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# INNOVATIVE TECHNOLOGIES FOR COMBATING HEALTH RISKS ASSOCIATED WITH RAPID MANOEUVRING OF FIGHTER AIRCRAFT

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***Abstract:*** *One of the most important factors in achieving victory on the battlefield in today's military environment is air superiority. As such the arms race that begun almost 100 years ago is still raging to this day. As the competition for supremacy over the sky is a fierce one the selective pressure acting on the design of aircrafts has made human biology the limiting factor in the kinetics of improving today's planes in terms of mobility and manoeuvrability. This paper aims to analyse the physiological problems associated with flying and manoeuvring at high altitude and provide a model rooted in biology for the development of equipment that will help the pilot survive and even thrive in conditions in which no creature, that we know of, ever lived.*

***Keywords:*** *G-induced loss of consciousness; altitude decompression sickness; serous body glove, negative pressure lower body; intracranial pressure*

## 1. INTRODUCTION

Large animals first started exploring the terrestrial environment approximately 400 million years ago(Clark J. A., 2007) through the adaption of the swim bladder for gas exchange (Clement & Long, 2010) (Graham , Wegner , & Miller , 2014) and the reinforcement of their limbs for supporting their body weight (Shubin, Deschler, & Jenkins, 2006) (Clark, Blom, & Ahlberg, 2005). Over time the swimming bladder got even more vasculature (Johansen, Hanson, & Lenfan, 1970) and the displacement of the would-be airways towards the dorsal aspect of the fish's head gave rise to the early organs of respiration as we know them in today's terrestrial mammals. Although these adaptions still amaze researchers to this day human ingenuity has given rise to the extension of our living media that evolution couldn't have ever anticipated. Beginning in the First World War airplanes became ubiquitous on the battlefield first as faster and safer means of reconnaissance and then as means to support troops on the ground through the deployment of supplies, the harassment of enemy forces or preventing enemy aircraft from supporting their own ground infantry.

The most interesting of those employments given to the early military aircraft was fighting other aircrafts mid-air. Considering the enormous speeds attainable by aircraft no longer constrained by gravity or ground friction forces and the evolution of their offensive capabilities that directed their lethal force towards the front of the plane we can clearly see why the predominant mode of fighting became chasing and rapid manoeuvring in order to ambush the opponent. Such tactics required rapid changes of direction at high speeds which generated acceleration, acceleration that the human body wasn't designed to cope with. Thus, a new branch of medicine was born, that of aerospace medicine.

Even though many solutions have been found throughout the years the fundamental problems remain more or less the same as each military searches for ways to win the evolutionary arms race that is fighter aircraft design by pushing the technological skills of their engineers and the biological borders of their pilots. To date the biological limitations of pilots are the primary limiting factor in fighter aircraft development.

The main conditions which arise in the physiology of humans which limit the capabilities of pilots are altitude Decompression Sickness and G-induced loss of consciousness.

## 2. METHODS AND MATERIALS

**Altitude Decompression Sickness (ADS)** (Ata & Karaca, 2021) is a condition similar to Decompression Sickness (DCS) which is observed in divers at high depths but it doesn't usually imply a loading phase as the organism's tissues are already saturated in inert gases at sea level. The condition is caused by a decrease in the solubility of gases in solution caused by a decrease in pressure which result from exposure to high altitudes. If variations in pressure are slow inert gases slowly come out of solution and are exhaled but when the decrease in pressure is rapid there exist the risk for the formation of emboli that circulate through veins and arteries and find their way to capillary beds where they can occlude the blood flow to vital organs resulting in complications such as stroke, heart attack or tissue necrosis and subsequent infection in the digestive system. ADS is characterized by two forms:

- Type I which mainly affect the bones, joints, muscles, skin and lymphatic nodules resulting in rashes, aches, loss of mobility or deep bone pains and can be a warning for the apparition of type II ADS which manifests through neurological and cardiovascular symptoms.
- Type II ADS can be characterized by headaches, numbness or paralysis of extremities, hearing or visual impairment, trouble speaking, loss of consciousness, vascular obstructions including pulmonary embolism and, if not addressed fast enough, death.

Also, repeated minor incidents of ADS which are not diagnosed and treated can have long time implications leading to a condition called dysbaric osteonecrosis which is characterized by mini fractures in the bones that form as a result of circulating gas bubbles.

Treatment of ADS as of DCS implies exposure to higher pressures to dissolve the gas bubbles. Although ADS has a slower onset than DCS due to the higher change in altitude required for a change in pressure we should also note the faster rate of ascent or descent facilitated by powered flight.

For preventing ADS studies have shown that a short excursion at a lower altitude modifies the contents of the micro bubbles that are formed inside veins and are sent into the circulation. After the excursion it is hypothesized that the bubbles that form are mostly composed of oxygen which is gradually taken up and consumed by the cells of the body. The excursion helps diffuse bubbles of inert gases back into the tissue and offers quite a large protection against the formation of further bubbles (Anell, Gronkvist, Gennser, & Eiken, 2021).

**G-induced loss of consciousness (GLOC).** Fighter aircraft's speed is not a problem for a pilot in a seated position as long as the plane is moving linearly. When the pilot decides to ascend or descend however the physiology starts working against him as blood starts to pool in eighter head or leg veins depriving half of the body of blood (Advisory group for aerospace reasearch & development (AGARD), 1990).

Histological veins are much looser vessels than arteries as they contain fewer elastic fibres and muscle in their wall thus making them much more susceptible to distension under hydrostatic pressure. Under normal conditions this is not a problem as veins are exposed only to comparatively low blood pressure and the valve system that they are equipped with prevents pooling in the lower extremities (Wojcieh & Ross, Cardiovascular System, 2020). However, most fighter aircrafts are capable of generating several times the gravitational acceleration of the Earth which tends to overcome the safety mechanisms of the lower extremities (which sometimes fails to counteract even one g of acceleration resulting in calf varices) and determine pooling which prevent return of the blood to the heart and subsequent oxygenation and distribution to the brain which very quickly leads to vertigo, syncope, permanent brain damage and even death as a result of brain ischemia.

Several techniques and equipment have been proposed to mitigate G-induced loss of consciousness including prone disposition of the pilot in the cockpit (which elicits the same problem only this time during horizontal acceleration), anti-G suits (Rood, 2014) and usage of the Valsalva manoeuvre.

Theoretical maximal tolerance of the human body to longitudinal acceleration is estimated to be 20g (the point at which vertebrae start to fracture and affect the spinal cord) (Hall & Hall, 2021) but the current record is around 9g for short periods of time. We are proposing to extend the amount of g's supportable by pilots through the implementation of liquid breathing associated with a new design of the anti-G suit.

While upward motion of the aircraft presents the possibility for blood pooling in the lower extremities due to the low viscosity of the fluid relative to the endothelium the downward motion of the aircraft isn't as dangerous for normal functions of the body. Even though we would expect an increase in blood in the intracranial vessels followed by increased extravasation of fluid from hydrostatic pressure rise resulting in brain oedema, the anatomy of the central nervous system counteracts this potential for fluid shifts. The brain and spinal column are surrounded by a covering layer of tissue called the meninges composed of three seethes (dura mater, arachnoid mater and pia mater). Between the pia and arachnoid, we can observe the cerebrospinal fluid (CSF) which cushions the brain and spinal cord during day-to-day activities that involve rapid acceleration and deceleration (Wojcieh & Ross, Nerve Tissue, 2020). When the organism is exposed to downward acceleration the inertia of the CSF determines its pooling in the subarachnoid space adjacent to the brain thus increasing the intracranial pressure (ICP) but preventing blood from pooling in the cerebral veins and causing oedema as the CSF doesn't pass (under normal circumstances) through the pia mater. This is the working principle that we are proposing for a design of anti-G suit. At the same time, the use of negative pressure lower body (NPLB) techniques for the simulation of brain hypovolemic hypoxia may represent an additional means of counteracting the redistribution of fluid in the body.

**The model of the anti-G suit** that we are proposing consists of a sheet of fabric tightly bound to the pilot's body along the legs, abdomen, thorax and neck upon which a thin layer of liquid with lower viscosity with respect to the sheet material than the blood to the intima of the veins and upon which another sheet of fabric to contain the liquid. In this manner we propose to create an extracorporeal serous membrane akin to those used by the body to cushion internal organs such as the brain, heart, lungs or gastrointestinal tract. Additionally, to further increase the efficacy of such a system we could adhere the external sheet to the internal one and connect intake and outtake vessels that would add or remove liquid from the compartments we have individualized depending on the needs for fluid in different parts of the body.

This biomedical approach to combating fluid redistribution during high-G manoeuvre is dependent on two kinds of variables for the final design of the anti-G suit: the trajectory

of the adherence lines between the two sheets and the specific pattern of fluid intake and outtake during specific manoeuvres that are to be expected during flight. As this is a complex problem the answer of such questions will be left to further studies but a general principle that we are expecting is the individualization of body segments that, when put under pressure transfer that pressure to underlying veins in an efficient manner. As such we would infer that the implication of AI technology and the development of synthetic models would be required for the development of such a product.

Of course, a more direct approach would be the direct encasing of veins in contractile devices and remote and precise control of this mechanisms from outside the body but such an approach would extend the time and cost of pilot specialization to levels which are not currently feasible.

In addition to such a serous membrane that would encase the axial part of the body we could also add devices that suck the blood from eighter the leg or head veins when the acceleration determines pooling. Such devices would rely on the NPLB principle and their application would lead to the creation of a buffer zone for hydrostatic pressure in the veins of the arms that would be able to store blood for short periods of time in order to decrease its accumulation at eighter extreme of the axial body. Such devices would be composed of inelastic and air-tight material wrapped around the upper arm and secured in place by thigh bindings: one inferior to the insertion of the deltoid (at the tourniquet application site) and one superior to the humeral epicondyles. The tightness of the bindings wouldn't be maintained during non-g-intensive manoeuvre. During activation of the system a pump will pull air out of the chamber described and will result in negative pressure on the exterior of the upper arm. This negative pressure will be transferred to the underlying vessels and the superior venous system which via the anastomoses that it realizes with the inferior venous system through the superficial thoracoabdominal veins (Grant, 2018) will create a pressure gradient between the upper and lower appendages that will lead to fluid flow toward the veins of the arm (the cephalic and basilic veins) where it will be stored instead of the lower extremity. In this way we would leverage an anatomical peculiarity of the venous system (its cavo-cave anastomoses) and a physiological mechanism that is already used in the body to drain blood from the legs (the negative pressure developed by the thoracic cavity during inspiration).

A problem we might run into in using this serous body glove (SBG) technology is putting too much pressure on the abdomen and thorax thus interfering with the diaphragm's capacity to move air effectively. To run effectively (that is to not impede circulation) a SBG system will need to work as an ancient hear, successively inflating and deflating adjacent fluid sacs to move blood from the veins back to the heart. The frequency of such inflations and deflations (akin to peristaltic movement of the first circulatory systems or current digestive systems) will certainly be higher than that of respiration thus exposing the diaphragm to inconstant pressure for which the Central Nervous System doesn't have an adaptative response. Pilots already inhale pressurized air enriched with oxygen as the cockpit isn't pressurized for flights up to 2500 meters and the negative pressure at this altitude wouldn't allow the pilot to generate enough pressure gradient to inhale via the use of his respiratory muscles alone. The outside pressure delivered by the SBG to the body will necessitate even greater pressure delivered by the ventilator that is connected to the pilot's mask. This raises the same problem as that faced by divers at high depths.

If the pilot would inhale pure oxygen at high pressure the risk of oxygen radical formation will increase resulting in tissular damage that can be compounded over time even from low duration of exposure (Cooper, Phuyal, & Shah, 2022). On the other hand,

mixing inert gases such as $N_2$ into the air breathed by the pilot to lower the concentration of $O_2$ will result in dissolution of such gases in bio solution requiring the need for slow decompression of the SBG or running the risk of ADS.

A proposed solution would be the use of perfluorocarbons (PFCs) which are substances that resemble hydrocarbons but in which all hydrogen atoms have been replaced with halogens thus conferring them high solubility for $O_2$ and $CO_2$, metabolic inertia and good physical properties that make them compatible with the pulmonary mechanism(Jagers, Wrobeln, & Ferenz, 2021). The respiratory system's functional unit is the alveoli which is a tiny sac in which the airways end and on which's external surface a large system of capillaries is present. These tiny sacs are composed of only one layer of squamous epithelial cells which facilitates oxygen diffusion. At the interior of the alveoli there exist a certain liquid that prevents the sac from folding in on itself and closing called surfactant. As of today, PFCs are a promising substance for eliminating the need for saturation divers to decompress for long periods of time and implementation as the first artificial blood substitute and are used to treat acute respiratory distress syndrome in pre-term children. Their prospective uses in aviation medicine include treatment of ADS, delivery of drugs and nutrient through the alveolar membrane and, we would suggest, countermeasures for risks associated with the use of an SBG (Mayer & Ferenz, 2019).

The idea is to ventilate the pilot with air through an interface of PFCs. When the need for SBG deployment is sensed, the ventilator will introduce, through a tracheostoma installed prior to take-off a quantity of PFCs that is sufficient to rise the intrapulmonary pressure to a level that will keep the alveoli open and then ventilate the interface of PFC with 100% $O_2$ which will diffuse through the liquid towards the capillary beds of the alveoli. The need for a tracheostoma becomes apparent when we consider the fact that we want the pilot to be able to verbally communicate with his peers during flight. Such communication would be impeded by the flooding of the larynx with a fluid denser than air.

Having had evaluated the response and delegated the task of analysing the input and sending the outputs to AI and the people behind it we will now conclude our presentation of the SBG with an exposition of the sensors that can analyse the physical parameters which can serve as the trigger for the deployment of the system.

One of the main concerns that the body has is to supply its brain with enough blood saturated in oxygen to ensure adequate function. The brain, being a very energy-hungry organ covers almost 20% of the energy demanded by the organism on a daily basis. So much is the brain affected by a lack of oxygen that an interruption in blood flow of only 5 seconds will lead to loss of consciousness. To prevent such situations the body has certain receptors that detect the pressure and oxygenation in the blood that circulates to the brain. If the parameters evaluated are not within normal limits (such as when we stand up too quickly) the organism triggers certain reflexes such as the increase in hearth rate, respiration frequency and constriction of the calf muscle that aim to fix the problem. Many of these physiologic responses can be measured and used as to approximate intracranial fluid dynamics but the fact that they are responses to a certain condition implies a latency that may not be afforded by the pilot during rapid manoeuvring. As such we will propose some techniques that can be developed and used to directly monitor instantaneous shifts in fluid dynamics.

First, we could measure intracranial pressure (ICP) directly by introducing a catheter into the ventricles of the brain.

This solution has of course a high degree of impassivity, necessitate specialized expertise and lengthy recuperation and may be associated with other complications which makes it ill-suited for our purposes. Next, we propose to use some parameters that are

directly affected by the variation in ICP such as optic nerve sheath diameter (ONSD) which is measured through ultrasonographic means and is the gold standard for approximating ICP as the sheath of the optic nerve is a direct dependency of the meninges. Another imagistic way of determining ICP is the employment of CT scans but the complexity and lack of specialized equipment on bord the aircraft makes them unfeasible for our purposes.

We finally come to methods that are built on top of the previous two and which are promising candidates for the development of portable robust devices that can asses ICP changes. First, we mention a sensor that detects changes in the magnetic permeability of the head as a result of biofluid intake or outtake. It is made of copper wires which makes it easily replenishable and its mode of operation consists of impulses sent to the head and the reception of signals. By determining the resonant frequency of the sensor with validation from the ONSD technique to verify the flux of biofluid researchers have establish a linear relationship between the resonance and the ICP which can be used to automatically trigger the engagement of the counter-G mechanism (Griffith, et al., 2023). Limitations of this method may consist in the slow adaption of the sensor as the study only presents relatively slow movements of the subject. A similar method involves spectroscopic analysis of the subject at different points of the head during relatively rapid manoeuvring of the body position. The sensor measures total haemoglobin as well as oxygenated and reduced haemoglobin in order to provide a detailed analysis of the expected hypoxic status of the pilot(Gerega, et al., 2020).

Such methods of fluid distribution analysis can be further leveraged to analyse different compartments of the body by integration in the SBG inner sheet and their measurements used to further refine, modify and even modulate the algorithm that determines the operation of the SBG in real time.

## 3. CONCLUSIONS & ACKNOLEDGMENT

The human organism is not equipped with reflexes that can cope with situations that were not common occurrences in nature and so when we expose people to such extreme conditions as high g accelerations and decelerations, we should also equip them with new reflexes which are rather based in their biology not in the parameters measured by inanimate mechanisms. As such we have proposed a system that takes as input the distribution of liquids (in particular blood) in the body and outputs a pattern of movement that is to be imparted to the vascular system in accordance to the instantaneous change in fluid distribution.

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# THE EFFECTS OF FAKE NEWS IN MODERN CONFLICTS

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***Abstract:*** *The main purpose of this article is to address the topic of information warfare, more exactly the term "Fake News", making the reader more accustomed to the issue. The concept of "Fake News" has become one of the most observed aspects of the 21st century wars. By acting on all media platforms, it can influence the masses, support destabilizing organizations and movements and, generally, sow discord among the society. The following article analyses the rise of the Islamic State in the Middle East and the actions of the Russian Federation in the Crimean Peninsula annexation. By oversaturating the media platforms with fake news, one cannot discern between false and real information anymore. In their attempts to greatness, some authoritarian states have even resorted to changing history, in order to increase their public opinion. In order to become resilient to actions of information warfare, the government must strongly cooperate with the population, media sources and technology companies, in order to improve the critical thinking skills, medial literacy and journalism credibility standards.*

***Keywords:*** *Fake News, manipulation, propaganda, the Islamic State, the Russian Federation*

## 1. INTRODUCTION

Information warfare as a concept is referring to the use of information, disinformation and propaganda as a weapon in conflicts. It can use cyber warfare techniques in order to achieve its goals and usually uses disinformation campaigns and propaganda efforts with the purpose of manipulating the popular opinion, achieve strategic objectives and, in general, sowing discord and confusion. Methods of information warfare were used from ancient to modern times, each period having different approaches. The twenty-first century saw the development of a tactic called "Fake News", which gave states a challenge in discerning fake information from real one. The term of fake news is a part of the informational warfare spectrum and consists of spreading false or misleading information, presented as real news. The spread of fake news has become easier due to the rise of social media platforms, which can allow false information, because of the lack of regulation. The main goal of its use is to undermine the trust in a country's institutions, manipulate elections and cause social unrest. By meddling in a country's media platforms, one can influence the views of the population, promote unhealthy organisations or movements and even change political leadership. In order to prevent a future crisis of this kind, the government must cooperate intensively with the population, media platforms and technology companies in order to increase the media literacy and critical thinking skills.

I chose to talk about this subject, due to the fact that unconventional forms of combat are deeply in my interest. As we can observe from the last modern conflicts, information warfare can strongly influence the outcome of the war, by diminishing the will of the people and spreading confusion and unrest. The last big examples of fake news in modern conflicts are the actions of the Islamic State in the Middle East and the intervention of the Russian Federation in Ukraine's Crimean Peninsula.

The first example offers us the methods of religious manipulation, combined with the spread of a militaristic spirit, tactics of the kind last observed in the Imperial Japan of Hirohito. In the second example one can observe the use of a minority population as a means of starting war, along with the shaping of history, with the purpose of washing away the mistakes of the past. The concept of Fake News is a serious threat to future conflicts and needs to be intensely analysed. The population must be educated in order to be resilient to acts of manipulation and fake news. Besides that, the media organisations must be imposed a journalism credibility standard, in order to maintain the truthfulness of the news.

## 2. THE CONCEPT OF FAKE NEWS

**2.1 Techniques used in information warfare.** In the last decades, information warfare saw a big development, due to the fast rise of social media platforms and the variety increase of media sources. The military analysts observed a set of techniques used by different entities in conflicts. The use of social media bots and trolling was perfected by the Russian Federation. Although it does not acknowledge that officially, the Russians intervened in several elections around the world, looking to promote parties or individuals who support the Moscow agenda. The most known case is the 2018 election in the United States of America, where with the use of bots and cyber warfare, Donald Trump won against Hillary Clinton. Donald Trump was known for his policy of diminishing the U.S.A's army presence in Europe, along with the change of focus from the Russian Federation, towards China. Appealing to Putin's agenda, he was the perfect candidate for the U.S. elections. Another information warfare technique is the use of deepfakes. Deepfakes are artificially created images or videos, with the purpose of appearing real, although they are fake. There are some famous false pictures, shared on the internet, that really created panic on the world stage. One good example is a picture from an international meeting, where Putin appears surrounded by powerful world leaders, like Donald Trump or Erdogan, focusing on him like on a mentor. The picture is obviously a fake. Along with deepfakes, astroturfing consists in the creation of fake movements or organizations who support a specific agenda. By creating a fake problem, one can generate social unrest along the population and undermine the institutions. Another method of information warfare consists of amplification and disinformation, more exactly exaggerating the significance of an information or creating false pieces of information. All of that with the purpose of deceiving the population into supporting the doctrine or agenda of the enemy, without even knowing it. The methods of information warfare and fake news can have severe consequences, which includes political polarization, erosion of trust in institutions, and violence caused by unsolved public issues. It is important to be aware of the presented techniques and to find solutions to combat them.


