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THE INTEGRATION OF UNMANNED AIRCRAFT SYSTEM (UAS) IN CURRENT COMBAT OPERATIONS

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ABSTRACT
The accelerated evolution of Unmanned Aircraft System (UAS) leads to the need to integrate UAS into operations, sometimes with unexpected results. In particular for special operations forces, reconnaissance, surveillance and deep precision strike, will remain main missions for which the utilization of UAV it is becoming critical. Whether we talk about missions such as: direct actions, objective security, force close protection, Imagery intelligence (IMINT) close fire support, maneuver, or combat resupply, UAS can cover a large spectrum of potential missions. However, when integrating UAS in military operations, the most intriguing developments are the impacts on the decision-making process, on the balance between the human factor and artificial intelligence, on force structure design.

KEYWORDS: Unmanned Aircraft Systems, Unmanned Aerial Vehicles, Artillery Systems

1. Introduction

NATO will continue to support, assist a stable, independent Ukraine, and condemn Russian Federation's aggressive, unlawful actions. On daily basis NATO is monitoring the war situation in Ukraine but also a wide range of warning indicators, essential elements to forecast offensive Russian operations or even escalation/ provocations toward all the countries in the region. *"Our world is contested and unpredictable. The Russian Federation's war of aggression against Ukraine has shattered peace and gravely altered our security environment ..."* (NATO Strategic Concept, 2022).

It is critical for any deterrence and defense concept to have simply enough defined the strategic and operation objective and end state. The main objective represents collective defense of the alliance, to safeguard the territorial integrity and stability of the Alliance, three major tasks (defense, prevention, cooperation) being deduced from this objective. Every task is divided in sub-tasks with line of effort and clear responsibilities.

"Our new Strategic Concept reaffirms that NATO's key purpose is to ensure our collective defense, based on a 360-degree approach. It defines the: deterrence and defense; crisis prevention and management; and cooperative security. We underscore the need to significantly strengthen our deterrence and defense as the backbone of our Article 5 commitment to defend each other" (NATO Strategic Concept, 2022).

For achieving the end-state of *Alliance's three core tasks the force restructuring and modernization is necessary.* Here starts the role of emerging

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technology which can provide the sufficient advantage over the opponent. Emerging technology is a two face coin. Falling into the wrong hand emerging technologies become disruptive technologies. In order to survive, a modern force has to know, operate or counter both types of technologies.

2. UAVs – an Emerging Technology in NATO

No doubt the modernization of NATO forces is a priority, and addresses several areas, such as: *"readiness"* built up, force digitization, connectivity and communications security, Cyber defense, *expeditionary role*, deep strikes integration, JSTAR (*Joint Surveillance Targeting Acquisition Reconnaissance*) integration at all operational levels. Last mentioned objective implies the necessary integration of modern UAS in operations in parallel with standardization of counter UAS measures.

It is widely accepted that missions like: *reconnaissance, surveillance and precision deep strikes* are also certified UAS main missions. Surprisingly, new areas of integration are emerging, such as: *applications for autonomous land and sea systems, resupply, maneuver, fire coordination, communication, mine hunting etc*. The need for UAS integration operational plans leads directly to organic standardization of ISR (*Intelligence, Surveillance, and Reconnaissance*).

As appropriate response for an effective situational awareness in the SACEUR AOR (*Area of Responsibility*), in 2020, SACEUR declared Initial Operational Capability (IOC), of NATO component AGS (*Aerial Ground Surveillance*) in Sigonella, Italy (Stoltenberg, 2019).

2.1. Current Trends for Development of Unmanned Aircraft System

"Changes of waging modern unconventional warfare are necessary in order to achieve long term results. These changes are regarded as: commitment of proper forces, technological advancement multiplication of internal defense, an irregular thinking revolution, decentralization of command and control, and a profound understanding of a dual – political and military leadership (matrix-network type of organization)" (Iancu & Ciolponea, 2007).

Throughout history, the evolution of military systems has changed the physiognomy of war, doctrinal guidelines, tactics and procedures. In recent decades, such a major technological breakthrough has been foreshadowed in the way modern conflicts will unfold, whether was unconventional or a conventional conflict. The accelerated development of Unmanned Aircraft Systems/UAS, both in the commercial area, and especially in the military industry, creates the opportunity for rapid integration in military actions. Unanimously accepted in the community of UAS, there is the classification of the three important categories according to operating altitude, maximum flight duration, range and payload.

"NATO classifies UAS into three dedicated classes, from Class I for micro, mini, and small, to Class II for medium, tactical-systems, to Class III for medium-altitude long-endurance (MALE) and high-altitude, long-endurance aircraft (HALE). By comparing the three different classes, their application, size and solo operating altitude, it can be concluded that countering this spectrum of UAS requires a multitude of different, class-specific approaches" (Joint Air Power Competence Center, 2021).

