systems, the Russian army is using the Bylina EW system, built by Ruselektronics, that applies AI to conduct ISR, information operations, and autonomous EW operations. The Bylina is also capable to degrade and jam communications satellite transmissions[28].

2.4. Air defence systems

The Pantsir-S air defence system, is one of the few systems that has been deployed to Ukraine. The Pantsir-S is used to shoot down attack drones, GRAD and Tochka-U missiles, and is enabled by AI for greater autonomy in air defence operations[29].

Only a few weapon platforms possessing emerging disruptive technologies are observed on the battlefield in Ukraine. The most popular type remains UAVs, however, augmented legacy systems with AI remain widely used as well. Definitely, modest improvements brought by AI were not designed to increase the lethality of the weapon or system itself, but rather to provide enhancement allowing to narrow the decision-making cycle, find and indicate targets faster, or provide more automated solutions to deal with data.

Implications for NATO

There are relatively few systems enhanced by emerging disruptive technologies used by the Russian army in the war with Ukraine. Instead, Russian Forces are using legacy systems in combination with a few novel elements, like hypersonic missiles, UAVs, radars, or artillery automation systems that enable accurate surveillance on the target and target's elimination. The reason for this is mainly the availability and maturity of the systems. Sanctions in a long-term perspective would most likely impact the pace of development of weapons augmented with emerging disruptive technologies used by the Russian army.

Regardless of the fact that Russia has multiple EW capabilities, it has not performed well as Ukrainian forces are capable to command and control units. Decentralization of C2 elements, usage of normal mobile phones, and utilizing landlines are a few examples of successful counteraction implemented. It is clear that Russians did not do proper management of electromagnetic spectre, as some of their jamming is interfering with friendly communications.

Hypersonic weapons represent the biggest challenge at the moment as they can accommodate a nuclear charge, and can arrive at the target within a limited time and via unpredictable trajectory. As a result, surveillance, tracking, and counter missile systems should be augmented or reinvented to decrease the risk posed by a new type of weapon. Technologies such as directed energy weapons, particle beams, and other non-kinetic weapons offer the biggest potential for an effective defence. Cyber and electronic attacks could significantly degrade the effectiveness of weapons. In terms of detection, a network of space-based satellites and dispersed sensors would be required, which would also be linked with JADC2.

It seems that the Russian intent to utilize a central defence management centre has failed, therefore the USA and NATO countries, enthusiastic about multi-domain operations, have to consider some lessons learned while implementing its JADC2 concept. The focus should be given while connecting firstly all necessary sensors and effectors at divisional or even lower levels. Also, the system's operational functionalities in peacetime would be different from the ones required in wartime.

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End Notes

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