**FIG. 1** Fake picture of world leaders around Putin
(Six Fake News Techniques and Simple Tools to Vet Them (gijn.org) – acces date: 05.03.2023, 18:50)

**2.2 Methods of combating informational warfare.** In order to keep up with the development of informational warfare techniques, there needs to be a collective effort between individuals, governments, technology companies and the media sources. Some useful solutions can be fact-checking the information, developing critical thinking skills and supporting credible journalism. At an individual level, one can check at any time the reliability of the information, verify the source of information, and share with others credible sources of information. Governments must develop policies and regulations regarding the spread of fake news and the support for credible journalism and critical thinking. By imposing sanctions to those media platforms that promote false information, it can maintain the problem of fake news spreading. The technology companies must ensure the implementation of tools and policies, able to detect and remove false information from their social media platform. Also, the AI (Artificial Intelligence) can also play an important role in finding and combating false information, using intelligent searching algorithms. The Media platforms are responsible for the information that goes to the public and are enquired to uphold the journalistic standard and to promote fact-checking and media literacy. By taking action in order to prevent the spread of fake news, a country protects itself from future threats and public manipulation. Media literacy programs such as News Literacy Project are good examples of resilience against information warfare. The organization aims to provide resources and tools for fact-checking and verifying different sources of information and strives to promote critical thinking skills. Also, fact-checking organizations such as FactCheck.org and PolitiFact try to verify the accuracy of information in the news and to provide ratings to indicate the level of truthfulness of an information. Only by better educating the population, a state becomes resilient to acts of information warfare. Supporting small journalism organisations, in order to expand the sources of information is a key part of undermining the monopoly of only a few media companies. Also, by creating and imposing proper journalism credibility standards, the media platforms will be able to maintain only true and well-done news articles. The fight for resisting fake news infiltration must become a collective struggle, the entire society becoming a part in it. That is how a state won't become a victim to information warfare techniques.

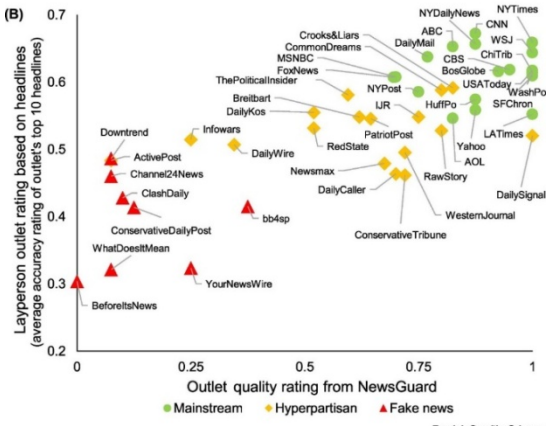


**FIG. 2** Ratings of different sources of information
(1-s2.0-S1364661321000516-gr3_lrg.jpg (2500×3993) (els-cdn.com) – acces date: 01.03.2023, 12:30)

**2.3 The effects of the Islamic State propaganda.**The Islamic State represents one of the most complex, closed and effective military and political structure in contemporary international stage.

Although it is considered, by many Western countries along with Russia, to be a terrorist organization, in the Middle East its public opinion has increased, becoming the only solution to combat western influence. According to a survey conducted by the Quatar TV channel Al Jazeera, almost 70 percent of its viewers endorse the goals of the Islamic State. Between October 2016 and January 2017, the official media houses of the Islamic State published over 1000 propaganda products. A few of the media outlets used by the Islamic State in its conflicts are "The Nineveh Province Media Office", "Bayan Radio" and "The Furqan Foundation". The priority of the Islamic State propagandists was on the military dimension of the conflict. By promoting suicide fanaticism and foot soldier heroism based on exaggerating the teachings of Islam, the propagandists focused on depicting the Islamic State as a utopia founded by Islamic laws, incorruptible by western pagans. Also, by having its own magazine "Dabiq", along with a film studio, webmasters, a marketing group, a group of hackers and the advantage of deeply understanding the culture of the local population, the Islamic State is promoting the pan-Arab revolution, creating instability in the Middle East and holding the development of the region. The Islamic State's propaganda has created a complex brand, based on 6 principles: brutality, mercy, victimhood, war, belonging and utopianism. Brutality can be observed in all media videos, where terrorists are decapitating innocent victims in the name of Islam, or in the terrorist attacks all around the western countries, spreading panic and terror. Although brutality is the most observed practice, the idea of utopianism is the most important one. By creating the image of a perfect place, in which religious teachings are common laws, one can be tricked in supporting rebel extremist groups in their struggle to control innocent people.

The strategy of combating censorship consists of outsourcing and saturating the online media platforms with jihadists ideas. The disseminators of propaganda are often self-appointed and have no official position in the organisation and receive no reward for their activism. Another important thing is the fact that radicalisation in the organisation happens only offline. On the online media, the Islamic State tries to promote a beautiful picture of itself, selling the image of a perfect heaven. Only when the fanatics reach the Islamic State are they exposed to true radicalisation. The extremely efficient information warfare techniques of the Islamic terrorist organisations posed a real challenge to the western countries in their attempts to develop the region.

By recruiting thousands of followers, it maintained its territory in the Middle East, and with good propagandists it managed to improve its public image among Muslim population.

**2.4 The Russian way of information warfare.** Based on the Gerasimov Doctrine of conducting warfare on all spectrums, the Russian way of informational warfare depends on the spread of fake news and the use of trolls and bots. Due to the neediness of maintaining the sphere of influence of the old Soviet Union, Putin's Russia tries to meddle in the news and elections of the eastern European countries, supporting pro-Russian parties and views. In Russia it has come to a point where one cannot discern between real and fake news. The Russian strategy of oversaturating the media with fake news, in order for them to be considered as real has become a serious threat for the global community. One good example is the presence of a photo in which one Ukrainian soldier is kissing the American flag, which appeared from after the start of the Russian-Ukrainian war. The purpose of the picture is to undermine the authority of the Ukrainian army, picturing them only as American puppets. The presented image is a fake one, due to the fact that the soldier is a Pakistani border guard and the picture was taken years ago. By sharing the picture on the internet, the Russian propaganda organisation wanted to spread unrest trough the Ukrainian population, by appealing to their ego. By creating fake news

and spreading it as real, the Russian media opened a way of shaping the future, with the cost of modifying the past. There have been cases of changes in the Russian history, with the purpose of improving the image of the Soviet Union. Putin's affinity towards the Soviet Union has been observed for a few years. As two of Putin's quotes say "The demise of the Soviet Union was the greatest geopolitical catastrophe of the century." (Speech on national TV, April 25, 2005) and "Anyone who doesn't regret the passing the Soviet Union has no heart. Anyone who wants it restored has no brains." ("Spy who came in from the cold" by Tom Parfitt, www.theguardian.com, December 23, 2007). As one can observe, Putin tends to preserve the ruling methods of the Soviet Union, but shape the country around him being the irreplaceable leader.

**FIG.3** Fake photo of Ukrainian soldier kissing the USA's flag
(Six Fake News Techniques and Simple Tools to Vet Them (gijn.org) – acces date: 06.03.2023, 20:10)

A significant difference between the western and the Russian view of informational warfare is the term of its workspace. While the westerners name it cyberspace, as it is placed in the virtual world, the Russians refer to it as "information space". If we are to talk about the methods of information warfare, they categorised it as "information-psychological warfare", affecting the armies and the population, and "information-technology warfare", affecting the technology systems of the enemy.

To better understand the concept of the Russian "information space", we must analyse the concept of "information weapons". The Russians came to the conclusion that "information weapons" has more domains than cyber, an important part being the human cognitive domain. In order to accomplish political and diplomatic ends, the Russian Federation tries to influence the political leadership and public opinion of foreign states and organisations. To give an example, we must analyse the events of 2014, where Russian state and non-state actors turned to tactics like exploiting history, culture and nationalism in order to influence the views of the enemy. As the "little green men" were entering Crimea, the Russian administration stated that no Russian soldier invaded Ukraine and that the troops occupying the territory are represented by the Russian citizens wanting to be a part of the motherland. By using paramilitary groups, presented as the oppressed Russian minority, the Russian administration succeeded in conquering a territory without going to war. Another important action is considered to be the referendum held on March 16, 2014, where the Crimean population decided to be a part of the Russian Federation. Even if the results of the referendum were tricked, the whole procedure gave the impression of a diplomatically solved crisis.

In the same way, the Russians succeeded in diplomatically annexing the territories of Luhansk and Donetsk. Starting the conflict in Donbas region as a military operation, it was shaped to look as the de-Nazification of Ukraine, with the purpose of protecting the Russian minority population.

It was intentionally organised to look similar to what the U.S.A. did in the Middle East, in order for them to have a strong motif of declaring the war. Although it is indeed true that the Donbas Region has a strong minority of Russian ethnics, it is historically Ukrainian, given to them by the Soviet Union in the Cold War. At the start of the "Z" military operation, after the Russians captured Donbas, the media started to spread pro-Russian propaganda, in order to increase the Russian national sentiment. After a short period, the Russian state organised a new referendum, in the same way as in Crimea. The results of the referendum culminated in the creation of the Donetsk People's Republic and the Luhansk People's Republic, both loyal to the Moscow regime. It is only then, when the Russian state declared war on Ukraine, by stating that the Ukrainian army is stationed on Russian soil. By using propaganda to shape the views of the population and creating and solving a false diplomatic solution, the Russian Federation obtained a way of conducting military operations and gaining territories, looking like a regional power solving a crisis in a neighbour state. As military analysts observed, the Russian administration conceived a strategy of pursuing modern conflicts with the role of annexing foreign territories and looking as a peacemaker of the international stage, further developing its hybrid warfare doctrine.

## 3. CONCLUSIONS & ACKNOWLEDGMENT

The effects of "Fake News" in modern wars have shown that unconventional forms of warfare can do more damage that the simple conventional clashes. Using information warfare techniques, one can diminish the population's will to fight, making it impossible to achieve victory. That's why, in order to combat actions of fake news, the governments must take initiative in a strong cooperation with the population, media sources and technology companies. They must implement laws and regulations regarding the truthfulness of news articles and sanction those media platforms that spread false information. Also, the overall population must develop critical thinking skills and media literacy, along with imposing the media companies' journalism credibility standards and algorithms in order to spot fake news spreading.

As observed in the presented examples of the Islamic State and Crimean Peninsula annexation, fake news and propaganda can have a significant impact on civilian population, spreading confusion and panic. It can also affect the military, by promoting a false sense of heroism, based on fake religious principles or teachings. Suicide warriors or state armies disguised as paramilitary groups have become modern war tactics, due to the power of media and fake news. The modern war developed in such a complex way, that non-state actors have become as important as the state ones. Information warfare has become a key point in undermining the will of the enemy or influencing him in supporting wrong agendas. It is our duty to take initiative in implementing the laws and regulations and promoting media credibility, in order for the next generations to live in a society that is resilient to fake news.

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# DEFICIENCIES OF RUSSIAN SUPPLY LINES IN THE SOUTHERN AREA OF THE RUSSIAN-UKRAINIAN CONFLICT IN 2022

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***Abstract:*** *The Russian-Ukrainian conventional conflict that erupted in the first part of 2022 has changed the environment of security of the European area, the way the big pawns on the European map related to the security of national territories. Level I and Level II supply lines, respectively, the key element of logistical support and supply to the frontline fighting force, are analysed, with the spatial and temporal landmarks being the southern axis of the Russian-Ukrainian conflict in the first year of the conflict, 2022. This paper aims to interpret some key events of the conflict period, thus finding causality between the military actions taken by the two states and the deficiencies of the logistical support of the Russian Federation army, especially on tactical supply lines. This analysis is based on a comparison of the elements of logistical support found at the doctrinal level of the Russian Federation, Romania and the North Atlantic Alliance with the logistical support itself, put in execution by the army of the Russian Federation in the conflict.*

***Keywords****: conventional conflict, supply lines, deficiencies, Ukraine, logistical support.*

## 1. BACKGROUND

Tensions between the Russian Federation and Ukraine have existed since the Middle Ages, the cause being a common root found in Kievan Russia and perpetuated for years in nationalist discourses by Russian opinion leaders, tensions that culminated in the biggest armed conflict in 21st century Europe [1].

The annexation of Crimea was another step in the deterioration of diplomatic relations between the two pawns on the map of Europe. The year 2022 began with the Russian president's declaration on 24 February at 5:00 a.m. to begin a "special military operation" to "demilitarize and denazify" Ukraine, a military operation of aggression against another country, operation turned into a conventional conflict, a war of attrition. The build-up of Russian troops began as early as March 2021 all along the Russian-Ukrainian border and also on the territory of Belarus under the pretext of conducting various military exercises. The first days of the conflict imposed a title of superiority of the Russian armed forces by accomplishing multiple objectives, neutralizing various Ukrainian defense structures and destroying infrastructure and military capabilities, thus preventing Ukraine from responding promptly to aggression [2]. The implementation of the Blitzkrieg strategy proved effective for only a few days, with the Russian Federation's fighting forces advancing several hundred kilometers deep into the adversary's territory, but with logistical structures failing to advance quickly to provide support, the front advanced against Russia in the period that followed [3]. The supply of fuel, weapons and military supplies are logistical elements that can have a major influence on the course of a war, which is why, at the outbreak of a conflict, the armed forces that start an offensive must have powerful logistical support to achieve the objectives set.

Taking an analysis of Russian logistics on the 2022 Ukrainian front a year after the outbreak of the conflict, the data concludes a flawed logistical planning, perhaps too optimistic for what it actually encountered on the ground, insufficient resources to provide supply lines to meet the needs of the fighting forces, and the inability of command structures to fall back when pre-conflict planning shortfalls are identified. The simultaneous opening of several fronts can also be a cause of stagnation and regression on medium and long term of the Russian army in view of the material and human resources needed to sustain the requirements for successful combat [4]. In the first phase of the conflict, the Russian Federation executed a multi-pronged attack on several fronts; on the northern front, the main objective was the conquest of Kiev. Russian forces pierced Ukraine from Belarus with parachute and mechanized infantry structures, which is a fundamental doctrinal error in the use of airborne forces in the offensive simply because they are effective for short periods of time to reach an objective where the enemy defence is not coherent, requiring the parallel advance of ground and support troops, which on the northern front in Ukraine was carried out with difficulty; the north-eastern front was opened by the Russian Federation simultaneously with the southern and eastern front by the well-known Russian BTGs (Battalion tactical group), units providing a rapid response, subordinate to the Russian armed forces [5]. From the first year's data, the Russian army had the fighting forces to engage in a conflict of such a scale, but did not plan coherently to provide the logistical needs, and the military on the front faced major difficulties because of this, and this paper is precisely concerned with operational-level activities of the supply lines on the Ukrainian conflict front, a vital subfield of logistical support in time of conflict, trying to identify some of the shortcomings that contributed to change the course of the war, a course which, comparing the ratio of forces of the two states, favored the Russian Federation in the first phase of the conflict [6].

## 2. THE IMPORTANCE OF LOGISTICAL SUPPORT

The rationale for logistic support in times of conflict is based on the following concepts: prioritization of the logistic needs of a mission; all the effort put into logistic support to forces, both military and civilian providers, must be focused on meeting the needs of the mission; cooperation and coordination. An important component in the provision of logistic support to a mission is determined by the cooperation and coordination of specialist personnel within the logistics structures with the forces participating in actions of a military nature. Sufficiency, in the planning process of any military action, all the needs that may arise during the course of carrying out objectives, needs that must tick both the quantity and quality required. Simplicity and flexibility; logistics must meet all the conditions of "flexible logistics", structures must be able to cope with the unexpected, reduce risks from the planning stage onwards, and supply items from all classes of supply in the best conditions.[7].

It will look generically at logistical support to forces from a multiple perspective. On the one hand, the *North Atlantic Alliance* politico-military alliance logistics doctrine will be used, together with the *Rules of the Joint Operations Logistics*, national doctrine, for the supply of forces at operational and tactical level, but also elements of the doctrine of the Russian Federation, the state leading the offensive in Ukraine. Logistical support is only possible through the existence of supply lines, which must meet a number of requirements in order to exist and withstand enemy attacks.

The term “supply line” is a suggestive name for the fundamental mission of logistic structures, i.e. the supply of the force, a mission which implies covering the need for supply of materials and equipment indexed in all classes of supply.

In times of conflict, force supply becomes a challenge for logistical planning structures and movement and transport structures given the unpredictable evolution of the front to the advantage or detriment of the army itself [8]. We thus distinguish supply lines constituted at the operational and tactical level, I, II and III, as well as strategic level supply lines, level IV. The tactical level structure providing logistic support to the force is placed in the district at a distance that allows the delivery of a continuous flow of materials of all supply classes to the fighting force, which is also the case when the Russian Army's logistic structure is placed in the district where the action is taking place, the command post of the logistic structure serving a brigade-type unit being positioned at a distance of about 15 kilometers from the front line with access to the railway infrastructure. The logistical support line is set up between the deployment district and the front line and meets a number of requirements: supply and evacuation routes, base and reserve routes, en-route roads, and units or sub-units, depending on the size and importance of the support line, to protect the logistical support. The supply and evacuation axes consist of roads of the public infrastructure system land, air and sea in the vicinity of the military action, so the maintenance of communication routes is ensured by the logistic structures through specialized units [9]. In terms of doctrine, the Russian Federation Army divides its logistical structures and logistical effort into three steps (operational, tactical and strategic), in the same way as the other two doctrines mentioned above. The logistic effort is divided into: national-level logistic support, force categories, divisions, brigades, regiments and battalions. One difference in the logistical structure of the Russian Federation's armed forces compared to Western European armies is the subordination of the support structure to that of the fighters. Specifically, a Russian infantry battalion is supported by a logistics support platoon in contrast to the same type of combat unit in the US Army which is supported by a logistics company, thus showing the Russian Army's reliance on logistics support, giving it a lesser degree of importance than other Western states. [10] Similarities of a doctrinal nature are also found in the way logistic structures operate in the conduct of offensive actions, thus noting the waiting for orders from the higher echelon, planning of logistic support of the force, organization of defense and camouflage of subunits deployed in the district and providing the frontline forces with materials from all classes of supply.

## 3. SOUTHERN AXIS OF THE RUSSIAN-UKRAINIAN FRONT, SEPTEMBER 2022

This section will describe the military actions of the armies of the two states in the Russian-Ukrainian conflict, military actions that will mainly provide an image of the logistic support executed by the logistic structures of the Russian Federation Army, the research is based on the following spatial-temporal indices: Ukraine, the southern axis of the Russian-Ukrainian front in September 2022. On September 1, 2022 Ukrainian forces attacked Russian logistical nodes and command points in the area of Kherson oblast in the counter-offensive on the southern front. Ukrainian military officials in the General Staff said they destroyed command posts and weapons depots of the of the Russian Federation army between 29 and 31 August 2022. Oleksiy Gromov, the deputy of the Ukrainian Main Operational Department, claimed that the attacks took place using home-made missiles, UAVs, and artillery in meeting targets in the southern part of the front.

The Ukrainian Southern Zone Operations Command (U.S.Z.O.C.) reported that its own forces destroyed a makeshift pontoon bridge on the Inhulets River in Darivka positioned about 18 km northeast of the city of Kherson.

Ukrainian forces began attacks on the bridge as early as 29 August to ensure the impossibility of a prompt enemy response to a planned and executed offensive by Ukrainian army during this period. The U.S.Z.O.C. also reported the hitting of 6 arms depots that served the Russian army on the southern front of Ukraine, more specifically, Bersylavsky and the Khersonsky area. In response to the counter-offensive launched by Ukrainian forces in the Kherson area, the Russian army has moved a number of troops from eastern Ukraine south across the Kerch bridge in the form of military convoys [11]. On 2 September, the attacks against the logistical support of the Russian Federation army. The U.S.Z.O.C. declared the hitting of a ferry crossing the Dnieper River and providing supplies to the frontline forces. The Ukrainian General Staff states that they neutralized 5 Russian precision artillery pieces, an armament depot, and a company-level subunit in the Enerhodar area. Residents of Kherson reported the Russian pontoon bridge near the Antonivsky bridge being hit. Also, 9 km southeast of Kherson, Ukrainian artillery hit Russian technical equipment waiting to be loaded onto a ferry from the town of Oleshky [11]. Lieutenant-Colonel Oleksiy Arestovych told Wall Street on 3 September that the objectives set for the campaign on the southern front are centred on discovering and neutralising the structures providing logistical support to the Russian armed forces, thus making it possible for Ukraine to conduct a counter-offensive. Ukrainian forces have also continued their efforts to uncover and destroy the Russian Federation's ground lines of communication (GLOCs), troop massing and technical equipment. The U.S.Z.O.C. declared 22 air strikes and 400 Ukrainian artillery engagements on 3 September on the Russian 205th Mechanized Infantry Brigade around the town of Snihurivka, on a pontoon bridge crossing a river near Kozatske, an important element in providing logistical support to the forces. On 5 September, the Ukrainian General Staff reported the destruction of 6 trucks under the control of Russian logistical structures by an anti-aircraft missile strike [12]. On 7 September the Ukrainian armed forces took advantage of the relocation of Russian units and managed to retake 400 square kilometres of Ukrainian land in the area of Kherson oblast. The U.S.Z.O.C. reported the execution of 250 missions by its own forces between 6 and 7 September and the General Staff Ukrainian said the neutralization and striking of several operational and tactical level ammunition and fuel depots succeeded in suppressing the logistical response along the entire southern axis of the Ukrainian front. Next, September 8 captures satellite images of the relocation of a new ferry on the Dnieper River in the area of Kherson in providing logistical support and the destruction of two pontoon bridges on the Dnieper and Inhulets rivers [13]. From 8 to 30 September, Ukrainian troops continued attacks on Russian supply lines, logistical elements, underground communication routes, enemy troops, using artillery, UAVs, HIMARS precision missile system received from the US Army, while advancing their own troops in the liberation of territory on the southern axis of the front. During this period Ukrainian troops advanced about 60 km from near Mykolaiv south to near Kherson [11].