Specialists are calling UAVs counter-measures – *effectors*. Thus, passive counter – UAS *effectors* are found in the area of reducing the visual, thermal, infra-red of forces footprint. Complementary active effectors manifest in the area of ensuring no fly zones, active jamming measures, C-RAM, and air-defense architecture.

Moreover, these new tactical missions where tested by different armies, in different conflicts such as Ukraine, Syria, Iraq, Afghanistan. *"Killing targeting"* is a US concept widely used now by modern armies. *"In Idlib, the Turkish Army employed new drones for the first time, field testing its ANKA-S and Bayraktar-TB2 with intensity. Aside from traditional strategic or tactical roles, the UAVs were used to conduct so-called "sniper" missions, liquidating targeted groups and specific persons of interest. For example, Turkish UAVs reportedly liquidated two Syrian brigadier generals, a colonel, and foreign fighters from Hezbollah and Iran in an attack on Syrian headquarters in Zerba, south of Aleppo"* (Urcosta, 2020).

In Afghanistan, integrating ISR platforms in the informational and decision-making cycle from the beginning was a must. This integration brought to light succinctly expressed shortcomings in the construction of the multinational ISR architecture. *"Afghanistan, Pakistan and Iraq are places where the US has used armed UAVs for more than 2 decades with missions to identify and neutralize terrorist groups, the campaign being called targeted killing"* (Bachmann, 2013).

As the campaign in Afghanistan continued, the availability of both manned and remotely piloted ISR platforms improved. This meant that ISR systems could be assigned at the tactical level to combatant units in mission escort, with a direct and noticeable impact in decreasing the response time to the request of troops in contact (TIC) for close air support (CAS). The reverse effect showed up. Ethical and moral dilemmas have impact on international public opinion whenever UAVs become a tool of power to achieve a political objective. Looking from both angles (*blue and red forces*), either when considering a conventional scenario (*similar with the current Russian-Ukrainian conflict*), or unconventional one, (*terrorist attack*), the development of UAS has generally the following trends.

A. Inter-connectivity technological race (longer range is better, but also often requires SATCOM connectivity. Generally, these types of connectivity leave out of the game, small nations and terrorist groups). Connectivity is the first link to be exploited by the opponent in order to counter the UAVs mission. Depending on the visibility the commands to the UAV platform can be transmitted via radio links at the distance of sight (LOS) or beyond the visible horizon (BLOS) through a satellite channel. From this point of view, the connection system between the control station and the platform in flight constitutes the weak link that will be permanently exploited by the adversary, electronic warfare being the method of jamming or blocking communication. In this context, communications become the key element in the information cycle/data collection, but also the other side of the coin, the exploitation of this element for jamming or neutralizing the drone through different methods. Connectivity can be broken through active or passive jamming or through Cyber attacks. Thus, anti-jamming protection on UAVs command module becomes a norm with a *fly home return* feature. In the process of modernizing communication networks, we are witnessing two divergent trends that directly affect both the development and the integration of UAVs in military operations.

The first trend worth mentioning is the need for reaction speed and rapid processing/decision on the battlefield. This connectivity speed ensures the survival of the force or combat platform. The process of selecting critical adversary targets in the battle-space is executed at a rapid pace and is followed in a cycle that ensures a high tempo of kinetic engagement and neutralization of the targeted objectives.

The second trend refers to the protection of the connectivity and even more to the necessity of redundancy integration. Having always a backup plan, it doesn't matter what jamming measures the opponent will apply. The connectivity will be secure and will ensure the rapid target engagement cycle.

Joint integration – "The real advantage of unmanned aerial systems is that they allow the projection of military power without projecting geopolitical vulnerability. Major General David Deptula" (Gusterson, 2012).

Especially, in Ukrainian conflict we could observe the integration of all type of UAVs at tactical, operational and strategic level. UAVs become omnipresent, in this sense.

Consequently, in Ukrainian conflict, we could notice that UAVs were used especially for direct actions of conventional and special operations forces in combinations with other traditional platforms, antitank weapons, antiaircraft missiles, artillery fire, air strikes, ballistic missiles strikes, in all domains (air, sea, land), at all distances, with multiple objectives, for all operational levels. Mission command principle was dominant in this sense, tactical commanders had more flexibility and autonomy in decision process, furthermore could engage simultaneously tactical or operational objective, based on dynamic targeting process and opportunities revealed during active combat. *"By putting swarming robots in the front line, the decision-makers aim to decrease risk, providing vital information to soldiers before they make contact with the enemy, if not allowing them to locate and eliminate opponents before they were get within visual range. However it will be teamed closely with humans and there is no suggestion that Legion-X could engage targets without a human operator's approval"* (Hambling, 2022). *Main hypothesis is inspired by the above arguments and it sounds as follows: the integration of UAS in military operations requires a joint approach, in multiple domains (air, land, sea*, *Cyber, space*).