## 4. ANALYSIS OF THE KEY EVENTS OF THE RUSSIAN-UKRAINIAN CONFLICT FROM THE POINT OF VIEW OF SUPPLY LINES

The Ukrainian army's campaign to locate and neutralize all logistical support capabilities of the Russian Federation army proved to be the best strategy adopted on the southern front of the Russian-Ukrainian conflict, with Ukrainian troops succeeding not only in halting the advance of enemy troops, but also in going on the offensive at the end of 2022 positioned north of the Dnieper River, retaking the city of Kherson.

Logistical support capabilities include operational and tactical level depots in the conflict zone, depots of all supply classes, bridges located in districts near the front line, supply lines, and logistical support technology.

These are elements which, having been destroyed by the Ukrainian army, changed the course of the offensive launched by the Russian Federation in early 2022 [11]. The Antonivsky Bridge located in Kherson oblast, near the town of Kherson over the Dnieper River facilitated the crossing between two oblasts on the M14 highway: Kherson and Crimea. The strategically important bridge served the Russian military for the first half of 2022, facilitating a possible continuous flow of military personnel, as well as materials specific to logistical support, such as weapons, ammunition, food, fuel, a potential flow that was established between the area controlled by the Russian Federation, the naval port of Sevastopol, and the city of Kerch, towards the southern axis of the Russian-Ukrainian front. Between 17-27 July 2022, the Antonivsky bridge was hit three times by the Ukrainian army. On the night of 26-27 July 2022, the third attack on the Antonivsky bridge was launched using the High Mobility Artillery Rocket System (HIMARS) as follows: 8 rockets on the road-bound bridge and 2 rockets on the rail-bound bridge, which is 6km east up the Dnieper River, resulting in the Russian army slowing down logistical support to the forces. Kirill Stremousov, Deputy of the Kherson Oblast Administration, announced immediately after the incident the closure of the road and rail bridges [11]. This was confirmed by official statements from the UK Ministry of Defence on 13 August 2022 which stated that the bridge was damaged and its structural strength was questionable. It also refers to the railway bridge in the vicinity of Kherson, which it states is damaged. On 27-29 August, satellite images showed that the Russian army had started work on a pontoon bridge near the Antonivsky Bridge. The alternative used to allow logistical structures to cross the Dnieper River was the installation of a ferry north of the town of Kherson, a ferry that has limited capacity for loading technical equipment, which led to a slowdown in the flow of supplies of all classes to the front line. The Ukrainian Southern Area Operations Command reported on 3 September the location and destruction of a pontoon bridge across the Dnieper River in the area of Kozatske (approximately 55km from the city of Kherson) [11]. Also on 8 September the represented by the destruction of 2 other pontoon bridges by Russian gennistic structures crossing the Dnieper and Inhulets rivers. From the attacks centered on these critical infrastructure points, one can discern a pawn strategy, [11] which, according to official data, has a force ratio approximately 5 times smaller than its opponent, [14] a strategy based on slowing down, blocking the advance of enemy troops, using precision missiles from HIMARS systems and the terrain of the national territory, a case in point being the Dnieper River, Ukraine thus managing to establish a demarcation line between the two armies along this river. On 11 November 2022, Ukrainian troops entered the city of Kherson and retook possession of it, with Russian forces retreating south of the Dnieper River.

Stellar images showed the consolidation of a new Russian base 70 kilometers southeast of the city of Kherson, a distance most likely established in order to get out of missile range of the HIMARS [13]. On 12 November, Ukraine's Southern Area Operations Command officially declared Kherson retaken. Another element in the area of providing logistical support is the establishment of depots of all supply classes close to the front line at operational and tactical level. The Russian Federation Army has adopted the same strategy, positioning armaments and ammunition depots in the area of the Kherson oblast to shorten supply lines considerable and to ensure a continuous flow of material between logistic structures and the fighting force.

Thus, the Russian Federation acted in accordance with its own national doctrine, but due to shortcomings the depots were discovered and destroyed.

As an example of the events of 29-31 August 2022, in the campaign conducted by Ukraine to locate and neutralize all logistical support capabilities of the Russian Federation army, six weapons and ammunition depots were located and destroyed by Ukrainian forces in the town of Beryslavskyi and Kakhovskyi district [11]. Another ammunition depot was also hit on 5 July in the town of Kherson, near the town's railway station, and on 3 September 2022 an ammunition depot in the town of Oleshky was also hit [13]. Interpreting this data, it can be said that the Russian logistical planning structures have positioned these depots in key points of the oblast in the conflict period. The depots maintained a balanced distance from the front line, were positioned near road or rail infrastructure that ensured the continuity of the supply line from the strategic to the operational level, exemplified by the destroyed depot in the town of Oleshky that met these criteria: access to the railway line railway, location close to the M14 motorway, but also close to Kherson. This is also true of the depots in Beryslavskyi and Kakhovskyi district, where the geographical position and the front line at the time allowed them to create a supply line to the fighting forces. The fluidity of the supply lines was facilitated by the M14 motorway running through the Kakhovskyi district, the railway infrastructure, and the bridge over the Dnieper in Nova Kahovka.

However, the above mentioned deposits were located and destroyed. There is no official data on the causes of these events, but a number of hypotheses can be made. There is a possibility that requirements for camouflage of military objectives were not respected, but also the possibility of information leakage, thus giving the opponent a chance for an immediate, prompt and accurate artillery response. The solution found by the Russian army after repeated artillery strikes by the Ukrainian army on the bridges across the Dnieper was, in addition to the pontoon bridges of the genesis structures, the technical ferry crossing, a solution that ensured continuity of material flow between logistical structures and the front line in the Kherson Oblast area, but their quantity was a limited one in contrast to a supply line that consists of a working bridge across the Dnieper, not a ferry. In an effort to sabotage Russian logistical support structures on the southern front of the Russian-Ukrainian conflict, Ukrainian partisans undertook actions aimed at disrupting rail supply lines between the towns of Melitopol and Zaporozhye. On the night of 23-24 July 2022, Ukrainian partisans blew up a railway junction near the town of Novobohdanivka, a railway that was probably used to transport material goods and personnel between large warehouses and Russian tactical-level fighting structures on the front line [13].

## 5. CONCLUSIONS

The year 2022 was a landmark year for the European security environment, but also for the Ukrainian people. The "special military operation" started by the Russian Federation, which later turned into a conventional conflict, is a topic of discussion among military, political and economic analysts. This topic of discussion, seen from the perspective of logistical support, gives specialists the opportunity to re-examine doctrinal concepts of the logistics of their own states through the lens of a topical conflict, a conflict between two pawns on the European map, where new requirements of the front are to be found. The line of tactical-level supply, an element of the logistical support examined in this paper, is a decisive factor in sustaining the fighting force and holding the front line.

Translated into the reality of the conflict, the Russian Federation Army's supply lines suffered from a combination of possible factors: the predictability of the supply, leakage of information, insufficient camouflage of logistical structures, conducting an offensive on enemy territory, disabling critical infrastructure points or poor logistical planning of military actions. Thus, a likely assumption regarding this logistical support element, the supply line, on the southern axis of the Russian-Ukrainian conflict, the decommissioning or limited capacity of these supply lines led to the loss of initiative of Russian forces to lead the offensive, subsequently retreating to new defensive positions towards the end of 2022. This paper discusses concrete data of military actions undertaken by the two armies of the Russian-Ukrainian conflict, interpreted in terms of logistical support and its importance. At the beginning of 2023, no conclusions can be drawn about the Russian Federation's conflict with Ukraine simply because it is still ongoing. However, it is possible to identify planning mistakes, structural shortcomings, the difficulties faced by tactical level structures on the front line, and every reader can form their own opinion on the current security situation in Europe.

Concluding all the information presented, it is possible to form a picture of the logistical support needs present in a 2022 conflict, but it is not possible to make a forecast of the evolution of the front line in a medium or long time horizon, the reason being the complexity of a war, the variables that can change to the advantage or detriment of any player.

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# AN UPGRADE TO THE GEPARD SYSTEM. POSSIBLE USAGE OF THE CA-94

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***Abstract:*** *The threat to state security is constantly evolving, and there are many factors that directly impact its development. Two of the most significant factors are the increasing prevalence of advanced weapons systems such as tactical ballistic missiles, air-to-surface missiles, antiradar missiles and cruise missiles, which pose a significant threat to land targets and require the improvement of air defense systems. Additionally, the threat to state security is also influenced by the dangers faced by ground troops in the battlefield, including the constant threat of aerial attacks.*

*To address these threats, mixed air-defense systems can be used to optimize the characteristics of both guns and missiles. This approach integrates small caliber anti-aircraft guns and VSHORAD missile systems to provide troops with increased coverage and efficacy against a variety of targets. Two Romanian developments in mixed air-defense systems theory are presented in the paperwork, providing basic considerations for the development and implementation of such systems. Overall, the evolving threat to state security requires ongoing innovation and adaptation to ensure the safety and security of nations and their citizens.*

***Keywords****: VSHORAD, mixed air-defense system, air-to-surface missiles, improvement.*

## 1. INTRODUCTION

The Gepard Mobile Air Defence System is a well-known air defense platform that has been in service for many years. The system, developed by the German company Krauss-Maffei Wegmann, was originally designed to provide comprehensive air defense to mechanized units and mobile formations, with a focus on engaging low-flying targets such a helicopters , aircraft. The Gepard system has been deployed by several countries around the world and has proven to be effective in various combat scenarios.

While the Gepard system is a robust air defense platform, there is always room for improvement in light of emerging threats. One potential upgrade to the Gepard system is the addition of the CA-94 surface-to-air missile (SAM), which could significantly enhance the system's capabilities. The CA-94 is a man-portable, shoulder-fired SAM system that has b2een widely used by various armed forces around the world, and has a high success rate in engaging low-flying targets such as helicopters and aircraft.

The Gepard system has undergone several upgrades over the years, including the Gepard 1 A2 variant which features improved radar, fire control, and engagement capabilities. However, the addition of the CA-94 SAM could further enhance the system's engagement range and improve its ability to engage fast-moving targets. The CA-94 SAM's portability and reliability make it an attractive addition to the Gepard system, which is already known for its mobility and flexibility on the battlefield.

In this paper, we will explore the potential benefits and drawbacks of upgrading the Gepard system with the CA-94 SAM, including its impact on the system's effectiveness, engagement range, and overall combat capabilities.

We will also discuss the strong and weak points of both the Gepard system and the CA-94 SAM, and examine how their integration could contribute to a more robust air defense platform.

**FIG.1** The Gepard System with CA-94 attached. (ROMEXPO 2005)

## 2. GEPARD SYSTEM Upgrade with CA-94 SAM

The effectiveness of the Gepard Mobile Air Defence System has been demonstrated through years of service and combat operations. The system's ability to provide comprehensive air defense to mechanized units and mobile formations is well known and highly valued by military forces around the world. However, with the emergence of new threats, it is important to continually improve and upgrade the system to maintain its effectiveness.

One potential upgrade to the Gepard system is the addition of the CA-94 surface-to-air missile (SAM). The CA-94 is a highly effective missile that has been used by many countries for air defense purposes. The addition of the CA-94 to the Gepard system would provide an additional means of engaging airborne targets, which would increase the overall effectiveness of the system.

The Gepard system is equipped with a fire control system, radar system, and electro-optical tracking system, which allow it to detect and engage low-flying targets such as helicopters and aircraft, as well as ground targets such as lightly armored vehicles and infantry. With the addition of the CA-94, the system would have an increased ability to engage a wider range of airborne threats.

The CA-94 is a portable, shoulder-launched missile that has been widely used by both state and non-state actors. It is designed to be easy to use and highly effective against low-flying targets such as helicopters and aircraft. The missile is equipped with an infrared seeker that allows it to track the heat signature of the target, making it highly accurate and difficult to evade.

The CA-94 can be used as a standalone system or as part of a larger air defense network. When used in conjunction with the Gepard system, it would provide an additional layer of defense against airborne threats, increasing the overall effectiveness of the system.

### 2.1. Weak points.

However, there are also potential weak points associated with upgrading the Gepard system with the CA-94 SAM. One of the main concerns is the system's vulnerability to countermeasures.

The CA-94 SAM is a relatively old missile system, and its effectiveness against modern countermeasures such as flares is uncertain. In addition, the CA-94 SAM is a man-portable system, which means that it requires a separate crew to operate it. This could increase the logistical burden associated with operating the Gepard system.

One potential weakness of the CA-94 is that it is a short-range missile, with a maximum effective range of around 4 kilometers. This means that it may not be effective against high-flying targets such as jet aircraft or ballistic missiles.

Another potential weakness of the CA-94 is that it is a line-of-sight weapon, which means that the operator must have a clear line of sight to the target in order to engage it. This can be problematic in certain environments, such as urban areas or heavily forested terrain. However, the Gepard system is designed to operate in a variety of environments, and its radar and electro-optical tracking systems can be used to detect and engage targets even when line of sight is obstructed.

The addition of the CA-94 surface-to-air missile to the Gepard Mobile Air Defence System would increase the system's effectiveness against airborne threats. While the CA-94 has some weaknesses, such as its short range and line-of-sight requirements, these can be mitigated through the use of other weapons systems and the Gepard system's advanced sensors and tracking systems.

**2.2. Eficiency**

The Gepard Mobile Air Defence System is a highly efficient and reliable air defence platform that has been in service for many years. However, in light of emerging threats, there is always room for improvement to enhance its capabilities. One potential upgrade to the Gepard system is the addition of the CA-94 surface-to-air missile (SAM), which would improve the system's range and efficiency.

The CA-94 is a man-portable air defence system (MANPADS) developed by the Soviet Union in the late 1960s. It is designed to engage low-flying targets such as helicopters, aircraft, and UAVs at ranges up to 4.2 km (2.6 miles). The missile is guided by an infrared seeker and can reach speeds of up to Mach 1.6, making it highly effective against fast-moving targets. The addition of the CA-94 to the Gepard system would significantly enhance its capabilities, allowing it to engage targets at greater ranges and with greater accuracy.

In addition to the CA-94 upgrade, the Gepard system has several other features that make it highly efficient and effective. The Gepard's 35mm Oerlikon cannon is capable of firing up to 550 rounds per minute, with a maximum effective range of 4 km (2.5 miles). The system's fire control system and radar provide excellent tracking and targeting capabilities, enabling the Gepard to engage multiple targets simultaneously with high accuracy. The Gepard also has a highly reliable and robust chassis, which allows it to operate in harsh terrain and extreme weather conditions.

The Gepard's range and efficiency are further enhanced by its ability to operate autonomously or in a networked configuration with other air defence systems. This allows it to share data with other systems and provide a comprehensive air defence umbrella over a wide area. The Gepard system's mobility is also a key factor in its efficiency, allowing it to rapidly deploy and reposition in response to changing threats or mission requirements.

**2.3 Effectiveness**

System would provide an additional layer of defense against airborne threats, increasing the overall effectiveness of the system. While there are potential weaknesses associated with the CA-94, such as its short range and line-of-sight requirements, these can be mitigated through the use of other weapons systems and the Gepard system's advanced sensors and tracking systems. The CA-94 is a proven missile system that has been used by many countries for air defense purposes, and its effectiveness has been demonstrated in various conflicts around the world.

The upgrade to the Gepard system would provide mechanized units and mobile formations with comprehensive air defense capabilities, which would be highly valued by military forces around the world. As threats continue to evolve, it is important to continually improve and upgrade the system to maintain its effectiveness.

The addition of the CA-94 would be an important step in this process, and would help to ensure that the Gepard system remains a reliable and effective air defense platform for many years to come.


**FIG. 2** The Gepard System with CA-94 attached. (ROMEXPO 2005)

## 3. CONCLUSIONS & ACKNOLEDGMENT

In conclusion, the addition of the CA-94 surface-to-air missile to the Gepard Mobile Air Defence System would provide an additional layer of defense against airborne threats, increasing the overall effectiveness of the system. While there are potential weaknesses associated with the CA-94, such as its short range and line-of-sight requirements, these can be mitigated through the use of other weapons systems and the Gepard system's advanced sensors and tracking systems. The CA-94 is a proven missile system that has been used by many countries for air defense purposes, and its effectiveness has been demonstrated in various conflicts around the world.

Overall, the Gepard system with the CA-94 upgrade would be a highly effective air defense platform, capable of providing comprehensive protection to mechanized units and mobile formations.

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# A HOLISTIC VIEW OF STEALTH CHARACTERISTICS OF THE F-16 OPERATED BY THE ROMANIAN AIR FORCE, IN TERMS OF THE GENERAL LO (LOW OBSERVABILITY) CAPABILITIES AVAILABLE FOR THIS AIR PLATFORM

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***Abstract:*** *The property of aircraft or any military asset to be invisible or nearly invisible to the radar effect is a considerable advantage in air combat. Self-protection during aerial battles is not only about the use of the weapon system, as the technology in the field of aeronautics is developed continually and more and more identification equipment is being fitted to modern aircraft.*
*The importance of the following paper is to provide knowledge about the most controversial technology for avoiding detection by hostile radars, the methods for its implementation in modern aircraft and the prospects for the future of this relatively new facility. It is important to know what is the level of the Romanian Air Force aircraft in terms of stealth features, specifically technical data about the airframe and radar absorbing materials from which they are made and even the prospects of their survival in a possible conflict, depending on their operating capabilities. From an engineering point of view, the construction of these improved flying machines has been difficult, because the problem of ensuring a balance between their structure and flight aerodynamics (in order to obtain reliable mechanisms) inevitably occurred. As a result, it will be clarified the principle approached in the creation of low observability air platforms, and it will be possible to outline a comparison between the version of the F-16 Fighting Falcon owned by Romania and the stealth capabilities of other blocks of the same aircraft.*

***Keywords :*** *detection; radar-absorbing materials; low observability; flight aerodynamics.*

## 1. INTRODUCTION

The exponential technological advance of recent years is primarily associated with the ease of global dissemination of information in a context that aimed to collect, process, interpret and use them to increase mobility. Following the development of the technological era, airborne forces have been endowed with a range of optimized capabilities to counter enemy offensive actions and intercept threats by the algorithms of electronic countermeasure techniques, with the possibility of targeting high-precision weaponry and facilitating destabilization of the opponent. Stealth technology or low observable technology is a part of the military tactics which targets the methods used to make personnel, ground vehicles, aircraft, ships, or other military capabilities less visible to detection methods.

## 2. NEEDS

Stealth aircraft emerged as a need for camouflage in the electromagnetic spectrum and aimed to increase the chances of avoiding enemy radar detection, so that airspace supremacy could be achieved. Some difficulties occurred while creating such a flying machine, capable of reducing thermal emission from thrust. The first attempt was registered during World War I when Germans used Cellon (cellulose acetate) for the construction of aircraft, a transparent covering material, which turned out not to meet the characteristics of stealth innovations. The material was proved to be affected by sunlight and drastic temperature changes, so it was considered counterproductive and was no longer used. After almost three decades, a fighter bomber (Horten Hoo 299) is conceived in Nazi Germany and seems to fulfill some stealth characteristics, as its design does not include vertical surfaces. This concept allows the aircraft to operate without being identified by enemy forces. Through the years, interception technologies have evolved and, as a result, modern stealth vehicles were also brought to the next level.

**FIG.1** Horten Hoo 299

## 3. EVOLUTION

In the initial stage, the development of such aircraft capable of deceiving radar activity was focused mainly on its radar cross-section characteristics, and, as a consequence, the aerodynamic performances were left in the background. This led to the construction of fighters that were indeed difficult for radar receivers to perceive, but whose manoeuvrability did not allow them to fight an aerial battle advantageously or safely. Thus, researchers began to develop planes whose shape was not rounded but were made of flat surfaces, so that the reflected signal did not return to the transmitter. It was also intended to cover them with materials capable of absorbing radar signals. An important thing to mention is that not only the outer material is a criterion to be met when building such a flying machine, but also the concept beyond what is visible from the outside. The interior of stealth aircraft is made up of concave triangles (reentrant structures with angles between 180 and 360 degrees) that capture the signal and block it until it loses energy. As a general principle, the intersection of three flat surfaces is known to be the simplest method of reflecting a signal back toward the direction of transmission, which is why new-generation aircraft are conceived in a different way. Usually, these reflective corners are formed in the vertical stabilizer area, so the latest technologies use another design for it or even completely omit the tail. A great example is the *NORTHROP B-2 SPIRIT* (also called the Stealth Bomber) which can operate in electromagnetically dense environments without being intercepted.

*NORTHROP GRUMMAN B-2 SPIRIT* had its first flight 33 years ago and it was a remarkable innovation of the time, primarily because it is considered the only aircraft that can operate with *STANDOFF WEAPONS* in stealth layout. This equipment actually comprises either bombs or missiles capable of being launched from a distance that allows the attacker to leave the impact zone and avoid the effect of the weapon in time.

It is worth mentioning that despite their short range of action, they have very high effectiveness and are a real advantage in air combat. The B-2 stealth bomber has a specific shape, a flying wing, which is based on the property of convex surfaces to spread the waves from the radar to different directions so that the quantity of energy reflected back is drastically reduced. Other features of the plane send the impacting radar signals in any other direction than that of the transmitter.

**FIG.2** Northrop B-2 Spirit

## 4. DESIGNING FOR STEALTH

What are the steps by which we manage to on the radar display a symbol that does not signify a threat, when in fact it is a combat aircraft weighing tens of tons? To avoid providing valuable information about their own technology to the enemy, the design details of stealth aircraft are tracked down to the smallest detail.

### *A. VISUAL*

Although the human eye is sometimes underestimated to the detriment of onboard equipment, in many cases the pilot can visually observe a hostile force before it appears on the instrument panel. This is why man has tried to camouflage aircraft by painting them in shades of blueish grey underneath and greenish grey above. The choice of colors relates to the perspective from which a fighter plane is viewed: from above it has to resemble the shades of the earth, and from below, the sky.

Another thing the engineers are considering is the use of light-coloured paints that minimize the shadows formed on the aircraft due to its hulls.

New engines can also reduce exhaust fumes and minimize moisture by using additives in the exhaust gases. It also reduces pressure differences around the wings.

### *B. RADAR*

What designers aim for in aircraft design is to avoid forming 90-degree angles or using flat surfaces that reflect radio waves back toward the direction of emission. The basic principle is that electromagnetic waves will travel along surfaces until they meet a discontinuity, so, to stop the high intensity of the echo, the edges are made in a specific shape": saw teeth. The energy from radio waves that touch surfaces covered in radar-absorbing materials converts into heat. Whether absorbent materials are used outside or inside the fuselage, they are typically made of fibreglass.

### *C. HEAT*

Stealthy aircraft have to reduce heat emissions. In order to do that, engine intakes or engine exhausts can be mounted above the wings, so that the heat-seeking missiles that

are shot from below have fewer chances to detect them. Any feature of the plane can affect its manoeuvrability, which is why the best fighters follow more traditionally located inlets or exhausts.

Air friction is another important source of heat. Whose effect is mainly found at the leading edge of the wing. The aircraft's signature is reduced in this case by putting cool jet fuel in the interior of the wing. The use of IR-absorbing paints is necessary in order to beat the infrared radiation caused by sunlight glinting.

***D. NOISE***

Noise comes from the engines of aircraft. If the engine is placed on top of the fuselage, the sound heard on the ground is diminished. Designers focus on creating quiet engines, capable of generating thrust by increasing the amount of air absorbed and accelerating it less. More air leads to a more dampened sound.

**FIG. 3** NASA's X-59 Supersonic jet – Quiet Engine

## 5. THE FIGHTER PLANE OF THE ROMANIAN AIR FORCE

Romania's airspace is defended by the F-16 Fighting Falcon aircraft. Our country has 17 aircraft bought second hand, which have been modernized through the Mid-Life Update (MLU) program. At the base, they are F-16 A/B block 15, and following the process mentioned above, they have become improved weapons, reaching the equivalent of block 40 with some elements of block 50/52. The need for enhanced capabilities has led to the acquisition of a new tranche of some A/B block 20 aircraft, which will be similarly upgraded. Although they are considered world-class aircraft, their nature does not allow for many stealth capabilities to be incorporated. These aircraft were specifically designed to have particularly good maneuverability, down to the finest details, and, as mentioned earlier, stealth configurations would reduce it considerably. The F-16 has two horizontal stabilizers and a vertical one, which form 2 corner reflectors, each of ninety degrees, a structure that is forbidden in stealth technology. As explained before, those can enhance radar images of the planes. So the fighter aircraft model that Romania owns cannot be considered a stealth one.

**FIG. 4** Romanian F-16 AM/BM Block 15

## 6. WHAT WOULD AN F-16 FIGHTING FALCON WITH A STEALTH CONFIGURATION LOOK LIKE?

A stealthy successor to F-16 was something discussed among designers. This prototype has some new features, such as internal weapons bays, two ventral intakes on the sides, huge internal fuel tanks, internal sensors, electronic warfare systems and targeting equipment. Of these, a big difference was made by doubling the vertical stabilizers. Its maneuverability has been analyzed for stealth configuration and the loss of speed that created control problems at high alpha angles has been solved. However, the most important change is the avoidance of the two right angles at the tail of the aircraft. The overall design resembles that of the F-22 and YF-23. The prototype is manufactured in Forth Worth, Texas.

In the latest generations of aircraft, the radar cross-section (RCS) reduction has been optimized. However, it has been established that this section is not the same as the actual cross-section area. If the RCS used to be measured in square meters for past versions, now it relates to a metal sphere emitting the same radar energy as the plane, at the same altitude. This still makes it visible to radar, but from shorter distances ( 5-10 km), so it would be nearly impossible for defensive systems to react in time. This technique would have only been valid if the aerial platform was designed from the start with stealth capabilities. If the RCS of an F-16 was reconfigured with something similar to a Super Hornet, for example, radar detection would be reduced by 30-45%, leading to improved chances of mission success. The possibility of reducing the RCS of an F-16 consists of structural modifications, which is far from practical or affordable on a general level. Another feasible thing would be to adjust the outer surfaces. The program to improve the stealth capabilities of the F-16 is called Have Glass. It involves coating the fuselage in indium-tin-oxide, whose film appears to reflect radar waves and protect the pilot while sitting in the ejection seat. At the same time, RAM foam coating behind the radar antenna seems to be efficient, because it delays the radar effect and contains ferromagnetic particles that absorb energy. The Have Glass project was originally estimated to minimize the RCS of an F-16 by about 15 percent.

Apart from surface treatments, stealthier fighters should reduce their electronic signature by preserving communications and sensors.


**FIG.6** Stealth F-16 refit – a “brand new” concept

## CONCLUSIONS

One of the key features of stealth technology is the use of special materials and coatings that absorb or reflect radar signals away from the source, making the aircraft less visible on radar screens. These materials are often made up of composite materials that contain carbon fibers, which can also absorb radar waves.

Another technique used in stealth aircraft design is the shaping of the aircraft's body to minimize its radar cross-section. This means that the shape of the aircraft is designed to scatter incoming radar signals in a way that minimizes the reflected signal that comes back to the radar source. This is achieved by using flat surfaces, sharp edges, and other features that reduce the amount of radar energy that is reflected back to the source.

Additionally, stealth aircraft often use internal weapons bays to store their weapons instead of external pylons. This reduces the aircraft's overall radar cross-section and increases its ability to evade detection.

Overall, stealth technology is a complex and multifaceted approach to reducing the detestability of aircraft, and requires careful design and engineering. However, when properly implemented, it can make an aircraft much more difficult to detect and therefore, more effective in carrying out its missions.

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# AN INVESTIGATION INTO THE EFFECTIVENESS OF ENCRYPTION TECHNIQUES IN DATA PROTECTION

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***Abstract:*** *Data security and privacy are crucial in the current digital era. Sensitive information must now be protected using encryption methods due to the rise in cyberattacks and data breaches. When plaintext is encrypted, it is turned into ciphertext, rendering it unintelligible to those lacking the necessary decryption keys. The efficacy of encryption methods for data encryption is examined in this research article. The research investigates different encryption techniques, including symmetric and asymmetric encryption, and assesses their advantages and disadvantages. The significance of key management and the effects of quantum computing on data encryption are also covered in the research paper.*

***Keywords****: Encryption, Data Protection, Encryption Algorithms, Key Management, Security*

## 1. INTRODUCTION

Data encryption involves applying encryption techniques to change data from its original format into an unreadable one. Data security and privacy are ensured through encryption, which only allows authorized workers with the right decryption key to access the data. Given the frequency and sophistication of cyberattacks, the significance of data encryption cannot be emphasized. The effectiveness of data encryption is based on the quality of the used encryption algorithms and the control over the decryption keys.

## 2. ENCRYPTION TECHNIQUES

The word "plaintext" or "cleartext" refers to the data that needs to be encrypted. The plaintext must be transmitted using specific encryption techniques, which are essentially mathematical operations on unprocessed data. The applications and security indices of the various encryption techniques vary.

Together with the algorithms, an encryption key is also necessary. The plaintext is transformed into the encrypted data, sometimes referred to as ciphertext, using the specified key and an appropriate encryption technique. The recipient receives the ciphertext instead of the plaintext thanks to insecure communication connections. The intended recipient can employ a decryption key to restore the ciphertext to its plaintext form after it has arrived at their location. This decryption key, which may or may not be the same as the key used to encrypt the communication, must always be kept a secret.

Symmetric Encryption - Also known as secret-key encryption uses the same key for both encryption and decryption of data. The secret key and the plaintext are inputs into the encryption algorithm, which outputs ciphertext. The secret key and the ciphertext are inputs into the decryption algorithm, which outputs plaintext.

Large volume of data can be encrypted with symmetric encryption since it is quicker and more effective than asymmetric encryption. Its main drawback is that the secret key must be known by both the sender and the recipient. The encrypted data gets exposed if the secret key is stolen.

Asymmetric Encryption - Also known as public-key encryption, uses two different keys, one for encryption and one for decryption. The decryption key, also known as the private key, is kept a secret, whereas the encryption key, commonly known as the public key, is shared with everyone. Because the private key is never shared, asymmetric encryption is more secure than symmetric encryption but slower. With the recipient's public key, the sender encrypts the data, and the recipient uses their private key to decrypt it. This makes sure that the data can only be accessed by the recipient.

Key Management -Data encryption's strength is influenced by both the encryption technique and how the decryption keys are handled. To guarantee that encrypted data is maintained secure, decryption keys must be kept private. The process of managing keys includes their production, distribution, storage, and deletion. Key management includes key distribution as a crucial component. Both the sender and the recipient are responsible for making sure the recipient receives the right decryption key and that it is kept safe. Key storage is crucial because keys need to be kept in a safe place to avoid illegal access.

Impact of Quantum Computing - Data encryption could undergo a revolution thanks to quantum computing, which can defeat current encryption protocols. The ability of quantum computers to conduct calculations significantly more quickly than conventional computers allows for the rapid decryption of encryption keys. Researchers are working on post-quantum encryption algorithms that can fend off quantum attacks in order to combat the threat posed by quantum computing. These algorithms make use of mathematical puzzles that quantum computers find challenging to answer.

Symmetric Algorithms:

- 3DES(Triple Data Encryption Standard). It has a key length of 168 bits three 56-bit DES keys but due to meet-in-the-middle-attack the effective security is only provided for only 112 bits. However 3DES suffers from slow performance in software. Triple DES is well suited for hardware implementation. But presently 3DES is largely replace by AES.
- AES(Advanced Encryption Standard). The United States government and other organizations utilize the trusted standard algorithm. It uses 192- and 256-bit keys for very demanding encryption tasks even though it is incredibly effective in the 128-bit variant. AES is typically regarded as impervious to all attacks aside from brute force. Yet, a lot of internet security professionals think that eventually AES will be the preferred method for encrypting data in the commercial sector.
- Blowfish. This symmetric tool divides messages into 64-bit blocks and then individually encrypts each one. Blowfish has a reputation for being quick, adaptable, and unbreakable. It is free because it is in the public domain, which increases its popularity. Blowfish is frequently used in password management programs, e-commerce platforms, and payment security.

Asymmetric Algorithms:

- RSA (Rivest-Shamir-Adleman). An asymmetric encryption scheme is based on the factorization of the product of two big prime numbers. Only a user who is aware of these two numbers can correctly decode the message. RSA is frequently used for digital signatures, however it is slow for encrypting large amounts of data.
- ECC (Elliptic Curve Cryptography). It is an alternative technique to RSA, is a powerful cryptography approach. It generates security between key pairs for public key encryption by using the mathematics of elliptic curves. The ECC approach to

public key cryptography is based on the algebraic structure of elliptic curves over finite fields. As a result, ECC generate keys that are mathematically harder to decrypt. Because of this, ECC is regarded as a more secure version of public key cryptography than RSA and the implementation of the next generation.

Asymmetric encryption algorithms like RSA and ECC are typically slower and less secure than symmetric encryption algorithms like AES and Blowfish. Yet, key distribution and the validation of digital signatures are areas where asymmetric encryption schemes excel.

Which one is more efficient?

Both symmetric and asymmetric encryption are more appropriate in particular circumstances. For data that is at rest, symmetric encryption with a single key is preferred. To guard against theft or hacking, databases must have their data encrypted. This data only needs to be secure until it needs to be recovered in the future, therefore only the one key provided by symmetric encryption is needed. On the other hand, asymmetric encryption ought to be utilized when sending data to other people over email. If only symmetric encryption was used on data in emails, an attacker may steal or compromise the material by obtaining the key used for encryption and decryption. Asymmetric encryption is used by the sender and receiver to ensure that only the recipient can decrypt the data because their public key was used to encrypt it. Both encryption techniques are used in conjunction with other processes, like compression or digital signature, to provide further data security.

2.1 Charts.

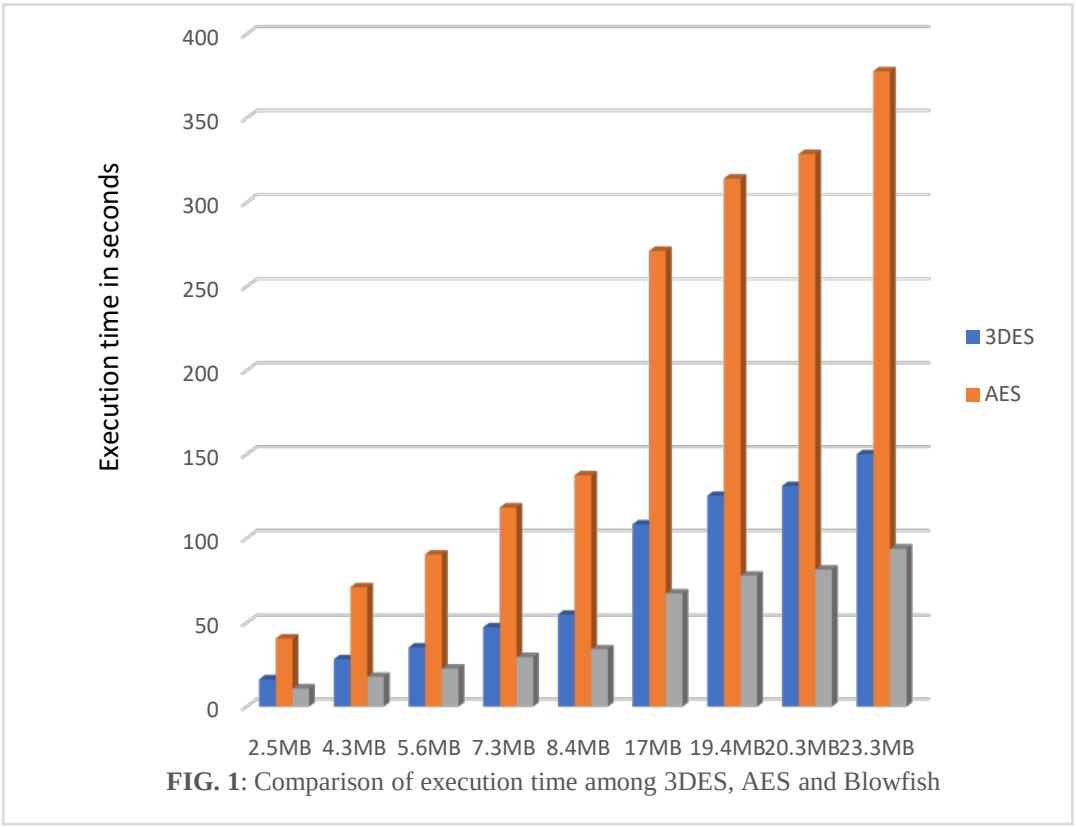


**FIG. 1**: Comparison of execution time among 3DES, AES and Blowfish

For various data input size, the performance execution times for the algorithms 3DES, AES, and Blowfish are shown in Figure 1. Blowfish has the worst execution, as is evident. AES is first used across all input sizes, then 3DES.

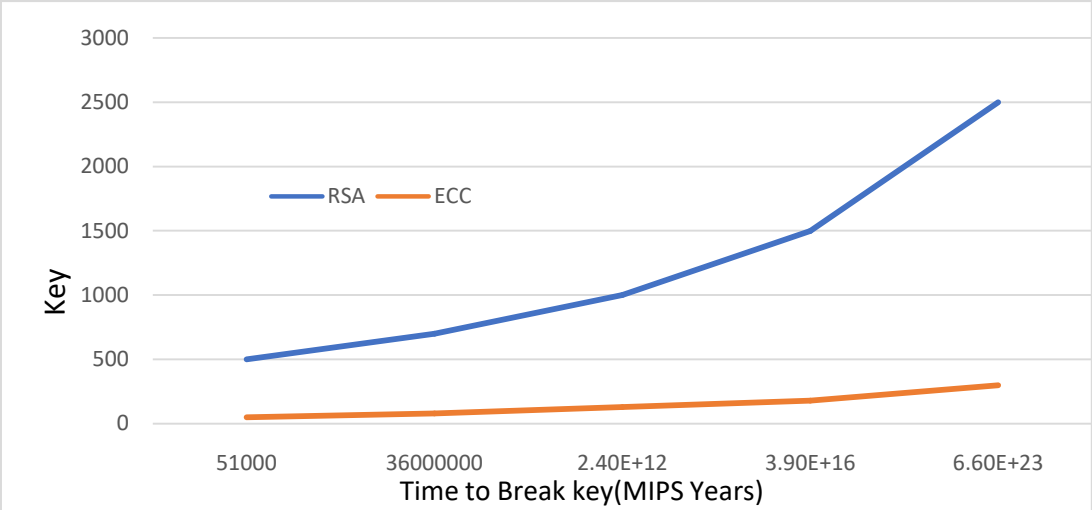


**FIG. 2** Comparison security level of RSA and ECC

Fig.2 contrasts the key lengths of each method and the degree of security assessed in MIPS-Years, illustrates this. Due to its reduced key size to achieve the same level of security, ECC is more effective than RSA in terms of key lenth. Small key sizes can reduce Computation and storage requirements, making them more efficient than RSA.

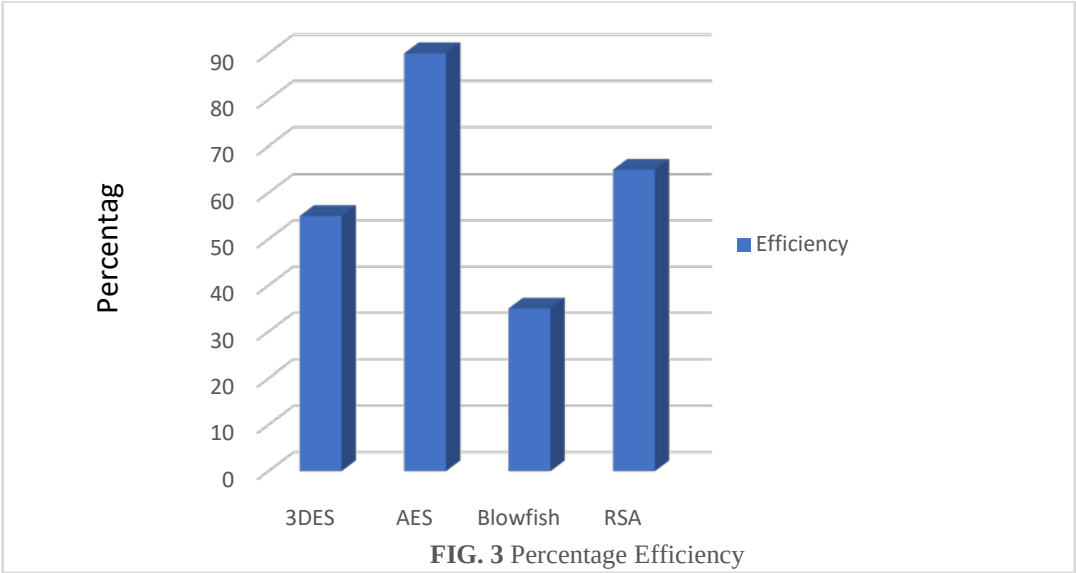


**FIG. 3** Percentage Efficiency

Fig. 3 is showing the effectiveness of different encryption algorithms. As shown in the chart AES is most effective between the ones shown in the chart and Blowfish is the least effective. Probably this was the case before the appearing of ECC, which in present is the most secure one. In Table 1 is displayed the time taken to generate ECC and RSA key with different input key sizes. While both ECC and RSA offer the same level of security, it can be seen that ECC's key length is less than RSA's. ECC employs a smaller key size than RSA, hence it generates keys faster.

*Table 1: Key generation Performance*

| Key length in Bits | | Time(s) | |
|---|---|---|---|
| RSA | ECC | RSA | ECC |
| 1024 | 163 | 0.16 | 0.08 |
| 2240 | 233 | 7.47 | 0.18 |
| 3072 | 283 | 9.8 | 0.27 |
| 7680 | 409 | 133.9 | 0.64 |
| 15360 | 571 | 670.06 | 1.44 |

## CONCLUSIONS & ACKNOLEDGMENT

In conclusion, the choice of encryption method relies on the particular situation and security requirements. Both businesses and individuals should carefully weigh the advantages and disadvantages of various encryption methods before choosing the one that best suits their needs. It is possible to conduct additional research to enhance the performance and security of encryption algorithms, particularly in light of contemporary dangers like quantum computing. ECC is superior to RSA in most parameters for the asymmetric algorithms RSA and ECC with the exception of the time required to generate the signature verification key. The benefit of ECC has an advantage over RSA because it uses shorter keys for encryption and decryption while maintaining RSA's level of security. ECC and RSA are two effective asymmetric techniques for encrypting data. Unfortunately, because symmetric algorithms like AES and Blowfish take a lot of resources, they are not as effective as those.

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# THE IMPACT OF DISINFORMATION AND PROPAGANDA ON INTERNATIONAL SECURITY. ANALYSIS OF RUSSIAN AGGRESSION AGAINST UKRAINE

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***Abstract:*** *Since the beginning of Russian aggression against Ukraine, the international security system has changed drastically. There are various factors, which make it difficult to reclaim peace and balance. One of them is disinformation and propaganda. The aim of this paper is to show the difference between these terms and illustrate their impact on international security using Russian aggression against Ukraine, as well as present the function of mass media in the existence of those two dangers. The main research problem of the paper is: How can disinformation and propaganda affect international security? For the realization of such an aim and to provide an answer to the research problem, methods of Russian propaganda and disinformation activities were analyzed as well as cases from either international organizations or the academic community were used.*

***Keywords****: disinformation, propaganda, international security, Russia, mass media*

## 1. INTRODUCTION

Even though disinformation and propaganda are separate terms included in information security, they are constantly being merged, equated, and mistaken. There are plenty of different definitions, which, in fact, are not full enough to put a bold line between these phenomena. Moreover, in order to distinguish them, particular assumptions have to be adopted, but there is no guarantee that then, they will be adequate. Regarding their direct impact on international security, it is a topic, that can be too general, due to the distinct natures of various states. It is obvious, that disinformation and propaganda begin in a single individual, then is being spread among other individuals, and finally end in the target, which is an international system. Those phenomena can drastically ruin the balance of various entities including states and organizations, as well as disturb global peace and priorities of entities.