B. Multi-role function (more and more producers are now integrating the surveillance capabilities with precision strike capabilities. The tendency is to acquire and integrate ***a multi-role UAV*** having a longer range). HALE and MALE UAVs can tip the military balance in a regional conflict by being game players and force multipliers on the battlefield. As the UAV increases in physical size and technical capability, the volume and scale of impact in the area of operations increases exponentially. In addition to the flight platform itself, large-footprint UASs consist of UAV launch and recovery stations (LRUs), ground control stations (GCS), satellite communications equipment, and logistical support systems. Nevertheless, class 1 drones become more versatile, more difficult to intercept on radars, able to carry a wide range of missions. *"Hmeimim Air Base operated by Russia has been under multiple UAV attacks. It is located near Latakia in Hmeimim, Latakia Governorate, Syria, which is very close to the Bassel Al-Assad International Airport. ... the air defense and electronic warfare systems deployed at the Hmeimim airbase shot down or disabled 118 unmanned UAVs during terrorists' attempted attacks on the military facility over the previous two years. The first attack on this airbase was on January 6, 2018 when 13 combat fixed-wing UAVs attacked the base. For some of these UAVs, the control signals were overpowered and control was obtained, while others had to be destroyed by short-range Pantsir-S1 anti-aircraft missiles"* (Chamola et al, 2020).

It is widely accepted that missions like: *reconnaissance, surveillance and precision deep strikes* are certified UAS main missions. Surprisingly, new areas of integration are emerging, such as: *applications for autonomous land and sea systems, resupply, maneuver, fire coordination, communication, mine hunting etc*. *"Today, Class 1 UAS can be an* *effective tool in the hands of SOF groups. The anti-aircraft defense system surrounding the SBADM missile launch facilities, even organized on complementary layers, is insufficient and inadequate to respond to UAS threats – the system must be simultaneously oriented towards force protection and anti-aircraft defense"* (Joint Air Power Competence Center, 2021).

2.2. UAVs Operating in a Network Have a Clear Advantage over Any Defensive System

Without any doubt the most impressive feature of UAVs is the fact they can ***work in a network***. Much easy to integrate at tactical level, the swarm technology could be the *point break of 21st century warfare development. "As technology continues to evolve and so do drones in their capabilities and roles, there are already many innovative new drone concepts that will change warfare forever such as the explosive swarm-attack concept or autonomous drones"* (Kreps, 2016).

Machine learning algorithm, supercomputing capacity is transforming a network of UAVs (*it doesn't matter the size*) in a lethal threat, for any defensive weapon system, to include 5th generation platform. Mass will prevail over developed technology. ***Swarm UAS represents the future of warfare.*** Depending on the commander's intention it is predictable that, by using UAVs in the network – "swarm attack" one could configure different UAS roles: false targets "decoy", target designators, defense penetrators, suicide missions' vectors and precision strikes platforms. As an immediate consequence, engaging UAS (multi-role) in the network – "swarm attack" in order to reach the critical offensive mass, could potentially lead to a saturation level and eventually neutralize any complex, air defense system.

"The swarm has «adaptive, complex, collective behaviors for intelligent movement, decisions, and interactions with the environment», according to the makers. In particular, they are described as having varying levels of autonomy «from remote control to fully autonomous capabilities». Distributed sensing, and sensor fusion means it combines and distills information collected from multiple units, so the operators is not overloaded with information. The swarm can, for example, map buildings or other terrain as it goes through them" (Hambling, 2022).

For UAVs, network integration does not only mean interconnection with the command system and other striking capabilities (missiles, aircraft, artillery systems, AA systems) but especially, instant and secure connectivity with all participating drones. The integration of UAVs in the network opens up a new universe in military terms and leads directly to the orchestration of a military action in two ways: presetting an action algorithm from the planning phase, or adapting the UAV network **(*swarm attack*)** according to the adversary's reaction, quick adaptation provided by each UAV's internal processing power and existing connectivity.

"These small-sized UA can create severe problems for friendly forces on the ground. Their size, small radar and electromagnetic signatures, and quieter operation capability make them difficult to detect and track. ...Identifying the location of the terrorist workshops that produce UA of small size, but with large weapons impacts and their rapid destruction within the scope of AI will allow the friendly ground forces to continue their activities without facing these complex threats on the battlefield. In future Alliance operations against an asymmetric enemy, consideration should be given to attacks against drone workshops like those in the previous examples" (Aksu, 2021). Certainly, the other side of the coin is the race to develop active and passive jamming systems.