In the face of the war that is still happening beyond the eastern border of Poland, disinformation and propaganda are something more than just a danger, they are the main tools of the Russian offensive activities against not only Ukraine but also all of the West. The Kremlin attacks not only the territorial but also the social sphere, relying on the previously mentioned phenomena. The most significant aspect of their activities is that they do not directly attack the state in the understanding of political structures, Russian target is society, which is the core of the nation, individuals, who create the state.

To fully understand how disinformation and propaganda can affect international security, this article contains an analysis of two essential events that preceded and began both the Russian invasion and intensified functioning of the disinformation and propaganda apparatus with its core in Moscow, as well as the role of mass media in this process has been featured.

## *2.* DISINFORMATION AND PROPAGANDA

The term *disinformation* means *misleading someone by providing deceitful or false information* [Polish Dictionary PWN: Disinformation]. Based on this definition, it can be concluded that the concept of disinformation applies only to a social unit. This is an understanding whose meaning in the field of politics, security, or military matters turns out to be too narrow and, despite its specificity, too ambiguous. It is obvious that in the context of national and even international security, disinformation should concern the individual as an element of the state, organization, nation, or army, not the individual as a single human being.

One of the many sources referring to the distinction of a relatively complete definition, merged various aspects undertaken by researchers, thus the author created a definition that for the purposes of the article can be considered sufficiently exhaustive, but not complete. Marek Świerczek (Świerczek, 2018:213-214) explains disinformation as *a process of influencing the behavior of the disinformed subject by distorting his perception of reality, leading the disinformation victim to take actions consistent with the deformed image, and at the same time corresponding to the interests of the disinforming subject. It is a process planned and carried out by specialized state institutions that have appropriate resources and try to control various channels of obtaining information by a disinformed entity.*

Propaganda, in turn, is a concept that is defined as:

• *spreading some views, political slogans, etc. aimed at gaining supporters*

• *a technique of controlling the views and behaviors of people consisting in a deliberate, insistent, combined with manipulation, influencing the community.*[Polish Dictionary PWN: Propaganda]

Expanding the meaning of propaganda by a strictly psychological aspect, which is used by American authors, it should be pointed out that it is *a skillful use of images, slogans, and symbols, referring to our prejudices and emotions; is the communication of a certain point of view, aimed at inducing the recipient to voluntarily adopt this point of view as their own* (Aronson, Pratkanis, 2004:17) they can be defined as a coherent, exhaustive whole.

The question that will allow us to go into full consideration is: How to cut disinformation off propaganda?

The Information Security Doctrine of the Republic of Poland equates both concepts and merges their separate definitions into one: *dissemination of manipulated or fabricated information (or a combination of both), to induce their recipients to certain behaviors beneficial to the disinformant, or to divert their attention from actually occurred events* (National Security Bureau 2015:4), which is a rather inaccurate, general move, but determining the full, sufficient meanings of both terms is an extremely difficult task, which allows for a certain margin of error. As it can be seen, even in documents at the state level, the issue of the exact determination of the border is almost impossible now. In order to separate these two phenomena, it is necessary to adopt specific assumptions - the purpose of disinformation is to mislead an individual and, as a result, cause a specific reaction in the form of an action or omission in favor of the disinformer, while the purpose of propaganda is to induce specific behavior in the form of a change of attitude or way of thinking. Moreover, disinformation is identified with an individual, while propaganda with a collective, organized entity.

## 3. THE IMPACT OF MISINFORMATION AND PROPAGANDA ON INTERNATIONAL SECURITY

In the current world, which abounds in various forms of increased development - especially technological, military, and political, as well as globalization, concepts of disinformation and propaganda are significant. The international flow of information is a high-speed and efficient phenomenon. Therefore, it causes more and more opportunities in the context of information manipulation. Thus, creating content that is infected causes some disturbances of the broadly understood balance, but the most important balance is the global one. Propagandistic or disinformation content in the light of international security has its origin in the entity that is the state. Then, mainly through the mass media, as a rule, they spread to the sub-regional, regional, and international arenas.

Disinformation and propaganda are of particular importance in the context of creating possible threats to international security. The main threat posed by infected news content is the destabilization of the international arena. It is worth noting that it is not only interstate conflict that disturbs peace and order, but also intra-state activities. A perfect example, but less abundant in disinformation and propaganda activities, is the civil war in Libya, which had a large impact on decisions made by international organizations such as the United Nations or the North Atlantic Treaty Organization. The actions of entities are dictated by the growing anxiety and lack of full security, and attention is effectively distracted from issues that, in principle, should be implemented as a priority. The dissemination of infected content is designed to effectively disorient selected entities, between which there may be misunderstandings - these in turn may lead to initiating unauthorized actions, such as a diplomatic conflict or simply creating stereotypes and prejudices.

## 4. RUSSIAN DISINFORMATION AND PROPAGANDA

A flagship example of the intense impact of disinformation and propaganda on international security is certainly the actions presented by the Russian government apparatus. However, the etymology of influence should begin with the political core. It is evident, the population is one of the main guidelines according to the state's existence. The population contains not only people representing the will of the nation but also its supreme leader emerges.

The State Duma currently accounts for almost 50% of all deputies (Bartosiewicz, 2021) from the United Russia party. The ruling party is a kind of base for the greatest personalities of Russian politics: the current president – Vladimir Putin, the former president, and prime minister, and current leader of the party - Dmitry Medvedev, the head of the Russian diplomacy - Sergei Lavrov, and the defense minister - Sergei Shoigu. Looking at the evolution of the positions of important people in the Kremlin, it is noteworthy that since 2003 United Russia has been expanding to effectively take over the entire government apparatus (Jendrysko 2016:143). Its ideology is also worth noting – United Russia presents itself as *a centrist and pragmatic formation, focused on solving current problems* (Jendrysko 2016:152). Under the cover of the central party, researchers expose Putinism, liberal conservatism, and Russian nationalism. Those are views that determine the consolidation of Russia as an authoritarian state with the makings of a fully totalitarian regime. The current actions of the Kremlin are strikingly similar to the techniques used in the times of the Soviet Union. In the USSR, the Communist Party of the Soviet Union was in the lead, while in the Russian Federation, United Russia.

According to researchers, both parties are accompanied by one, specific germ, which, depending on the country, was or is developed to a different degree (Łucjan, 2022). It is fascism, which is defined as *an ideology advocating dictatorial rule, total control of the state over the lives of citizens, and the subordination of their personal interests to the good of the national community, which is treated as the highest value* (Wielki Słownik Języka Polskiego, 2013). In the USSR it appeared as communism, in Russia a variety of fascism is Putinism. United Russia is therefore a product for the individual, not individuals, as understood by the nation. Just like the nation, which is supposed to be a crowd of zealous supporters, an undifferentiated society cooperating with the head of state, as it looks in the intra-group structure called democratic. The Russians are supposed to follow the authorities in the context of every decision. The Kremlin has fulfilled its decision, the public follows the authorities. In the 2018 elections, Vladimir Putin won with almost 77% support, which is the current record in the history of the state (Domańska, 2018). An important issue regarding this aspect is the question: What is the reason for such high support? The answer is not unequivocal - some Russians follow out of loyalty, other part out of longing for Stalin's state, the third out of indifference, and the last one, probably the most numerous - out of pure fear.

The authorities find various ways to control their citizens, but the key ones are, of course, the manipulation of information, i.e., the repeatedly mentioned disinformation and propaganda. In light of the Russian aggression against Ukraine, which has been going on for more than a year, the Kremlin is increasingly manipulating society, and when it knows that disinformation and propaganda alone are not enough, it uses coercive measures or limiting civil liberties.

On the morning of February 24, 2022, the leader of the Russian Federation launched a bestial act of aggression, which he called a *special military operation* in his homeland, citing the broadly understood historical context. Beginning his emphatic reflections in the Nazi Reich, which has now taken the form of Ukraine - he hailed wartime Ukrainians as *Hitler's accomplices* and called the current Ukrainian government *neo-Nazi* - ending with a call to support and defend the homeland, which cannot behave in the same way as then when, through a series of inappropriate decisions, it was not ready for Hitler's aggression. The president placed extraordinary emphasis on national security not only in the context of the state but also of the nation itself. In the propaganda vision, Putin entered Ukraine as a savior of the oppressed society, which must be liberated and protected from the terror that the Ukrainian government is preparing for it. The natural human behavior is fear for one's life and one's loved ones in the face of danger, but also deep compassion for people who are irretrievably in danger. The Russians once again followed their sun-king to save innocent lives. An extremely emotional narrative, but in reality Putin began the process of closing the country behind a kind of iron curtain. According to the account of one Polish immigrant, Kremlin propaganda led to *the introduction of a code according to which any negative statement about Russia, any support for Ukraine, and even the use of the word "war" results in the imprisonment of up to 15 years* (Jachimiak, 2022). The federal agency called Roskomnadzor is also worth mentioning due to its persisting control of the media and striving to block any content that is inconsistent with the position of the state.

A few days before the start of the aggression, the Security Council of the Russian Federation was convened, during which theses were voiced not only those unjustifiably attacking Ukraine and insinuating genocide, the existence of a puppet regime, or the bloody coup in 2014, but also those that burden the West with the United States and NATO. Western countries were shown as those that effectively incited to take radical action.

They are mainly accused of appointing a puppet government in Kyiv, escalating the situation, blaming Russia for the responsibility, causing a threat to the existence of the Russian Federation, and these actions are ultimately intended to lead to the disintegration of the state. Moreover, the president drew attention to the absolute dependence of the West on Russia on many issues, which the former prime minister, Dmitry Medvedev, summed up by saying that *Russia means more to the world than Ukraine* (OSPP (9), 2022:3). In the diplomatic aspect, these words effectively degraded relations with Western countries and caused concern in the international arena.

Did the disinformation and propaganda coming from the Kremlin affect only Russia? The answer to this question can be found in the community of the Baltic States, which mostly speaks Russian very well and has a large Russian-speaking minority. So it is natural for the existence and popularity of Russian television and media in these countries.

In the face of Putin's aggression, the Baltic states have developed three strategies to combat the spread of propaganda and disinformation:

• Lithuania punished Russian media for hate speech with a ban on broadcasting for a certain time

• Estonia has created its public channel in Russian

• Latvia applied a ban on broadcasting like Lithuania, later strengthening the Russian-language media (OSPP (24), 2022:1).

It has to be emphasized that Poland is another main target of Russian disinformation and propaganda. Poland has been the target of Russian attacks for many years – aggression against Ukraine has only strengthened the power and duplicated attempts at such undertakings. The Russians only want to cause chaos, destabilization, and the creation of negative phenomena in society, such as discrimination or xenophobia. Human nature in the face of a threat reveals its weakness - the first reaction of any individual to information about a potential threat is fear and panic. Research conducted in September 2022 and January 2023 perfectly shows how more and more Poles succumb to the Kremlin's actions. The respondents were presented with theses such as: *If it wasn't for the expansion of NATO to the East, Putin would not have attacked Ukraine and Ukrainians, We should not help Ukraine until it repents for Volhynia and condemns Bandera, We should promote peace at all costs - even at the price of Ukraine's territorial concessions to Russia, or We should stop supplying arms, because this further ignites a conflict that has no connection with us*. January's results compared to September's are extremely worrying - according to the report, more than 40% of respondents *strongly agree or rather agree* with at least four theses, while in September it was 34%. People aged 25-34, who use the mass media, are more likely to adhere to pro-Russian theses (Kropiwiec, 2023).

The small anti-success of Kremlin propaganda is probably dictated by Hitler's propaganda technique, the so-called *Große Lüge*. The technique says that *in the big lie, there is always a certain force of credibility; because the broad masses of a nation are always more easily corrupted in the deeper strata of their emotional nature than consciously or voluntarily, and thus in the primitive simplicity of their minds they more readily fall victims to the big lie than the small lie since they themselves often tell small lies in little matters but would be ashamed to resort to large-scale falsehoods* (Hitler, 1925:196)

The results of the research, as well as the Kremlin's broadly understood disinformation and propaganda activities, can therefore be summed up in a quote by Joseph Goebbels: *A lie repeated a thousand times becomes the truth.*

## 5. MASS MEDIA AS A TRANSMITTER OF INFECTED CONTENT

The mass media are now the hard core of the dissemination of disinformation and propaganda. Nowadays, all disinformation and even propaganda content is called fake news. According to sources, it is the *act of conveying a message not only by lying but also by concealing information to lead someone into a false belief* (Palczewski, 2019:139). People encounter this type of content every day, but a special type of fake news is military-political ones because they have the greatest impact on broadly understood security.

An excellent basis for spreading such content from the political and military area is the press doctrine of the communist variety. The Marxist-Leninist ideology believes primarily in the transfer of economic patterns to other sectors of the state structure, including the means of mass production of information. The media were to play the role of *a collective agitator and propagandist,* as well as *a collective organizer of socio-economic life* (Goban-Klas, 2000:167).

On the other hand, in the era of such widespread access to mass media, as it is today, disinformation and propaganda are developing extremely quickly. Moreover, their repetition takes place at an even tremendous pace. Despite the created pretense of free media, states spreading propaganda find, especially on television, the key to impressing their own ideas on viewers. Disinformation is carried out mainly through social media, e.g. services such as Twitter, as well as informational websites. People are becoming more and more addicted to electronic devices and the Internet, and they are eager to read the most shocking or secret topics.

Fake news, under whose name exists disinformation and propaganda, is, therefore, a powerful weapon that affects moods, and public opinion, and provokes broadly understood changes in various structures, including state ones. The most dangerous is, of course, those created at the request of the state, because when citing important, significant institutions or individuals as the source, the rank of information in the eyes of an ordinary reader increases drastically.

As an example of fake news, there is a flood of disinformation about Ukraine, such as:

• *Nazism is spreading in Ukrainian politics and society, supported by the authorities in Kyiv - Candidate of the far-right nationalist party in the elections, in 2019 he won only 1.6% of the vote,*

• *NATO has a military base in Odesa in southern Ukraine – Foreign military bases are not allowed in Ukraine* (Bochyńska, 2022).

## 7. CONCLUSIONS

Disinformation and propaganda in the context of international security are activities that can effectively and clearly influence many aspects. However, everything begins with the individual. The example of the Russian Federation perfectly illustrates how well and scrupulously controlled political structure in the state can cause forced resocialization, thus injecting infected content, i.e., disinforming society and promoting specific assumptions, ideas, and behavior. Fringe edition of biopolitics applied to not only citizens but also supporters of Russia or Russian-speaking minorities, clearly emphasizes how rigorously the processes of control and training are used. Cases of disinformation attacks against other countries, especially the already mentioned Baltic countries, and Poland, introduce the target topic of the impact of disinformation and propaganda on international security.

For the generally understood international arena, with international organizations at the forefront, these activities are a factor dissuading from all plans and priorities. Despite the complex structures of these organizations, it is impossible to function in one specific routine, in the face of danger and concerns. An example is the United Nations, in which a separate body - the Security Council - watches over global security, however, in the event of any disturbance of the peace, the entire organization is involved in all activities related to the given situation.

In turn, limiting the importance of the international arena to separate states, and ignoring aspects of global cooperation, disinformation, and propaganda affect international relations. Such actions are an excellent source of all kinds of conflicts, especially diplomatic ones, and in the extreme, military ones. Disinformation and propaganda are used to harm the other side, so it is natural for feuds of lower or higher rank to arise. A good justification is certainly attacks directed at Poland, not only as a whole but also as individual units and institutions. In 2020, the attack from the Russians was directed towards the War Studies University, when Russian hackers published a fully gaffed letter from the Rector-Commandant, which not only degraded the military relationship between Poland and the USA but also was supposed to lead to informational chaos, destabilization of both Polish-American and Polish-NATO relations, as well as weakening the morale of Polish soldiers and American soldiers stationed in Poland (Gliwa, Kozłowski, 2020).

The given examples and meticulous analysis in the form of a case study prove that in order to harm international security through such activities as disinformation and propaganda, the parties do not have to be many states or only international organizations - the parties can be a state as a government and society, or a state and specific unit. It is true, however, that the community or individuals ultimately lead to the state as a complex structure that one wants to dismember and deprive of stability (Urych, 2021:830-840).

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# NEUROSCIENCE OF COMMUNICATION IN THE MILITARY SYSTEM MAPPING OF BRAIN AREAS AND FUNCTIONS

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***Abstract**: With the present article we aim to address, with the scientific tools of communication theories, issues of the nature of nonverbal communicative behaviour prescribed by military regulations. Starting from the inventory of the types of frontline training movements prescribed in the frontline training regulations, we found that they can be analyzed from a neurophysiological point of view. Taking into account the broad physiological process of transmitting the military command and executing it, as well as the other non-verbal communicational aspects prescribed by the regulations, i.e. drawing on the common area of knowledge in communication sciences and neurosciences, we proposed a mapping of the brain areas and which ones are being active during the military's frontline training in order to streamline the training process.*

***Keywords:** neuroscience, nonverbal communication, mapping of the brain*

## 1. INTRODUCTION. RESEARCH METHODOLOGY

With this article we aim to reconsider the research on the prescribed communicative behaviour of the military, extending it from the area of interference of knowledge in the field of communication sciences with ethology, psychology, anthropology and sociology, to the confluence with neurosciences, trying to build, on the skeleton of the prescribed nonverbal communicative profile, a map of brain activity associated with individual, squad and platoon frontline training, the basis of training for participation in missions.

For the brain mapping of training as a form of rational control of frontline training movements, we proposed to carry out a mixed quantitative-qualitative research, carried out by means of a document analysis (military regulations), consisting in collecting data relevant to the area of interest and making the connection with the neurophysiological processes that allow frontline movements to be carried out. While the first is accessible to specialists in the field of communication sciences who study the physiology of the central and peripheral nervous system, the second is accessible to neuroscientists who deepen knowledge in the field of communication sciences. With this article we intend to go through the first path in the transdisciplinary knowledge process, without making use of precise measurements, and in the second phase of the research, based on this neurocommunication mapping, we will carry out measurements in the training process on subjects subjected to a complex communication experiment, carried out with the help of an external device that records the electrical signals of the brain and then analyzes them with the help of a computer, the EEG EMOTIV+ headset.

Globally, applied research in cognitive, behavioural and communication neuroscience has become increasingly important in modern research. In order to understand to some extent the functioning of the human brain, as its complexity does not allow for total understanding, various developed and advanced methods and procedures are used

nowadays, and a very important one is the EEG headset. It is of great importance in mapping human brain activity under conditions of movement/exertion, i.e. significant information can be obtained about the brain areas activated during the performance of various actions. This research presents a general overview of methods to identify psychophysiological patterns using direct biosignal measurement and identification technologies. The study particularly focuses on this EEG headset for recording these electrical signals, moreover, it is non-invasive, explicit/ intelligible and prompt. The fundamental objective of this research is based on the identification of close links between biosignal patterns, whereby the influence and interconnection of different types of electrical biosignals useful for obtaining information needed in many fields: medicine, psychology, performance sports, but also in the military system. This experimental research highlights the use of a technique that focuses on biosignals to obtain specific constants and to obtain inferences on the same type of behaviour, evidenced in many electrical signals.

## 2. PHYSIOLOGY OF TRAINING

The physiology of training as a psychoeducational training technique has been the subject of much research, most of it projecting mathematical modelling of central nervous system functionality from a mechanistic perspective (e.g. Krendel & McRuer, 1968:657-665). Also, the physiology of training as a technical projection concerning the achievement of the best possible results has been the object of study in various sports disciplines. The physiology of military training has not been an area of widespread interest. Adaptation to the rigours of military life, including front-line training, and resistance to the demands of this environment depend on the strength and balance of the nervous system. The experience of the military in various training situations and combat missions leads to a series of psychological effects, essentially neurological, characterised by inner changes in thoughts, emotions and, not least, the whole of behaviour.

Research on the effects of the training environment on the military has mainly focused on post-traumatic stress. There are numerous studies in the medical sciences focusing on post-traumatic stress disorder (PTSD), most of which focus on the treatment of this condition, and to a lesser extent on the anticipatory dimension. Among the works that target this issue are the works of the collective of Israeli and American researchers coordinated by I. Wald (2010:699-707), with reference to the simulation of combat conditions for the training of the military, but also those conducted by Eyal Yanilov and Ole Boe (2020), the latter of them partner, trainer and co-organizer of the Combat Mindset course in the Air Force Academy "Henri Coandă". Frontline training itself is an anticipatory pathway, involving military training and control of emotions, but effective results of frontline training require not only knowledge of prescribed nonverbal communicative behaviour, but also an understanding of the psychophysical adaptive functions of the human being. It is necessary, in other words, a proper knowledge of the nervous system, the one that controls all the other systems of the human body, the system that perceives the world and transmits the way the human being reacts, makes decisions, some of them last minute, and gives rise to emotions, ideas, memories. Moreover, a proper knowledge of the physiology of the nervous system is necessary to achieve the best results of the human body in adapting to the combat environment.

The training process within the military system makes less obvious, but nevertheless crucial, use of knowledge of the neurophysiological systems that enable different intellectual performances and responses or reactions to different pressures and demands.

This requires a thorough development of one's own humanistic conception of man, an understanding of his extraordinary capacities for adaptability and personal growth, and of the limits of his neurophysiological potential and susceptibility. Keeping these elements in mind means being better trained and armed in identifying the best and most appropriate ways and forms of military training and education.

## 3. TRAINING AND REACTION PHYSIOLOGY

The central nervous system, responsible for controlling the human body, including when adapting to the combat environment, is connected to a huge network of nerves and fibres that work in perfect synergy to turn data into action. The whole body uses a nerve communication system similar in operation to a computer network, which is why many references (including misinterpretations) have been made based on this model, in which digital data is operated and supplemented by analogue humoral emission. The human body is made up of systems, of which it is the nervous system that governs all the others and, moreover, defines the individual's identity. The SN is therefore 'the core of who we are'.

Few systems challenge the nervous system the way the military does. Within seconds, military commands subsumed under frontline training have to be executed, which is to the military's advantage from an anticipatory perspective, as it has to train itself to be able to process the opponent's movement and react. For the appropriate physical response, extraordinary mental agility is required first and foremost. Training for the appropriate response to the environment (we propose this general formulation to include both training and combat situations), which is the physical response, goes through technical, tactical and mental phases, with emphasis on the latter (Doss, 2007:65, apud Yanilov & Boe, 2014:7). Mental preparation for the battlefield involves five mental training strategies, preceding presence in the theatre of operations, most often carried out in parallel with the training programme: visualisation, goal setting, positive self-talk, actual mental setting (courage, determination, aggression) and relaxation.

Physiologically, psychologically and communicatively speaking, it all starts with visualisation/vision, specifically light. When light particles enter the eye through the pupil, they reach the back wall of the eyeball, where they hit the thin tissue called the retina. The retina has millions of tiny receptors called cones and rods that absorb light particles and transmit them to the brain as electricity. These nerve impulses then reach the brain via the optic nerve. The impulses resemble Morse code (i.e. they are digital signals), with the brain taking these digitally coded messages and transforming them into perceived reality. The amount of data transferred between the optic nerve and the retina is the largest amount of data observed in biology. It's all happening in the eye. Every second, the eye transmits ten million impulses to the brain at a speed of 430 km/h. Then, just as fast, the brain has to react.

The soldier visually perceives the danger, the information reaches the brain, where a preverbal interrogation takes place, a pseudo-conversation reducible to the question "Fight or flight?" (Responsible for answering this question is the amygdala, an accumulation of nerve cells, the physiological centre of emotions. It plays a major role in many basic functions related to instinct and survival of the species, anxiety, aggression, fear conditioning, emotional memory and social cognition (thought processes involved in understanding and relating to other people). The moment a human wakes up in a risky situation, the amygdala sounds the alarm, setting off a chain reaction. Thus, following stimulation of the amygdala, the fight or flight bodily reaction takes place, along with other reactions: a cocktail of hormones floods the body, the pupils dilate to get more light,

the heart starts pumping blood faster and it is directed to the most important organs, such as the leg muscles. Blood circulation to the stomach is reduced, which leads to a feeling of butterflies in the stomach and chills (fear), as the reduced blood supply to the dermis creates a feeling of cold. All these changes prepare the military to react to the threat, either by defending itself or retreating. Fear, controlled by the amygdala, is a very strong protective mechanism and is the extraordinary coping system that helps the soldier become aware of a threat.

As with any decision, it's about weighing the options; the soldier makes a decision and lots of neurons react, and nerve cells communicate through electrical signals and chemicals. What's more, the brain sends impulses throughout the body, triggering the right muscles to react. The possession and observation of psychophysiological mechanisms, as well as reactions and responses to various stimuli, are of great concern in all aspects of the educational process. Accelerating or enhancing motor learning - which can be aided by dietary supplements, stimulants or even transcranial electrical stimulation: "The effects of transcranial electrical stimulation have been studied on infantrymen and special troops in a variety of settings, with the aim of stimulating motor learning, prolonging wakefulness, amplifying memory, improving visual performance, planning abilities" (Dugan, 2020:218) - but, more importantly, simulation training (including simulation of stressful, theatre-like stimuli, v. Boe et al, 2022) helps the platoon commander achieve a higher degree of training for his subordinates. In addition, psycho-neurological concepts must be included in the comprehensive training of commanders and subordinate soldiers, especially when it comes to training.

## 4. NONVERBAL COMMUNICATION BEHAVIOUR PRESCRIBED BY GENERAL MILITARY REGULATIONS AND THE PHYSIOLOGY OF NONVERBAL COMMUNICATION

Military behaviour is largely influenced by an understanding of rules and discipline, as these are specific to life under arms. The understanding of rules and related discipline are perceived differently under the influence of emotional tensions. Within the military system, communication is a key element in the smooth development and smooth running of activities and the achievement of mission objectives. Through it, information has a continuous route, reaching predominantly vertically, downwards or upwards, from sender to receiver and vice versa. The simplest form of communication is the giving and execution of orders, the practice of which is carried out by means of front-line training.

General military regulations are nothing more than manuals of effective communication, all the more so as they also express the most complex and difficult form to understand within the limits of the logical code, namely non-verbal communication. Thus, the shaping of the profile of the military and the possibility of training skills through frontline training is mainly due to communication (including non-verbal communication).

Understanding one's own humanistic vision from the perspective of a complex existence, the possibilities of adaptation, self-improvement, moral upliftment and overcoming biological human egoism are influenced by information, knowledge, communication or intelligibility in this sector. All these factors contribute to the best manner of instruction and education, giving rise to a military. Ethology, anthropology, psychology, sociology and, more recently and increasingly, neuroscience, have all focused on body language research, emphasising its importance in human communication (thanks to neuroimaging techniques that allow brain observation). Because of its

comprehensiveness and continuous development, this silent code offers the possibility to communicate many systems beyond words.

The components of nonverbal communication begin, first of all, with the classification of the sensory channels involved, more specifically the analysers specific to the human being (visual, cutaneous, olfactory, kinaesthetic, acoustic-vestibular). In describing them, first of all, the signals picked up by the visual analyzer (facial expressions, kinaesthetic, proxemics, oculezics, artifacts) are highlighted, followed by the signals diffused through the auditory (vocalic) and olfactory channels, as well as chronemics, in other words, the perception of time, which does not present a specific sensory organ, but a comprehensive mental unfolding, both from a sensory point of view and from the point of view of thought, in agreement.

The regulation we will focus on is RG-5 (Regulation of Frontline Training) as it emphasizes the preparation of the nonverbal response of the organism in relation to an organized and systematized environment in which the triggering stimulus (military command) generates a certain manifestation of human behavior. This regulation includes various rules concerning the way in which the military body is trained to execute certain commands received from superiors through prepared and trained homogeneous reactions and manifestations. Moreover, it describes visible human behaviour, with verbal and nonverbal reactions related to the study of posture, gestures, proxemics, as well as gait, etc. The elements of nonverbal communication are very well highlighted by this regulation, as military communication takes place through hands, facial expressions, looks, and last but not least through the use of space (proxemics). It is not by chance that soldiers are obliged "to know their place in the formation, to keep alignment, cadence and established intervals and not to leave the formation without approval (RG-5, art. 4. lit.c, p.8)". Another example is when: "the military sub-unit/unit is in the assembly formation, the commander's place is in front of the formation, at the centre of the formation, at a distance from which he can command and observe the execution of commands" (RG-5, art. 5. para. (2), p.9). The terms "to command" and "to observe" activate the two stimuli: auditory (subordinate ) and visual (commander). Thus, in the case of proxemics, visual and auditory are very important.

It is remarkable how adaptable the human brain is with a little exercise. The soldier performs the same movements repeatedly, especially during frontline training, the brain learns, and the movements become ingrained in motor (motor or kinaesthetic) memory. The soldier is trained and prepared from the outset to respond to the demands of synchronisation and moulds his reactions to external rhythms, not those dictated by his own metabolism. The complexity of movements and adaptation depends on the brain's ability to change, a process called neuroplasticity. The system is quite flexible, each brain neuron can form up to 10,000 connections with other neurons, and those connections change according to the frequency of action. The training process therefore leads to a focus on the type of movement for which the skill is being trained. When the soldier learns a new movement, the new pathway is temporary, it is copied by the neurotransmitters around the neurons. But as they train day after day these neurotransmitters become fundamental and over time the neurons will change shape and place, neurophysiologically adapting the body to the frequent tasks. So as movement is learned, the connections between different areas of the brain become stronger.

Through practice, the soldier becomes better and better trained and thus forms different automatisms. So, during a fight, but also during training, he becomes calmer and calmer, in control of his mind and short-circuiting the chain of action, not needing to think too much because the movements and blows come instinctively and the mind and body are one, which means the effort becomes less intense. By training, the soldier

becomes more and more efficient and builds up a neural network to adapt and adapt to his environment. The mechanism of transmitting information from one neuron to another is the basis of information transmission in our body, both the basis of computation and the basis of motor memory. In addition, activated memory can be illustrated by the familiar talk in a group of neurons. By learning something new, an increasingly strong memory is built.

Walking is no longer something you have to focus on, left-right-left, when we learn something new, especially if it's complicated, the first part of the brain to learn is the neocortex, as it has to coordinate everything in real time. But interestingly, the old brain structures (brainstem and limbic), through repetition and association automate it.

Therefore, this regulation presents different rules on how the military body is trained to carry out certain orders from superiors through prepared and trained homogeneous reactions and manifestations. Moreover, it describes visible human behaviour, with verbal as well as non-verbal reactions relating to the study of posture, gestures, proxemics, as well as gait, etc.

**4.1 The physiology of command and execution in non-verbal elements frequently prescribed by regulations.**

The two parts of the military command used in frontline training: the preemptive and the execution part (there may be commands consisting only of the execution part) highlight elements of a prosodic nature, as the command must be "clear, brief and precise". After the foreshadowing part of the command, the soldiers wait with interest and caution for the execution part of the command, often expressed by the formula "MARCH!", which is pronounced after a short pause, "in a higher tone than the last syllable of the foreshadowing part, short and vigorous". The time between the two parts of the command prepares the body for an immediate manifestation of the military. However, the preparation of the body for the carrying out of orders or compulsory dispositions is also carried out by means of commands or signals: "Art.7. At this signal, the soldiers cease all activity, turn to face the commander, stand up straight and wait for the next command" (RG-5).

**4.2. Posture. Physiology of posture**. From this perspective, the soldier's posture is a still, frozen position, with the body facing face-to-face towards the superior, with the gaze directed towards it, making eye contact. These are simple descriptors of action response (the perlocutionary dimension of the speech act called military command). They are also used in the case of taking the upright position, the fundamental position of the soldier, from which all other frontline training movements are executed:

> Art. 8. - (1) The "righteous" position is the fundamental position of the military. In this position the soldier stands straight, with the weight of the body resting on both legs, with the knees stretched out, without being strained, with the heels together and the toes of the shoes on the front line, separated by the width of a sole; the shoulders are pulled down and back, to bring the chest to a normal position, without being strained or rigid; the chin is raised and the gaze directed forward at the level of one's own height; the arms are outstretched, with the elbows close to the body, and the palms are outstretched, in the extension of the forearms, with the fingers close together, with the middle finger next to the side seam of the trousers (RG-5).

The fact that in the fundamental position the soldier "looks forward at his own height" is a characteristic element of the sympathetic nervous system, namely the "fight or flight".

Posture is also under the control of various nerve pathways, these being the spinal pathways, cerebellar pathways and corticospinal pathways. The spinal pathways are made up of the spinal nerves that connect the muscles and joints of the body to the spinal cord and allow nerve impulses from the brain to be transmitted to them, which are involved in maintaining posture. The cerebellar pathways connect the cerebellum to the cerebral cortex, as they allow the cerebellum to receive information about body posture and send

corrective signals to the muscles involved in maintaining balance. The corticospinal pathways connect the motor cortex to the spinal cord, so nerve impulses are transmitted from the motor cortex to the muscles and joints that support posture. Also included here are the reticulospinal fascicles, as well as the rubrospinal fascicle (reaching the muscles and muscle spindles controlling postural tone). The vestibulospinal fascicle, from receptors in the inner ear via the vestibular nerve (cranial nerve VIII), and via cerebellar fibres to the vestibular nucleus in the superior medulla, travelling the length of the spinal cord, contributes to body posture (i.e. the base position) in relation to gravity.

One of the most important positions in the military system is the upright position, and this involves a series of body movements and positions that are coordinated by the central nervous system. Included are motor neurons in the frontal premotor regions for coordinating the muscles involved in maintaining upright posture (back and abdominal muscles are activated to keep the spine in an upright position and to support the torso; neck muscles are also activated to keep the head in an upright position, and leg muscles are activated to keep body weight in balance) and sensory neurons in the parietal region activated for processing sensory information that helps maintain balance and respond to changes in the environment. Therefore the stability to maintain gravitational and antigravitational postures along with the medial positions of the body, occurring through a simultaneous contraction of muscles is expressed by the connection of the pontine segment to motor neurons in the anterior horn of the spinal cord and to the muscle spindles that lifted the body through activation of the antigravitational extensor muscles (allowing standing today).

**4.3 The walk Physiology of walking.** In military body language, posture and gestures are basic communicative elements. The difference between the two concepts comes from the action. Posture is a static position, using the body as a communicator (e.g. the still position of the military in guard duty), whereas gesture is a movement to demonstrate an idea or to emphasise/emphasise an order. The gestures comprise a heterogeneous system of dynamisms of the whole human body (head, neck, torso and limbs, and each of these with specific portions and components). Generally speaking, they are largely involuntary, automatic and unconscious. In the military environment, they are trained to become signs or bearers of meaning in a more complex chain of signification. From the human face to the movement of the lower limbs, every part of the human body is a source of information and contributes to the transmission of a great deal of information. Walking is part of the same series of dynamic elements associated with prescribed non-verbal communication functions. In the military environment, gait has many characteristics, including: constant pace of movement, stride length, speed, cadence, and it is mandatory to respect them. In fact, it is an important non-verbal indicator that gives us a lot of data.

> Art. 19. - (1) Soldiers can move: in normal step, marching step, running step and running.
>
> Art. 20. - (1) The normal step is executed when the military moves in isolation or in formation. The length of the normal step is 60 - 70 cm, and the cadence is 100 - 110 steps per minute.
>
> Art. 23. - (1) The parade step is executed only with the formation during the presentation of the honor in motion. The step length is 50-60 cm, and the cadence is 118-120 steps per minute.
>
> Art. 24.- (1) The running step is performed for the rapid movement of the military or military subunit/unit. The step length is 70-80 cm, and the cadence is 170-180 steps per minute. (RG-5).

Moreover, "walking provides many valuable semiological data, from general medicine to specialties such as orthopaedics, neurology, paediatrics, etc." (Enătescu, 1987) Gestures, posture and gait express characteristics representative of the military role, as general military regulations are precisely and obviously made to reach a certain type of static or dynamic posture. Thus, they become (become) the so-called signs associated in the collective mind with the routine activity of the military.

Achieving an accurate and characterized gait can involve various cognitive processes that allow individuals to move accurately and in accordance with military standards. During gait, the body performs a number of processes related to motor coordination, attention and concentration, movement planning, precise timing, maintaining balance, adapting to the environment, as well as performing metabolic processes to provide the energy required for movement. This produces the movements needed to move the body forward. All these processes involve different areas of the cortex, e.g. the prefrontal cortex plays a major role in planning and executing voluntary movements, motor coordination and attention, while the parietal cortex plays an important role in sensory integration so that we use our bodies efficiently in relation to our environment, (e.g. the military system) and referring to the proprioceptive sense which provides information about the position of body segments (helps walking without looking at the feet), while the temporal cortex together with the cerebellum (through the extrapyramidal system) and the vestibular system is involved in establishing body balance, coordination, accuracy and precise timing, stable perception, making it possible to adapt to changes of position in space, and the integration of precision motor activity. These cognitive processes enable the military to move in a coordinated and purposeful manner.

**4.4 Achieving motility.**

In the foreground to analyze the regulation of front-end instruction from a neurophysiological point of view, it is important to decipher how the human being moves, since front-end instruction is characterized by the realization of motility. The only way a person can engage and connect with everything around them, including other people, is by intentionally controlling their physical actions. These cover a wide spectrum, not just control over upper and lower limbs, but also over facial or visual behaviour. To understand the functioning of the nervous system in relation to movement coordination it is important to answer the following questions, which in our case become research questions: (1) how do we move, how do we learn and how do we think we interact to move better? (2) are we really engaged in terms of body movement? (3) how important is the organization of the nervous system in improving the performance of voluntary movements?

Simply put, the human brain works and does only three things: it receives input, it interprets input (since movement is not only information from the lower limbs, but also from the upper limbs and especially information from the vestibular system as well as from the cerebellum to maintain balance; all of this has to be interpreted and joined by the brain in order to make a decision based on all this input) and it creates output.

Our neurological system is made up of a set of rigid connections and unchanging circuits that we either control or are controlled by, as evidenced by the rigid and predictable behavior manifest. Humans are the best examples of flexibility and adaptability, neurophysiologically speaking, being a complex neuroplasticity because we can reorganize and reformulate our brain connections to produce desired behaviors.

A simplified structure of an activity shows the following unfolding in the brain: Activation and awareness of thought - this is where it all begins, as a first sequence of action potentials is activated; Eye attention to the specific activity - the second sequence of action potentials occurs; Activation of areas in the occipital lobe - the image of what is seen is registered; Activation of areas in the temporal lobe to create an additional set of action potentials by connecting the image of what is seen with the memory; activation of areas in the frontal lobe which allows the intentional performance of a movement while maintaining concentration; activation of specific areas in the frontal and parietal lobes (more precisely the brain regions responsible for sensory, motor or speech mechanisms) - as they initiate the desired movements, taking into account sensory anticipation, but at the

same time the coordination of motor activities is also under the control of the cerebellum to perform various fine and precise movements.

**Brodmann mapping**

What makes the brain different from the rest of the organs of the human body is its ability to form and shape maps. Mapping is thus very important in terms of complex control, and control/life management go hand in hand. The human brain makes maps through which it informs itself. This information is used to guide motor behaviour, especially since survival depends on various coherent actions. Moreover, as the human brain creates maps, it also creates images, one of the main characteristics of our mind. Thus, consciousness contributes to the perception of maps as images, and it is only afterwards that certain reasoning is used. Map-making, which is extremely important for the development of actions, takes place in an environment of actions, because the very interaction with various objects gives rise to mapping. Ultimately, movement, action and maps are embedded in an unbroken chain, and map-making occurs continuously, even during sleep, as dreams demonstrate. The human brain is the best hereditary mapper, and the first mapping was of the body in which it lives. Although our "core" is a unitary whole, it works as subunits. Otherwise neurology would be much simpler without so many specialised areas and zones.

When the concept of brain is used, it is most often associated with the concept of location. When referring to the cerebral cortex, the most common reference is to the many areas and regions of the cortex. It is no coincidence that the cerebral cortex has different structures and functions throughout its surface and at all points, i.e. it has common features like a map with multiple networks and coordinate systems, but quite precise in relation to the proportions indicated. Scientists have mapped how pea-sized regions of the cortex respond to hundreds of semantic notions. Today, they rely on this work to understand the relationship between visual, linguistic and mnemonic representations in the brain. Topographical classification from an anatomical point of view, in particular of cytoarchitectonics (cell structure), gives rise to spatial divisions of the cortex with major functions, primordial in the field of pathology.

The cortex, by section, is divided into Brodman areas, which are based on cytoarchitecture (histological structure) and functional roles in cognitive and behavioral sensation. This "map" details all functional areas of the cortex based on anatomical features and shows a complex specificity of the human brain. This mapping by Brodmann remains the best known and most commonly used.

All movements in front training, whether we are talking about a left/right/left round turn, show largely the same areas of activation in the human brain. Each brain lobe has specific and characteristic roles, and they are all linked and organised in a logic of performing an action/activity. The cerebral cortex shows, in relation to the four lobes, many areas active during the performance of a movement, there is no single specific area, as the brain works in a coordinated/unitary way.

One of the fundamental prerequisites for typical and optimal behaviour and activity, as well as for contextual adaptation to situations, is spatial orientation. This is based on complex psychophysiological systems and processes.First of all, perception, discrimination and appreciation of dimensions (size, shape) necessarily require spatial orientation. This is made possible by tactile, kinaesthetic and, of course, visual sensory modalities. This information reaches the parietal lobe, each taken independently. The inferior parietal areas, namely Brodmann areas 5 and 7 (a,b) are important for the deliberate and spatial guidance of different movements. In general, they also play an important role in creating a mental representation of the environment. Area 5 is a region involved in fusing information from the basic senses with knowledge about spatial

direction and movement. Movement planning and coordination with the environment, as well as three-dimensional vision and spatial representation are influenced by Brodmann area 7.

> *"The associative areas of the left parietal lobe (inferior parietal areas) are involved in verbal information processing, while the same areas of the right parietal lobe are particularly involved in spatial and visuospatial activities "(Le Doux, 1982).*
>
> *The superiority of the right hemisphere is manifested in the control of complex behavioral interactions in the spatial environment (Le Doux, 1982). "*

The second component of spatial orientation is the assessment of distances between objects and positional connections. Thus, a contour map is made of the coordinates and positioning of the predetermined surrounding space (up-down, front-back, cardinal points). In this way the organisation and projection of actions in space takes place. Visuomotor coordination and conscious recognition perception, or explicit outlining of space, is achieved by Brodmann's 39 and 40 (Wernicke's Zones). Thus, the Wernicke's area, in addition to its importance in auditory information processing and language, also plays a key role in spatial perception.

> *"Posterior parietal areas play an important role in spatial information processing as well as working memory related to spatial information, while prefrontal areas control visuomotor processing as well as temporal integration of spatial and nonspatial information. (Quintano și Fuster, 1993)."*

Moreover, the existence of the primary somatosensory cortex, which includes Brodmann areas 1-3, involves the processing of various sensory information received from the body, necessary for the coordination of movements. Information received from the skin, muscles, tendons, joints to give rise to sensations. Access illustrates how important different parts of the body are in producing different sensations and perceptions of the human body. Furthermore, learning and recall of sensory information can be significantly influenced by Brodmann areas 1-3. In addition, the Brodmann 38 area also plays an important role in spatial memory and spatial data integration. In general, Brodmann area 13 (insular cortex) plays a complex function in processing sensory inputs, integrating them with other motor and cognitive information and controlling body homeostasis. This region is crucial to both how the body interacts with the environment and how it functions normally.Adjacent to Brodmann area 13 is Brodmann area 14 with similar functions. In addition, Brodmann area 14 may be important in processing sensory data related to posture and body movement.