Networked drone action inherently brings dilemmas and questions to which the future must identify answers. *"Decentralized approaches allow swarms of drones to spread out to search a wide area or to «deconflict the airspace» to ensure they are not all attacking the same target. An operator directs the swarm to the objective area, and the largely autonomous swarm automatically enters the network to complete the mission. Note that swarms of military drones, unlike light show or flocking bird drones, can be separated over large distances. Even basic swarming makes drones much more efficient than working in an uncoordinated mass. A 2018 US military study suggested the swarm would make attack drones at least 50 % more lethal, while reducing the losses they take from defensive fire by 50 %, but that's just the beginning. «Drones can coordinate their target selection, approach or other angle of attack. For example, in an omnidirectional attack, networked drones hit a target from multiple angles», says analyst Zak Kallenborn"* (Hambling, 2021).

Determining the value of the UAS offensive *critical masses an end state of the present research*. Through modeling, simulation and war-gaming, it is possible to determine the *optimal value of critical mass*, necessary to ensure *saturation level*, of the *"swarm drone attack",* on any type of objective. As an immediate consequence, engaging UAS (multi role*)* in the network – *"swarm attack"* in order to reach the *critical offensive mass*, could potentially lead to a saturation level and eventually neutralize any complex, air defense system. *"Ankara actively promoted Turkey as the first country to employ sophisticated small drones as a swarm in combat. 14 Turkish officials claimed that this military innovation demonstrated Ankara's technological prowess on the battlefield. This swarm of remotely-controlled drones destroyed Syrian bases and chemical warfare depots, as well as air-defense systems"* (Urcosta, 2020). When building the integration design, commanders might take into consideration: current performance of modern UAS, destructive potential of weapons on board, probability of survival, network connectivity simultaneously with the distribution of complementary missions (UAS multi-role) in the planning phase.

The analysis criteria, (*variable coefficients*) required to determine the value of the critical mass of the attack, could take into account: *defense system architecture, performance of air defense installations, impact probability, radio-electromagnetic jamming spectrum, and level of counter-UAS measures.* Other possible side effect, could lead to *reconfiguration of the anti-aircraft defense architecture for modern armed forces*.

Overall, the integration of UAS *could lead to more complex air operations and more demanding air defense tasks.* Approaching developing concepts such as: *"drones swarm attack"* and "offensive saturation level", could become very constructive in empirical research, being examples of *rapid modern warfare adaptation*. *"Israel has always been at the forefront of military drone innovation, and in 2021 used swarming drones in operations in Gaza. Mortar support companies were re-equipped with swarm drones which reportedly gathered intelligence, located targets and carried out attacks on Hamas forces. It also provided targeting information for guided mortar weapons and carried out more than 30 «successful operations» against militants attempting to launch rockets at Israel"* (Hambling, 2022).

The applications of swarm technology are not limited by the type of conflict or by environment. Swarm attacks could be used against military objectives protected by air defense but also against small terrorist groups located in highly dense urban populated areas. Recent operations are proving this thesis. *"Legion-X's tablet* *interface allows an operator to specify an area and assign a number of robots – which can be a mix of different types of aerial drones and ground vehicles – which will navigate autonomously to the area. Importantly for urban operations, it can work indoors as well as outdoors. The video shows a large octocopter drone acting as a mother-ship to small, sensor-carrying quad-copters which take off to explore inside an apartment block. These small drones may be fitted with explosive charges as expendable loitering munitions"* (Hambling, 2022).

3. Technological Adaptation of Civilian Drones for Military Purpose

An important current trend is the utilization of classic civilian UAVs (class 1) for military purpose. This type of adaptation is relatively cheap comparing with complex high-end UAVs, very efficient at tactical level for simple missions like: surveillance, reconnaissance, security. For the resistance movement in eastern-Ukraine, civilian UAVs have the role to confirm enemy disposition and intention and also to perform sabotage by launching artificial ordinance on enemy troops. These type of direct actions where very efficient based on a very short decision cycle, feasible confirmation of target by the UAVs, and immediate engagement of the target.

"The other obvious factor is the rise of cheap commercial drones. These have produced an economical and dispersed web of flying eyes and sometimes bombs, but they have also proven to have limited effectiveness when a modern, fully operational counter-drone defense is up and running. Another problem is that such commercial drones are used by soldiers, civilians, journalists, rescue crews, and many others, introducing the danger of blurring the line between combatant and noncombatant, thereby increasing the risk of putting innocent civilians at risk by making them, arguably, legitimate targets" (Szondy, 2022).

Inspired by the success of civilian's drone adaptation to military scope, some companies decided to develop so called suicide drones. Those are lethal having an impressive fire power, difficult to intercept due to the law radar print and quite precise based on GPS navigation system. On Ukrainian side, we have information about US Switchblades systems, on Russian side more present in the media are the attacks launched by Russian forces with Iranian drones Shahed -136. The demoralizing effect of the waves of Shahed-136 on civilian Ukrainian population is devastating. *"The Iranian-supplied Shahed-136 kamikaze drones which Russia is raining down on Ukraine are often described as swarming drones but this is not quite correct. Although the drones are launched in groups, enough so that some get through even though most are shot down, the drones do not exchange information or co-ordinate their movements like a true swarm. A true swarm involves multiple drones working together as a single, coherent entity, so the whole thing can be directed by one human operator – or let off the leash altogether. Many armed forces are working on this technology including the U.S., China, the U.K., India and Turkey, but with Legion-X, Israel have taken the lead"* (Hambling, 2022).