Thus, the regulation of locomotor behaviour is closely interdependent with spatial coordinates, since disorganisation of the mental components of spatial orientation leads to confusion of directions of movement or topographical positions.

Processing visual information and voluntary control of eye movements are two general functions of the visual cortex, which is an important part of the brain. The voluntary regulation of human behaviour and interactions with the environment are both strongly influenced by this cortical area. This cortical region is divided into a number of functional areas that are involved in many elements of visual processing, including the recognition of shapes, colours, motion and other visual properties.The Brodmann areas associated with vision are represented by area 17 (primary visual cortex V1) for the interpretation and processing of visual information received from the eyes, where the process of orientation takes place, as well as the mixing of information from both eyes, which is indispensable in the sequences of recognition and interpretation of depth and depth. Area 18 (Secondary Visual Cortex V2) is the mirror counterpart of area 17 and has important roles for detecting light intensity as well as processing more complex information, being a visuopsychic area and visual memory centre. Thus, for light-induced eye movements, object tracking and gaze fixation, areas 17 and 18 are responsible. Area 19 (secondary visual cortex V3, V4, V5) for visual recognition of stimuli, here being

stereoscopic vision and oculomotor distance reflexes, as well as reflex eye and head movements in response to visual inputs.

Simplifying, V1 and V2 are involved in categorizing and separating visual information, but V3 is skilled in analyzing asset shapes, especially when depth is considered, V4 is involved in color analysis, V5 in motion study, and V6 in rendering space. Moreover, very important is the fact that area 8 (Frontal eye fields) is involved with the control of eye muscles, area 37 (fusiform gyrus) is related to face recognition, and Brodmann's areas 20 and 21 associated with the processing of sensory information from sense organs, especially from the sense organs of sight and hearing.

The human brain can connect what it sees with what it hears so it combines visual and auditory information to achieve different visions and complex behaviours because of the close connections between visual and auditory centres. So the specific areas of the auditory cortex are represented by Brodmann areas 41 and 42 being the primary and secondary auditory cortex. Brodmann area 41 is important for the grasp and recognition of different sounds and where the sound comes from, while Brodmann area 42 is involved in more complex information, for example the context and different meanings of sounds.

Because of its connections to the hippocampus, the temporal lobe plays a role in generating and maintaining memories. During recall and memory processes, semantic memory - which is accessed - combines auditory and visual information into a single code. Thus, the realisation of what is meant by 'memories' involves the combination of visual and auditory information in a broader context of previous experiences. This function is associated with the 36 Brodmann area for the recognition of different images and memories.

Thus, the four cerebral lobes are closely linked so that the visual and temporal cortex provides information to the parietal lobe and is closely linked to the premotor cortex in the frontal lobe, which allows the transmission of necessary information about motor commands.

The mediation of motor function involves several areas of the frontal lobe, such as the primary motor cortex, the areas responsible for movement planning (supplementary motor area, premotor area and Broca's area) and, last but not least, the ocular cortical field. The precentral gyrus, specifically the posterior region of the frontal lobe, is known as the primary motor area of the brain.

This region is responsible for generating numerous corticospinal and corticobulbar impulses to give rise to body movement. This area is recognized as Brodmann area 4, which is of great importance in the performance of voluntary movements, as it contains characteristic nerve centres for command and control of movement. These are distributed symmetrically in the two cerebral hemispheres, but control of movements occurs crosswise. The functioning of Brodmann area 4 for the co-ordination and execution of various voluntary movements also depends on input from multiple areas of the cerebral cortex, including the supplementary motor area and the premotor area. In addition, it receives numerous inputs from the cerebellum, thalamus and basal ganglia. The premotor cortex and supplementary motor area correspond to Brodmann area 6. The former has major functions in adapting motor skills, as well as learning action sequences or reformulating an existing movement. While the second area has an important role in planning, preparing, organising, commanding and controlling complex movements involving various and numerous muscle groups. Moreover, it involves adjusting movements according to sensory feedback received. Thus, the 6th Brodmann area of the human brain is where the optimisation of movement characteristics such as direction, flexibility, amplitude, postural activity and coordination of visually guided movements takes place. A very important region of the human brain for many everyday activities,

which distinguishes the human being is the prefrontal cortex. Specifically, the prefrontal cortex is one of the most important areas that is activated during thought, as it is involved in self-control, decision-making, understanding intentions, emotions and regulating social behaviours and reactions. It is divided into Brodmann area 9 and Brdomann area 10.

> "It provides some of our intellectual, rational, and logical activity, distinctive elements of human behavior and cognition." (Morecraft și Yeterian, 2002)

For example, Brodmann area 9 is essential in higher cognitive processes corresponding to the ability to plan and organise, or develop and create new ideas, imagination and creativity. Likewise, Brodmann area 10 corresponds to abstract thinking or awareness of one's own thinking, in the formation of a sense of personal identity. Moreover, it is also involved in the control of emotions, although their generation/processing and the regulation of instinctive behaviour correspond to the limbic system (Brodmann area 23, 24, 29, 30, 31, 33, 35 and 38:Cingulate gyrus). Other areas that are involved in the thinking process include Brodmann area 46 (dorsolateral prefrontal cortex) with a key role in higher cognitive functions such as attention and working memory.

All these complex areas in the cerebral cortex are activated to perform a voluntary movement, and the extent and unfolding complexity of the human brain does not stop there. Mapping a single action involves processes of extraordinary diversity and abundance, as the connections and interactions between billions of neurons, each with characteristic actions seems to make it impossible to fully understand the workings of the human brain.

**Neural pathways**

Furthermore, the achievement of motility involves the activation of descending motor pathways through which motor commands are transmitted from the motor cortex. These are represented by the pyramidal and extrapyramidal pathways, so that these systems act concomitantly in a voluntary movement, in which the first moment is the achievement of a certain postural tone, followed by the realisation of the movement under the control of the extrapyramidal system. In this way, muscle tone and motor activity are regulated and posture and body balance are maintained. These pathways include the anterior corticospinal fasciculus (connecting the cerebral cortex to the spinal cord), the main tract responsible for controlling voluntary movements, within the pyramidal system.

The extrapyramidal system, originating in the brainstem, includes the rubrospinal fasciculus, vestibulospinal fasciculus and reticulospinal fasciculi involved in the regulation of muscle tone. Within this pathway, the tectospinal tract/fascicle has evolved, and links through the brainstem, allowing access to interneurons in the cervical cord, then to motor neurons in the anterior horn, then to spinal nerves, and finally to muscle spindles for postural twitching, signalling and attention reflexes. Moreover, the ascending proprioceptive pathways are also involved, conscious represented by the cuneate fasciculus with a role in the sense of position and movement in space and unconscious proprioceptive (automatic) represented by the spinocerebellar fasciculus, being movement control. The basal ganglia are responsible for the direction, speed and amplitude of movement, as they are the link between the sensory and motor neocortex through which motor efferents pass. Motor activity is also associated with the limbic system, as it is involved in the programming and procedure of movement in terms of intensity, timing and sequentiality. All of these play a major role in the performance of gait, since mobility is responsible for the possibility of initiating a movement and performing it throughout its physiological range.

**4.5 Kinesic elements (emblems and illustrators). Physiology of gestures.** The brain activates a long and complex series of neurons that are involved in planning and

controlling intentional actions, processing sensory information and, of course, maintaining balance. During the performance of intentional gestures, called emblems, a number of regions in the military brain are activated, including the frontal premotor region and the posterior parietal region. These regions are defined in terms of Brodmann's system of areas as area 4 (primary motor cortex) responsible for movement execution, area 6 (premotor and supplementary motor cortex) involved in the performance of voluntary movements, i.e. control of intentional actions, areas 5 and 7 (secondary somatosensory cortex) responsible for analysing sensory information related to the environment, and areas 1,2,3 (primary somatosensory cortex) responsible for the proprioceptive sensations needed to perform the gesture with characteristic meaning. Also involved are a number of nerve bundles and pathways that transmit motor signals to the muscles involved in performing the gesture. The corticospinal fascicles (take commands from the trunk region, limbs and part of the neck region) and corticobulbar fascicles (take commands from the head region and the other part from the neck region) are involved in transmitting motor signals to the skeletal muscles, which perform the voluntary movements. The cortico-cerebellar fascicles are involved in transmitting motor signals to the muscles that support the balance and stability of the body. These fascicles are part of the nerve pathways that connect the brain to the rest of the body and make it possible to perform purposeful movements.

During the performance of neutral gestures that complement a verbal message and contribute to its rhythm and intonation, thus connecting verbal and nonverbal communication, several areas of the brain are present. One of these areas is the temporal region, as it is associated with language recognition, comprehension and development, decoding each sound and turning it into meaning, or the way the base signaling for alignment fully describes it. For example, gesture interpretation may involve the prefrontal cortex and parietal cortex, while voice intonation may be processed by the temporal cortex. These areas of the cortex are involved in various cognitive processes such as attention, sensory processing, auditory processing and language.

One of the most important areas is Broca's area (Brodmann's areas 44 and 45), located in the frontal lobe of the dominant (left oblique) hemisphere of the brain, responsible for language production. Also, the Wernicke area (area 22 - superior temporal area and 39 - angular gyrus), which is located in the temporal lobe of the dominant hemisphere near the auditory area and is involved in language processing and understanding words that are spoken. This area plays an important role in interpreting gestures and tone of voice to understand the meaning of words and the overall message of speech. It plays a role in both verbal and non-verbal communication. Auditory information processing in the cortex is associated with Brodmann's areas 41 and 42 (primary and secondary auditory cortex). Parts of the human sensorimotor system are involved in analysing and processing other people's gestures and are associated with Brodmann's areas 3,1,2 and 4. The sensorimotor system is involved in analysing and processing other people's gestures because they are parts of the sensory information we perceive, as well as in controlling body movements. Moreover, in order to perform such gestures, as described how to signal the base pt alignment is also involved working memory and attention corresponding to Brodmann area 46 (dorsolateral prefrontal cortex).

## 5. CONCLUSIONS

The notion of "communication neuroscience" expresses two fundamental scientific trends. One is the need to understand the human being as a whole, where the term 'neuro' describes the most complex system of the human being, the one that controls the whole

human being, and the term 'communication' that best characterises the human being, both internally (it is not by chance that all networks of nerves and cells are in constant communication) and externally (since communication is the key element in a military system, and as in any organization of this kind, the element with the greatest flexibility exerts the greatest influence). Therefore, the "science of man" is certainly the most complex and studied science, all the more so since being subjected to an environment based on principles and rules of formation, integration and development. With the present research we aim to reconsider the research, extending it from the area of interference of knowledge in the field of communication sciences with ethology, psychology, anthropology and sociology, to the confluence with neurosciences, trying to build, on the skeleton of the prescribed nonverbal communicational profile, a map of brain activity associated with individual, squad and platoon frontline training, the basis of training for participation in missions.

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# IS THE SEA TRANSMOGRIFYING SHIPS INTO CORPSES OR GHOSTS?

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***Abstract:*** *Since the mankind started travelling to new and further places all around the world there appeared the necessity to find modern and more adaptive ways to move from one point to another. The idea of a boat and eventually a ship made us create. This was just one of the first steps in the revolution of traveling likewise for the upcoming mystery to keep humans in complete darkness and unsure about the reality around them. However, it is well known that all the beautiful voyages at sea have a great beginning but when surrounded by water one's luck can change any second and usually the most foolish ones who pretend to understand the whims of oceans are the first to hit the rock bottom. This is not a story about surviving; this story is about the shadows of the past which resurface from time to time to prove the fate combined with stubbornness which can turn one into either a legend or a ghost. The aim of this paper is very provocative, we would like to make you believe that ghosts exist.*

***Keywords****: ship, ghost, legend, mystery*

## 1. INTRODUCTION

The question is what makes these ships perish and emerge crewless or with lifeless ones? What makes them still come back to the shore? Is there something more they are looking for? What if the ship itself is bewitched? What if it is under the spell of their own captain who could not leave the ship considering the captain is the last one to leave? And more important, why must there always be the crew missing?

These are questions I will not try to spoil the mystery by answering them because as a future navigator myself, I consider that some mysteries are made to stay unrevealed and meant to turn into legends just like Houdini's who never told his tricks.

## 2. MOTIVATION

Since I am a student of the Naval Academy I have chosen to present some legends I read while I was searching a long time ago for the universal history of the navy. Somehow, I found some mysteries which kept me wondering if the sea and oceans are maybe enchanted.

## 3. MISTERY SHIPS

### 3.1. The Octavius

With the destination somewhere in Asia and departed from England, The Octavius never reached her final port. The odds of 1775 will never have a plausible explanation not

even in the modern days about finding the ship along with a crew of 28 people all frozen. The weather was more than great for any sailor when the journey started in 1761 yet the captain had the intention to make the impossible possible by sailing through the Northwest Passage which connects the Pacific Ocean and the Atlantic Ocean through the Arctic Ocean around northern Canada. This was a path no commander accomplished it alive and for all the previous travelers was a sentence to death. One of the main reasons he decided to try this unfortunate tricky route was to get faster at the targeted place than anyone else before but their luck had a timer and once they reached northern Alaska in the autumn of 1762, this was the last location known for the ship after it just disappeared into thin air for the next 13 years. Later on in 1775 Herald, a whaling ship, found the Octavius stuck in solid ice but the ship itself was not in such a bad condition as expected. A team from the whaling ship searched Octavius and they were horrified to discover all the crew members frozen solid in the exact position before their last breath. Nevertheless, the searching team got even more terrified when they found the captain who was still holding the pen as he was writing in the log journal an unfinished note. Next to him there were his faithful wife and child, and a few meters away a sailor trying to make a fire to warm things up.

With the blood running cold even for the Herald's captain, the only item saved from the ship was the captain's log which was eventually used to establish what went wrong for the innocent-brave crew of Octavius. In order to prevent to take the curse with them, any other object of the ghost ship was left behind especially because sailors are some of the most superstitious people.

Since 1775 the Octavius has kept sailing the seas and oceans without peace and it will continue sail until the whole crew will defrost.

**3.2. SEABIRD aka "The Lonely Ship"**

It is 1750 and the townsfolks of Rhode Island who decided to take a walk close to Newport Harbor were surprised by the apparition of a ship which did not seem to have any shipmen on the main deck while it was sailing through the rough breakers to the beach. After "anchoring" on the beach people were waiting for the human presence which of course it did not appear, so a few brave people checked the Seabird for the crew thinking it would be impossible for a massive "can" to sail all by herself so safely. Once on board the ship the quietness struck them but that was not all. While searching for any living creature they found a kettle still boiling on the stove, the breakfast on the table in the kitchen and after a while a cat and a dog showed up. The cargo was intact in the hold which means there was no sign of any possible violence or robbery or disease among the Seabird's crew. Only one of the longboats was missing. Although, the captain's log was carefully inspected no clue came to light, the last thing being mentioned the captain spotting a fisherman.

Later on, the ship was unloaded and overnight it vanished without any trace. Some old wise sailors said the ship was called back by the sea and like any other object or person who belongs to the unpredictable and unresistable power of water was bewitched to return to their mysterious path.

I like to think "The Lonely Ship" still wonder the oceans and the seas in search of a new crew or the old one and she will never rest until she finds brave people to travel with.

**3.3. SS Baychimo**

The ship was launched in 1914 by a Swedish company and used as a trading vessel by a German owner in the Baltic Sea and served The Imperial German Navy during the WWI. After the war ended Germany was obliged by the Treaty of Versailles, article 244, Annex III to replace the war damaged boats, so it reached the British harbor being sailed by a British crew too and destined to be sold for commercial reasons. The ship was

purchased by the Hudson's Bay Company and renamed Baychimo, joining the fleet of cargo ships of the company.

In 1921 she had her first voyage for HBC and the company's plans for the new recruit were to sail her in the Easter Arctic. Nevertheless, every winter SS Baychimo returned back to the homeport, Androssan, Scotland. Yet she still achieved to complete global circumnavigation in 1924 by sailing to the Western Arctic through the Suez Canal. For the next following years Baychimo was reassigned to travel between Vancouver and HBC posts along Yukon and Northwest Territories northern coast.

In September 1931 as she was sailing back to Vancouver passing by the Sea Horse Island, near Alaska's northern coast the weather changed suddenly and a blizzard hit and the crew had no other choice but to anchor until the storm would be all over. Unfortunately, their staying was extended due to the steamer which got caught in ice. The crew who decided to stay with the ship until spring when the weather would get better started to build some kind of improvised accommodation made out of wood and snow. The camp was set up next to the vessel. A daily responsibility for sailors was keeping the ice from accumulating around the ship's rudder, one of the critical pieces of equipment. By the end of November another rough storm hit the crew and the ship but when everything calmed down the Baychimo was gone.

The vessel was assumed to be sunk but after a short time it was found by an Inuk hunter 72 km south of their encampment, still trapped in ice. The captain decided to empty the ship as much as possible and to leave it there. The vessel was no longer seaworthy after drifting away alone through the icy waters of the Beaufort Sea. Additionally, was caught in ice two more times and the last one was expected to be the very end of the ship.

Later on in March, 1932, the captain Cornwell and the crew returned home. They had to give explanations regarding the incident of being trapped in ice. Soon the vessel was spotted again 480 km east from the last coordinates they had of her. As soon as spring came the ship was seen multiple times sailing alone. Her first notice was noticed in the very March of 1932 near Alaska's shore.

It did not take long until the Baychimo was called the "Ghost Ship of the Arctic" being truly worthy of the name considering that the following years would be sailing crewless undisturbed.

In 1933 she was discovered by a group on Indigenous Alaskans who boarded her and got stuck on it for 10 days because of a storm while they were trying to sail.

During the summer of 1933 she was boarded again but this time by the crew of Trader, a small schooner, which was checking the current state of the ship mostly driven by the curiosity of a Scottish botanist named Isobel Wylie Hutchison who was in an expedition to collect wildflowers. The next day, the Baychimo vanished again yet this time seemed to "hurry north in her private ice path" according to the Trader's captain.

Next time she sailed close to the Alaska's northwest coast in September 1935. Four years later driven by a true sea-love desire, Captain Hugh Polson tried to save the historical ship but the creeping ice flows intervened and again the vessel had to be abandoned. This is known to be the last time someone boarded Baychimo.

After 1939, the "Ghost Ship of the Arctic" often haunted the seas and was spotted many times the following years. In 1962, she has seen again drifting along the Beaufort Sea coast. Last time the Baychimo was recorded sighting in 1969, again frozen in an ice pack. Since then, the ship has never been found again but keeps people wondering how or what made Baychimo to be like this, a true ghost of the seas.

I believe the Baychimo still sails and wants to keep a low profile… at least for now.

## 4. CONCLUSIONS & ACKNOWLEDGMENT

The possibilities of ghost ships existence it might be questionable and unsure but what it is certain lately in this world? I believe on daily basis we need some dark stories to keep us with the breath taken and on our toes as temporary joy. This are the legends which keep us wondering and searching for some more, makes us dream of all the impossible things and increases the power of imagination for both kids and adults. No matter the age we will always be in search of some great, unexplainable mysteries even. This ghost ships are not certain for some of you nor for me yet they are one of the reason I consider travelling at sea worth trying no matter the consequences.

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# THE ENHANCEMENT OF ACCESS TO MILITARY UNITS BY ARTIFICIAL INTELLIGENCE AND FINGERPRINT RECOGNITION

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***Abstract:*** *Access systems in military units are an essential component of maintaining security and controlling access to sensitive in formation and equipment. These systems are designed to restrict access to authorized personnel only, which helps to prevent unauthorized access, theft, and damage to military assets. By using a combination of physical security measures, such as locks and barriers, and electronic security systems, such as keycard readers and biometric scanners, military units can ensure that only authorized personnel are granted access to sensitive areas.*
*Fingerprint-based access systems use biometric technology to authenticate and grant access to individuals based on their unique fingerprint patterns. But one of the key advantages of fingerprint-based access systems is their accuracy in identifying individuals. Because fingerprints are unique to each individual, these systems can provide a high level of security and prevent unauthorized access. These systems are user-friendly, as individuals do not need to remember passwords or carry access cards. Furthermore, fingerprint-based access systems are considered one of the most secure access control systems due to the uniqueness of fingerprints, difficulty in duplication or forgery, and the integration with other security systems.*
*It's important to observe that no access control system can provide 100% security, but an access system based on fingerprint recognition is the one that guarantees a higher percentage of trust and security which currently exists. This paper presents how to secure access in military units implementing a fingerprint recognition system, in order to increase the security level of the institution.*

***Keywords:*** *security, fingerprint, access, arduino.*

## 1. INTRODUCTION

The internal security is important in all types of institutions, as it helps to protect assets, information, and people from all types of harm or threats. In military institutions, the security is even more critical due to the sensitive nature of the information and activities carried out in these institutions. As we already know, the military institutions are responsible for protecting national security, which requires safeguarding information related to military operations, strategies, and technologies. This information, if obtained by unauthorized parties, could compromise the safety and security of the nation and its citizens. Therefore, military institutions must have robust security measures in place to protect this information from external threats such as espionage or cyber attacks.

To protect information or military institutions must also ensure the physical security of their facilities and personnel. This includes measures such as access control systems, perimeter security, and surveillance cameras to prevent unauthorized access and monitor

for potential security threats. Overall, security is critical in all types of institutions, but particularly in military institutions due to the sensitive nature of their operations. Implementing appropriate security measures helps to ensure the safety and security of personnel, information, and assets, and is essential for the successful execution of military operations.