3.1. The Alteration/Modification of Classical Tactics When UAVs Are Used

One of the most notable developments on UAVs is the fact that nowadays is present in all domains, having multiple missions. ***Tactics were developed*** accordingly, we can find in a UAVs squadron several specializations such as: reconnaissance and surveillance, precision strikes UAVs, loitering ammunition, decoy maneuver UAVs. The decoy drone is intentionally more visible on the enemy radar, attracts more attention in a specific area or direction, often the drone is sacrificed for the success of the mission, it can be armed or not, and also transmit important enemy data before being destroyed, it revels the enemy tactics, capabilities, reserves. In addition to C2 and ISR, the tactical UAV can also perform several resupplies, Medevac, fire support, target illumination, target pinpointing or communications missions. *"UAVs are transforming current campaigns against extremists and enabling an entirely different way of pursuing combat operations in which we enable host-nation forces in a way that we never could in the past and help them defeat enemies like the Islamic State in their incarnation as an army, and then help host-nation forces pursue the remaining ISIS elements operating as insurgents and terrorists",* former CIA Director and retired Gen. David Petraeus told the author on March 14, 2020. He said that drones, *"unmanned ships, tanks, subs, robots, computers and every additional conceivable system are also going to transform how we fight all campaigns. Over time, the man in the loop may be in developing the algorithm, not the operation of the unmanned system itself"* (Franzman, 2021).

The tactical UAV can also act as a communications relay when communications are obstructed by buildings, or as an emergency delivery system for critical, electronic, forensic, munitions, medical equipment, especially when troops are under direct enemy fire, and classical supply is impossible. In stability operations, counterinsurgency, unconventional warfare, any tactical commander would perform better (*especially during urban actions)* having organically integrated a direct support tactical UAV that could provide the battle picture and help identify potential threats or targets. Innovation and adaptation is present today in current conflicts or counter-insurgency operations. *During Operation EAST MOSUL, often referred to as the 'Battle of Mosul', Iraqi government security forces, and international Operation Inherent Resolve (OIR) forces retook the city of Mosul from the Islamic State of Iraq and the Levant/Dawlah al-IslāmiyahIrāqwa-as Shām (ISIL/DAESH). Over the nine months of war-fighting, more than ten ISIL/DAESH workshops producing and modernizing Unmanned Aircraft (UA) were identified. Even under intense pressure, the ISIL/DAESH continued to develop these technological innovations*" (Aksu, 2021).

The disposition and maneuver of blue and red forces are critical to mission success, decision cycle, speed of reaction, and survival of the tactical element. Sometimes the drones will provide the support fire function allowing the tactical element to outmaneuver the opponent. In the same way the entire maneuver, could be performed only by drones supported by the unit ground fire. In combination with other platforms artillery, air platforms, missiles, drones are contributing to the main effort or secondary direction, can secure or surveillance the objective during the attack, can direct artillery fire, are more flexible and agile for shifting fire towards the enemy from any directions, drones are not restricted by terrain usually. Drones could be restricted by weather and by defensive jamming of the enemy.

"Constant Hawk 12 is a wide-area automatic moving image recording system that can provide real-time or retroactive data and information from the area of operations. It has been widely used since 2006 in both Iraq and Afghanistan to counter improvised explosive devices (IEDs) placed on main lines of communication. Using this technique there is the potential to video-monitor (in multiple spectra) an area of approximately 100 square km for constant surveillance. Either in real time or when reviewed at a later stage, tracking footage

back from an identified launch/impact point can lead authorities to the location or origin of the IED attack, the actors involved, the building from which they started the action, uncovering the connections in the area" (Marion, 2017).

Remarkably, it is becoming clearly along with the alteration of the classical tactics, the integration of UAS, imply structural changes of armed forces, reform of education and training process, acceleration of targeting and decision cycle. Development of UAVs is directly connected and dependent to digital progress, artificial intelligence integration on combat systems, computing modernization, machine learning process integration**.** All these elements present today in the modernization of society are leading UAVs (drones) to grow in an accelerated pace, more rapidly than any counter drone technologies. This leads in the end to an alteration of engaging and waging wars. Current and future military confrontation is characterized by high operational tempo, multi-domain engagements, rapid and flexible decisions supported by automatic process (AI-artificial intelligence).

Rapid and precise striking is designed to break adversary decision cycle. Adam Jux, believes that in the targeting process it is recommended to break down the systems that contribute to the fulfillment of the mission to the objective of the UAV, which involves an analysis of the target systems (TSA), and where those critical systems and their vulnerabilities will be highlighted, which will then be exploited through an appropriate prioritization according to the available hit vectors. (Jux, 2020)

Naturally, the development of UAS will automatically require the integration of emerging digital technologies/concepts, to achieve network connectivity, for proper Cyber protection and to increase the degree of adaptability of these systems.

3.2. Competitive Effective Cost Ratio

Price is a significant determining factor that makes drones attractive for future warfare. Therefore, the governments of the leading countries must consider increasing the production and development of UAVs. Another important aspect is the UAS cost-of-use ratio and the destructive effect on the target. *"Simultaneously in the same time with technological progress, the cost of production of drones has decreased, developing exponential the lethality, which is defined by the ability to penetrate the most expensive, end high-tech air defense systems, which have required billions of investments"* (National Research Council, 2000).

Consequently, when planning the attack in volume, the result can lead to the rapid depletion of the adversary's stock of available missiles. Later, the conditions can be created for hitting the objective, with the last air wave or with classical means. (A2/AD system attrition concept). *"The MALE UAS can operate at altitudes up to 30,000 ft (feet) or even higher. The radar cross section (RCS) of these UAS is comparable to any other legacy aircraft, therefore they can be detected and engaged by most anti-missile defense (AMD) systems. However, modern surface-to-air munitions are not cheap and are designed to engage high-value targets. A large number or swarm of low-cost UAS can quickly change the cost-benefit ratio of traditional AMD and render current systems inefficient. Short-Range Air Defense (SHORAD), Missile, Artillery, and Mortar (C-RAM) systems, and even legacy anti-aircraft artillery can provide effective as well as effective defense against UAS"* (JAPCC, 2020).

3.3. Why Could the Integration of UAS in Military Operations Become Feasible?

During combat actions, by calculating the ratio between UAS operating cost and the damage on target could represent one way of looking at UAS feasibility. *"Such systems must be cheap and easy to produce. It is very likely that in the near future we will witness massive production of military drones for all types of armies for use in land, air and naval domains. The cases of Turkish military operations show that the price of replacing lost drones can become burdensome for the defense budget, especially for more expensive combat UAVs. To minimize such expenses, Turkey promotes the Kargu kamikaze drone, which is ideal for swarm tactics. These units are cheap and pose a serious threat to any military unit when they are able to avoid enemy countermeasures"* (Urcosta, 2020).

Given the fact that any UAS attack could automatically trigger the launch of a considerable number of expensive anti-aircraft missiles (*Patriot missile exceeds 1mil USD/unit)*, the potential outcome is unfavorable for defender. The UAS operating and production cost could be only a fraction of the cost of an anti-aircraft missile. Following the *estimation of the balance of forces*, a residual element will consist in estimating the ratio between action/counteraction in a UAS scenario. Certainly this value is quantifiable. Sequentially, through the simulation, I will estimate necessary calculus in order to identify the *optimal attack value* based on *defender architecture. Consequently*, when planning the *volume attack*, the result could lead to the rapid *depletion of the opponent's available missile stock*. Therefore, the conditions for destroying the objective using classical air power means increase exponentially. (*Attrition concept*.)

3.4. Modernization and Integration of UAVs Imply Also the Adaptation and Development of the Counter-Drones Technologies

"As the legislation regulating the field evolves, systems that emit electromagnetic pulses, sound or light, systems that detect drones such as radars or jamming or striking technologies are being considered by more and more involved actors. The development of drones automatically leads to the corresponding development of systems to counter them, both trends going in parallel and being interdependent" (Melcher et al, 2021).

Emerging Security Challenges and Defense Investment Division (ESCD) in NATO HQ (Brussels), develops the manual "Counter-measures for Class I UAV" and implicitly the NATO doctrine on countermeasures against UAS Class I (drones in the civil sphere). The C-UAS project has 4 lines of research and development: the identification of a common language accepted in NATO regarding C-UAS; solutions and scenarios regarding C-UAS through kinetic effectors; optimal solutions for UAS electro-magnetic jamming; methods of using cyber attack against UAS command/navigation modules. Drones have become an increasingly used tool in modern warfare, seeing state and non-state actors with increasing investment in this type of capability. With the proliferation of such systems, countermeasures are becoming increasingly sophisticated. Critical infrastructure is becoming more fragile as the use of unmanned aerial systems spreads, and events and public spaces face more risks. The integration of UAS in military operations determines the conceptualization, and implementation of Counter UAS (C-UAS) measures, in all categories of forces, implicitly the automatic adoption of TTPs (techniques, tactics, and procedures) and standards.

"Technology has already advanced to the point where a computer could single-handed manage operations during an armed conflict, coordinating from a command center armies of robots, themselves endowed with artificial intelligence.... the time will probably come when AI-equipped drones unilaterally decide to attack real targets in a war situation, for now the goal is to help the

US military conduct operations where independent human control of each drones would slow down the mission. A human would still make high-level decisions, but AI could adapt to the situation on the ground better and faster" (Mihai, 2015). Accelerated development of generically named UAVs (unmanned aerial vehicles)/ UAS (unmanned aerial systems), both in commercial area and military industry, leads to the necessity to better integrate: in military operations, force composition, in planning process. In the same time, C-UAS becomes a future imperative for force protection. *"Think about the upcoming drone arms race, in which drones and counter-drones manufactures will fight to deploy the smartest and most innovative technologies, bringing the current C-UAS issue to new heights, transitioning towards novel domains and concepts, from electronic to Cyber warfare, from kinetic to directed energy weapons"* (Palestini, 2021). In the specialized literature, we find numerous examples of a cyber attack to a UAV or to the control station in order to divert the capture of the device. Along with one-way active jamming, passive jamming in the target area, transmission of false signals (especially erroneous GPS navigation data) becomes the basic method of UAV countering strategy.

"Similar to Ballistic Missile Defense (BMD), defense against UAV threats cannot be treated in isolation. A BMD capable system is always vulnerable to other air threats, such as anSurface Based Air and Missile Defence (SBAMD) system, to ballistic missiles. This means that when using SBAMD systems in a NATO Integrated Air and Missile Defence System (NATINAMDS) context for anti-aircraftdefense, the UAS threat must be part of the layered defense design considerations. A clear gap analysis of active defense systems against the full set of threats must also be developed to optimize mitigation efforts and better protect SBAMD systems" (Valentino & Wurster, 2017). The integration of UAS in military operations determines the conceptualization, and implementation of UAS countermeasures in all categories of forces, implicitly the automatic adoption of TTPs (*techniques, tactics, and procedures*) and NATO standards, to counter UAS. This hypothesis starts from the premise of the proliferation of weaponized commercial UAS, *by terrorist groups*. *"The new generations of UAS become even harder to detect, or jam, due to the processing capabilities integrated with on-board artificial intelligence (AI) that ensures visual or automatic navigation, depending on the situation"* (Palestini, 2020).

Without a thorough integration of UAS countermeasures in the planning, synchronization, support of all combat groups, the achievement of tactical-operational objectives may be unlikely or at most deficient. *"Synchronization requires precise coordination of forces, means and activities in an operation, while visualizing the consequences of the actions and their necessary succession, in order to maximize the favorable effects pursued"* (Herciu & Lehaci, 2020). Ideally, in operations, any Task Forces, should have integrated C-UAS measures, directed against the vital systems of UAS. In this sense the new NATO Counter-UAS Strategy (2021) brings new perspectives and ideas to be implemented. *"...many 'traditional' countermeasures against small UAS rely on electronic jamming of the Command and Control (C2) link between the 'drone' and its remote control. Many current COTS products are, however, able to navigate autonomously to a given coordinate or can be controlled via a Global System for Mobile Communications (GSM) network from the operator's mobile phone. These features make jamming either completely useless, since the C2 link is no longer required to navigate, or unavailable, because of peacetime restrictions that prohibit the jamming of frequencies that are in use by the public"* (Haider, 2021).

The most important conflict where UAS were used on large scale is Eastern-Ukraine conflict. Both sides used extensively all type of UAVs including swarm attack or loitering ammunition. First reports indicate that Russian Federation lost so far more than 800 UAVs during 9 months of intense fighting. Ukraine forces also lost an important number of UAVs since Russian forces are adapting rapidly and learn from mistakes. *"Another system used for C-UAS is the Russian Pantsir-S1, which was originally designed to provide point air defense against aircraft and helicopters and to provide additional protection for AD units against enemy air attacks employing precision munitions, especially at low to extremely low altitudes. These characteristics make the Pantsir-S1 perfectly suited to also counter the complete spectrum from small to tactical UAS and to close the gap between the dedicated C-UAS systems against large-sized UA and drones in the regular air defense units, which are directed against larger medium- and high-altitude long-endurance UA"* (Aksu, 2021).

4. What Are the Consequences of Accelerated Development of UAS?

Thermal and electromagnetic signatures of command elements, platforms, equipments are physical characteristics influencing the targeting process for both combatants, in any conflict. Whoever is implementing efficient counter-measures against detection and strike has better chance to survive the battle field opponent strikes. Ukraine conflict is a very explicit demonstration in this sense: daily actions involving weapon platforms are described by specialists in numerous reports: *Bayraktar TB2, Shahed 136, Stunga antitank platform, Russian ballistic missiles such as: Kaliber, Iskander and so on.* Wide arrays of counter-measures against opponent cycle – find, fix, destroy – could or should comprise: *low and sporadic electromagnetic emissions, IR camouflaged equipment, decoy-false defensive positions, and faint maneuvers*. Survivability of the force is determined also by the level of integration of active and passive anti-detection systems. The implementation of UAS countermeasure has possible ramifications in areas like: *joint operational design, cyberspace and space planning, planning process, force structure composition.*

It is becoming clear that UAS integration has a direct impact on force education, training and specialization, brings novelty and challenges for joint training, creates new operational dilemmas for commanders: level of UAS integration in combat operations, impact on the structure and training of forces, causality that requires the standardized counter UAS measures in NATO. *"Any adversary using emerging technologies, like UAS or C-UAS, may have the potential to be a force multiplier that can play a decisive role on the battlefield, and also change the balance of power. ...The evolving security environment and its dynamics will impact the need for the development of future Alliance capabilities. The respective required technologies need to be assessed using innovative ideas to keep our military edge while conducting real-time analysis of NATO current operations"* (Aksu, 2021). For every commander, the following principle is valid and long-lasting: disregarding basic procedures, measures, tactics for force protection, cover, camouflage, concealment would only facilitate the detection and striking process conducted by the opponent.

What is next? *"In the future, the battle will not only be between platforms, but also between enemy networks, and only the most agile and adaptable will win. The employment of these effectors in the network will be based on resistance to any form of aggression (e.g.: electronic warfare, cyber attack) as well as rapid decision aids capable of calculating rapid* *changes in complex situations"* (GICAT, 2018). Future development reveals new possibilities for UAVs: integration of artificial intelligence up to the point UAV becomes fully autonomous. Computing speed and integration of all spectrum sensors will allow the artificial command module to take instant decisions in the battle field, to communicate rapidly with similar platforms, to share enemy vulnerabilities and attack opportunities with other systems, including the classical ones.

A fundamental dilemma in this sense rises when we talk about full autonomy concept for UAVs. So far, western international agreement requires that UAVs (especially those with striking capabilities) have *"human on the decision loop"* system, which means that the operator has the final call for launching the missiles. This might see new development in the future, nobody can tell for sure. *"A UCAV piloted by the Skyborg system will be much more maneuverable, due to its ability to process and exploit the enormous amount of information provided by the advanced sensors of the combat aircraft and, in particular, the information received from the other platforms and sensors of the network from which is part of UCAV. In parallel with the above, the concept of 'loyal wings', used to denote teamwork between manned and unmanned combat aircraft, is gradually gaining acceptance"* (Jordan, 2021).

Based on historical research and prospective approach Javier Jordan (Three Horizons, 2021), aims to identify the main factors that will condition the future role of UCAVs in air and air-to-ground combat missions. The article outlines the foresight framework (Three Horizons, 2021) system of reference and then applies it to the evolution of combat aviation, current development programs, and forecasts of the integration of UCAVs into military operations. Javier Jordan hypothesizes that the third horizon corresponds to a future in which unmanned systems will take the lead role as aerial platforms in air-to-ground and air combat missions, forming part of a "system of systems", based on a human-machine team, in which artificial intelligence will ensure a very fast decision-making cycle (2021).

"MBDA used the core elements of its missile expertise to develop the UAV, which can alternatively carry one of the company's 15 kg (33 lb) MMP missiles instead of the two Enforcers. The current duration of the UAV is about 60 minutes, …the UAV is designed around the Enforcer missile, Spectre's 25kg payload capacity will also allow it to be used as a cargo delivery system that will be able to deliver logistical supplies and weapons resupply – including Enforcer – the troops. The company is exploring the development of a fuselage belly door for this application, said M. Scott, director of MBDA's UAV division" (GICAT, 2018).

Like any other weapons system the development of UAVs will trigger a continuous technological race, designed to counter the possible outcome of swarm drones attack. Electromagnetic field is a possible direction, jamming connectivity between drones and home station or targeting the critical infrastructure of UAS are other directions. Classic C-RAM weapons systems are quite capable, because integrated with long range air defense systems they can provide feasible defence umbrellas. Sophisticated new sensitive radars are designed to identify as soon as possible even small size drones or micro-drones. All the counter- measures are exploited, as modern armies understand the fantastic offensive potential of drones, and the necessity of reliable defensive mechanisms against drones.

5. Conclusions

Due to the impact on evolution of future conflicts, UAS are registered as influential technology, with unpredictable effects in the doctrinal sphere, as follows: the integration of UAS could alter the space-time-combat correlation, by reducing the time for engagement and increased precision. The integration of UAS should ensure the preservation of the combat initiative and might lead to the diversification of the ground tactics and the multiplication of the support and fire support missions. Subsequently, this integration can lead to the improvement and standardization of countermeasures against the opponent's UAS. *Inter-connectivity* might be the key for war-fighting efficiency to provide a high degree of mobility, flexibility for C2 and execution. Another possible effect of UAS integration, could fall under force structure design, with indirect influences on education, training, specialization of operators (MOS) (AAP-6 NATO Doctrine Terminology-*MOS,* 2018).

These considerations, perhaps more than in the case of other weapon systems, may lead to the conclusion that the UAS can become a vector for an accelerated change in the physiognomy of war.

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