## 2. MEASURES AVAILABLE FOR A SAFER ACCESS

**2.1 Actual types of access systems.** When we talk about an access system we take into consideration a lot of parameters, starting with the modality of access till equipments used in the fabrication of the system. The current stage of development provides a various types of access systems, some of the most common ones including the followings: Physical Access Control Systems (PACS): These systems are designed to control access to physical spaces, such as buildings, rooms, and equipment. Examples of PACS include electronic key cards, biometric readers (e.g. fingerprint scanners), and PIN codes; Logical Access Control Systems (LACS): These systems are used to control access to digital resources, such as computer networks, databases, and software applications. Examples of LACS include user authentication systems (e.g. username/password), smart card readers, and biometric authentication systems; Network Access Control Systems (NACS): These systems are designed to control access to computer networks and resources connected to them, such as servers and workstations. Examples of NACS include firewalls, intrusion detection systems, and virtual private networks (VPNs); Mobile Access Control Systems (MACS): These systems are designed to control access to mobile devices, such as smartphones and tablets. Examples of MACS include biometric authentication systems and mobile device management (MDM) software; Visitor Management Systems (VMS): These systems are designed to manage and control access for visitors to a facility, such as a reception area or lobby. Examples of VMS include electronic sign-in systems, ID card scanners, and visitor badges., access systems are designed to provide security and control for physical and digital resources, and to ensure that only authorized individuals have access to them.

**2.2 The biometric identification.** Despite the technical talk, just as a principle, there are three main methods that can be used for authentication: Something a person knows, which can be a password, PIN value or answers to authentication security questions; Something that a person has; for example, a smart card, USB, key or access card; Something is a person, based on a unique physical or behavioral attribute, which is usually captured through biometric systems. But for a research development idea, a strong authentication that contains two of these three methods is commonly called "Two Factor Authentication". Biometric systems, as part of Physical Access Control Systems (PACS), are classified according to the number of features used for authentication purposes. There are various identification methods such as face recognition, iris recognition, voice recognition, fingerprint recognition, etc. With the advancement of technology, information security has become a major issue in the IT industry. Authentication therefore plays an important role in dealing with security. The main purpose of this system is to ensure that the services provided can only be accessed by authorized users and not by illegal persons. Biometrics can be used to confirm or establish an individual's identity.

**2.3 Fingerprint system of access.** The fingerprint, in the last time, is one of the most commonly used biometric feature for personal identification and verification in the biometric field. An important principle of fingerprint authentication algorithm combines point matching and image matching.

The algorithm relies on the singularity abstraction and wave transform coefficients. First, is essential to extract singularities for coarse adjustment and image calibration. Since the fingerprint image after finger skin wave transformation follows approximately a generalized Gaussian distribution, two parameters can be used to represent the wave subband properties. This greatly reduces the number of feature points and matching time. In this project, the final experimental results using the R307 fingerprint sensor show that the algorithm can effectively overcome the effect of image rotation, with a incredible final recognition rate and an average recognition speed of about 0.9 seconds. Furthermore, the study of fingerprint-based access systems relative to the speed of individual fingerprint recognition shows that it is difficult to circumvent by hacking or other electronic means, because the biometric data used for verification is stored locally in the access control system and is not transmitted over a network. This makes it more difficult for cyber attackers to access or manipulate the system remotely.

Once the advantages of access based on fingerprint recognition are taken into account, the scientific research of the project looks for the most optimal model for the implementation and practical realization of the intended idea. An analysis of the costs and the security guarantees that are needed guides the researcher towards an optimal option in terms of price, but as a maximum of reliability and safety. What is taken into account in the realization of this project is the connection of an arduino uno board, a fingerprint sensor, a 16x2 lcd display, a 12V solenoid, but also a voltage relay to be able to convert between the 12V required for the solenoid and the 5V allowed for the operation in optimal parameters, without causing damage, of the arduino board. There is known that Arduino boards are open-source microcontroller boards that can be programmed to control a wide range of electronics projects. They are designed to be user-friendly, with a simple programming language and a wide variety of pre-made software libraries that can be used to control different components and sensors. One of the key advantages of Arduino boards is their versatility. They can be used to create a wide range of projects, from simple LED displays to complex robots or Internet of Things (IoT) devices. Additionally, Arduino boards are relatively inexpensive and widely available, making them accessible to hobbyists, students, and professionals alike.

An Arduino-based system that utilizes a fingerprint sensor and an LCD display can have several scientific aspects, including: Biometrics: The fingerprint sensor uses biometric technology to recognize and authenticate individuals based on their unique fingerprints. This technology is widely used in security systems and has applications in forensics, healthcare, and banking; Human-computer interaction: The LCD display provides a user interface for the system, allowing users to interact with it and receive feedback. This involves aspects of human-computer interaction, such as interface design and usability testing; Microcontrollers: The Arduino is a microcontroller-based platform, which means that it uses a small computer chip to control and manage input and output devices. This technology is used in a wide range of applications, from automotive systems to medical devices; Embedded systems: The Arduino-based system is an example of an embedded system, which is a computer system designed to perform a specific function within a larger system. Embedded systems are used in many applications, such as home automation, industrial control systems, and robotics; Sensor technology: The fingerprint sensor is an example of a sensor, which is a device that detects and responds to a physical stimulus, such as light, sound, or pressure. Sensor technology is used in a wide range of applications, including environmental monitoring, medical diagnostics, and industrial control systems. So in this case of study, the Arduino-based system that uses a fingerprint sensor and an LCD display provides an excellent platform for exploring scientific concepts related to biometrics, human-computer

interaction, microcontrollers, embedded systems, and sensor technology. Also, the transformation of this project into reality is the guarantee of a security system among the best that exists in this period.

**2.4 Tests and measurements of the arduino project.** In this Arduino-based access system that uses a fingerprint sensor, an LCD display, a solenoid, and other components the principle of work is in the following way: The fingerprint sensor is connected to the Arduino board and is used to capture and recognize the user's fingerprint. This involves wiring the sensor to the appropriate pins on the Arduino board and using a software library to communicate with the sensor. The LCD display is connected to the Arduino board and is used to provide feedback to the user, such as displaying messages and prompts. This involves wiring the display to the appropriate pins on the Arduino board and using a software library to control the display. The solenoid is connected to the Arduino board and is used to lock or unlock a door or other mechanism. This involves wiring the solenoid to the appropriate pins on the Arduino board and using a software library to control the solenoid. The Arduino board runs a software program, based on a specific code, that performs the following steps: The program waits for the user to place their finger on the fingerprint sensor; The fingerprint sensor captures the user's fingerprint and sends it to the Arduino board for authentication; The soft compares the user's fingerprint to a pre-defined set of fingerprints stored in its memory. If the fingerprint matches, the program proceeds to the next step. Also, it prompts the user to try again or denies access and sends a signal to the solenoid to unlock the door or other mechanism if the fingerprint is authenticated. If the fingerprint is not authenticated, the program does not send a signal to the solenoid and the door or mechanism remains locked; The program provides feedback to the user via the LCD display, such as displaying a message that the door has been unlocked or denied access, as following: "Please scan!", "Finger known! Access allowed!" or "Unknown finger! Access denied!" but it can be customised from case to case. The user have to be conscious of the idea that this system provides a secure way of granting access to a door or other mechanism by using biometric authentication, while also providing feedback to the user via an LCD display.

## 3. CONCLUSIONS & ACKNOLEDGMENT

The fingerprint authentication is a crucial aspect of biometric authentication and plays an essential role in identity verification and access control. Fingerprint authentication involves capturing and comparing unique patterns on a person's fingertips to verify their identity. It has become increasingly popular due to its accuracy, reliability, and convenience. It offers several advantages over traditional authentication methods such as passwords and PINs. It provides a high level of security because fingerprints are unique to each individual and are difficult to forge or duplicate. It is also more convenient than remembering and entering passwords or PINs, and eliminates the risk of forgotten or compromised passwords. This type of acces is widely used in various settings, including mobile devices, access control systems, financial institutions, healthcare, and law enforcement. It provides a quick, easy, and secure way to verify identities and access information or resources.

It’s an obvious proof that the system based on Arduino, fingerprint sensor, LCD display and solenoid is an excellent example of how technology can be used to provide secure access control. Using biometric authentication through a fingerprint sensor, this system can ensure access only to authorized people. The use of an LCD display provides visual feedback to the user, improving the user experience and making it easier to understand the status of the system.

The solenoid, when connected to a lock or other mechanism, can provide a physical barrier for access control, increasing the overall security of the system. This system can be useful in a variety of settings, including homes, offices, and industrial environments where access control is essential for security and safety. Furthermore, fingerprint authentication has become more affordable and accessible, making it a viable option for individuals and organizations of all sizes. With the increasing demand for secure and convenient authentication methods, we can expect fingerprint authentication to continue to grow in popularity and become even more prevalent in the future. As technology continues to evolve, fingerprint authentication will undoubtedly play a crucial role in identity verification and access control.

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# REAL-TIME TRACKING SYSTEM

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***Abstract**: GPS technology is an important asset in our lives since it is useful in multiple domains. This technology can be essential in certain scenarios, as it can be used for tracking and saving people in critical circumstances, such as emergencies. This paper presents the development of a real-time GPS tracking system based on Raspberry Pie 4 model B and GPS-NEO-6MV2 module. The tracking system also includes software applications developed for equipment interconnections and a user interface (website) used to follow the device's position in real-time. The proposed system could be used for several military and civilian purposes. The presented device is a low-cost solution for vehicle tracking.*

***Keywords:** GPS, location, satellite communications, GSM, Raspberry Pi*

## 1. INTRODUCTION

Since the oldest times, men based their recognition on certain natural landmarks (such as the sun, the moon, tree moss, the north star, etc.). The development of assets based on which people could track their position started, so the compass was created. Nowadays, our technology has reached incredible heights so we can use smart devices to track our location and destination. Of course, our technology keeps evolving to make our lives easier. The development of our technology made it possible for us to use digital maps, which previously required a lot of time to be physically manufactured.

This article contains information about the development of a real-time tracking device. Multiple coding languages and scripts are being used, such as Python, to connect the hardware components based on software, so that a user interface can be created. This article contains multiple ideas as well as abilities, since connecting the hardware components and creating a user interface requires well-developed software. This kind of practice made me decide to develop a GPS-tracking device. Also, there is a secondary tracking method, based on GSM signal, through SMS.

## 2. DESCRIPTION OF GPS

Satellite-based communications have been developed based on our need to quickly share information over long distances. Those have provided us with a worldwide communications network. For this to be possible, multiple satellites have been launched into space and are currently orbiting the earth.

The idea of the satellite has been created by Arthur Clarke in 1945, who published an article that presents the basics of man-made satellites. A few years later, this idea was the basis of a project which involved the moon, a natural satellite that orbits the earth, being used to reflect electromagnetic waves.

As a result, the first manmade satellite was launched on the 4th of October 1957. It ended up having approximately 1400 laps around the earth after which its components unbundled while entering the atmosphere.

The global positioning system is made up of 3 segments:

- the space segment
- the control segment
- the user's segment

The space segment is made up of 32 satellites that lap the earth every 12 hours. The satellites are positioned at a height of 20.000 km, and their orbits are designed so that the GPS receiver's layout on the earth can receive a signal from at least 4 satellites at any given moment. There are 6 orbits that the satellites can follow. Regardless of their orbit, the satellites aim to be positioned toward the earth.

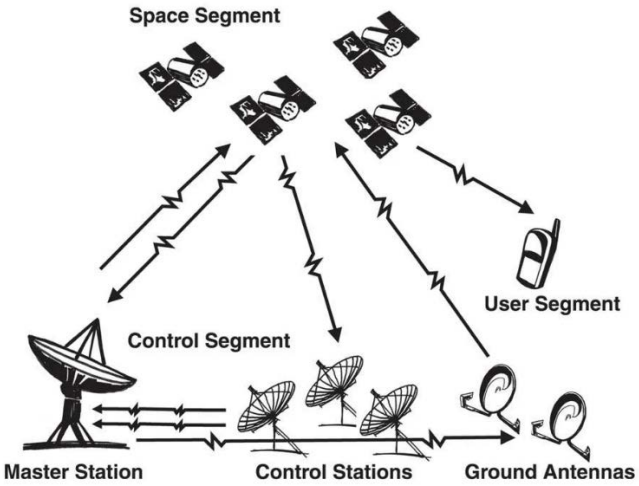


**FIG. 1** Segments of GPS

## 4. GEOLOCATION

Achieving geolocation involves a device that can be located through the satellite positioning system based on multiple methods such as Wi-fi and GSM/GPRS (Global System for Mobile Communication/General Packet Radio Services). The registered locations can either be stored on the device or can be sent to a real-time geolocation software platform. To achieve real-time transmission, the device is required to have at least radio, satellite, GSM, and LTE (long-term evolution) capabilities. In the 6th image, a GPS-based geolocation is presented

Geolocation is used nowadays in multiple areas since it does have multiple applications. GPS-based geolocation has also been used for entertainment purposes, such as videogames. Augmented reality videogames are using the geolocation concept.

The logistics area became dependent on geolocation since this area implies trucks, ships, or planes to move items from one place to another. Geolocation is necessary to determine the location and the circumstances, such as the speed, the traveled distance, the traveled path as well as other telemetry-related information.

Social media is also regularity nowadays, and it is supposed to provide real-time interactions to its users. For example, job recruiting websites offer location-based job suggestions. Most types of sales are pierced through the online environment, which makes use of the geolocation concept to ease the necessary effort to ensure the products are properly delivered.

## 3. EASE OF USE

The GPS tracking device was created to reveal the applicability of this technology. Most people understand global positioning systems as simply providing navigation for their car or mobile phone. This device demonstrates that location tracking and route monitoring can become vital elements. The device was designed for emergencies such as driving, mountain climbing, and traveling to remote locations. Because GPS Technology uses satellites to determine location, it is advantageous in location even the deepest or highest geographic areas. The addition of a GSM module that uses base stations to transmit text messages adds to the assurance of location discovery, as it can be requested through a text message.

Location tracking and monitoring have applications in other fields such as transportation, and economics, but safety for people seemed to be the most important to me.

## 4. METHODOLOGY

### *A. Block Diagram*

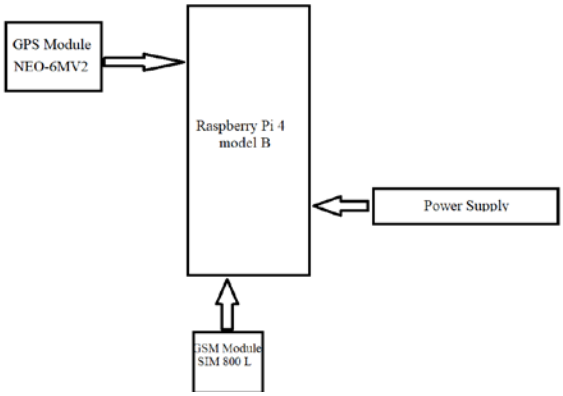


**FIG. 2** Block Diagram

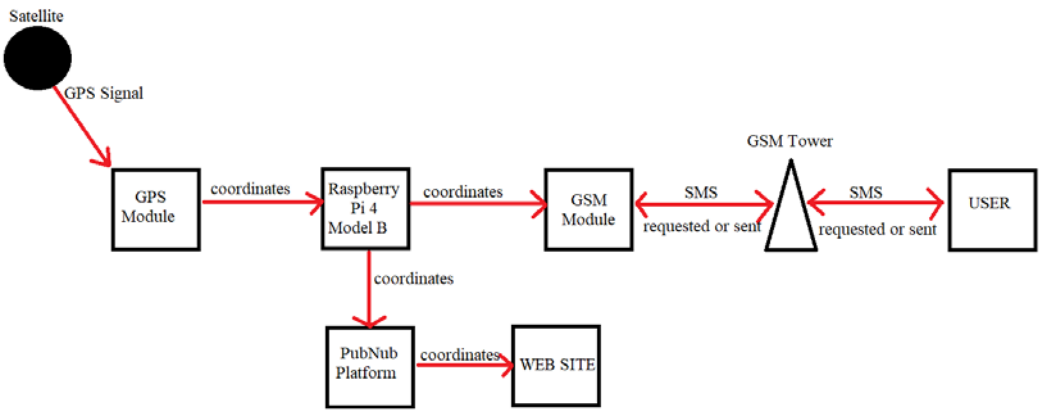


**FIG. 3** Procedural Diagram

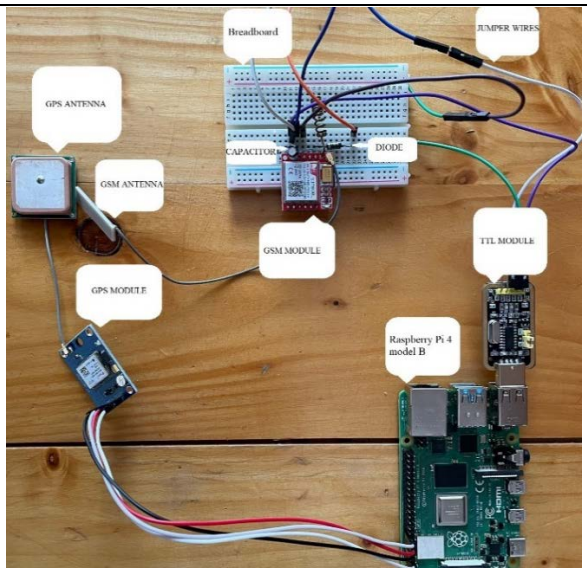


**FIG. 4** Final ensemble

*B. Block Description*

This project is an attempt at designing an embedded system that is used for tracking and positioning any type of user using a Global Positioning System (GPS) and Global System for Mobile Communication (GSM).

For the realization of the GPS location and tracking device, I chose to use the Raspberry Pi 4 model B development board with 8GB of RAM. The choice of this development board is supported by the innovative increase in performance of these Raspberry Pi products, as they offer increased processor speed, improved multimedia performance, increased memory, and connectivity capacity, as well as other improvements and innovations.

The realization of a real-time tracking and location device involves creating an embedded system from the Raspberry Pi 4 model B development board and various modules. The ideal feature of the Raspberry Pi 4 model B development board is its GPIO port, consisting of 40 male pins used to control and read data from different modules or sensors, which is an advantage in building an embedded system

The pins are divided into three categories:

- VCC - which has two types of pins: 5V and 3.3V. These pins are used to power the modules or sensors, and the 5V pins can be used to power the development board.
- GND – represents the ground.
- GPIO - can be set as input pins, in the case of programs, or as output pins, to control other modules. They also perform some special functions, such as SPI (Serial Peripheral Interface),
- UART (Universal Asynchronous Receiver/Transmitter) for RX (reception) and TX (transmission),
- PCM (Pulse Code Modulation), and ID EEPROM pins are specially reserved for the use of HAT (Hardware Attached on Top).

To realize the GPS location and tracking device, it is necessary to use the 5V and 3.3V power supply pins, the GND ground, and the UART TX and UART RX pins.

To complete the realization of the GPS location and tracking device, I chose to use the SIM-800L GSM module to improve location services.

The SIM-800L module is a GSM/GPRS module that provides voice and data services while using low power consumption. The module operates on frequencies of 850/900/1800/1900 megahertz. The module's power supply voltage is between 3.4-4.4 volts, with a maximum consumption of two amps. The module's transmission rate is 1200 bits/second to 115200 bits/second with automatic detection.

The pins required for the project are those on the left side of the module, namely the GND, TXD, RXD, VCC, and NET pins. The VCC and GND pins are for power supply and grounding, TXD and RXD are used for message transmission and reception, and the NET pin is where the helical antenna is attached.

This module is used for transmitting and receiving SMS messages, transmitting, and receiving voice calls, transmitting, scanning, and receiving radio stations, and receiving emails that allow connection to the internet. For message and call transmission and reception, the module uses the AT protocol.

AT comes from "ATtention.". This protocol assumes that any command line begins with "AT" or "at." AT commands are used to control wired modems, and GSM/GPRS modems, and are used in mobile phones. For example, mobile phones contain AT commands for sending, listing, storing, and reading messages.

Connecting the Raspberry Pi 4 development board and the NEO-6MV2 GPS module is done using female-to-female Dupont wires. The corresponding pins of the GPS module are connected to the development board pins as follows:

- NEO-6MV2 VCC-Raspberry Pi 4 3.3/5V
- NEO-6MV2 GND-Raspberry Pi 4 GND
- NEO-6MV2 RX-Raspberry Pi 4 TX (GPIO 14)
- NEO-6MV2 TX-Raspberry Pi 4 RX (GPIO 15)

To create an efficient GPS, I chose to use the SIM-800L module to be able to get the user's location using the Global System for Mobile Communication (GSM) network. However, the technical specifications of the SIM-800L GSM module do not allow for direct connection to the 5-volt power supply of the Raspberry Pi 4 development board. Therefore, I created a circuit on a breadboard consisting of a 1N4007 diode, a 100 microfarad capacitor, and the SIM-800L module.

The diode allows current to pass in one direction, but on the other hand, silicon diodes also cause an estimated voltage to drop of 0.7 volts. The diode is used to decrease the 5-volt voltage by 0.7 volts to bring the GSM module's power supply to the optimal voltage. Also, the diode does not affect the current intensity.

The capacitor is used to stabilize the power supply. They charge with the electric current when there is excess and discharge when there is insufficient current in the circuit. To create the circuit, I used this principle of the capacitor and introduced a 100 microfarad electrolytic capacitor.

To create the circuit, I needed to connect the SIM-800L module to the breadboard with the GND, TXD, RXD, and VCC pins. I attached the capacitor in parallel with the VCC and GND pins. I connected the silicon diode in parallel with the power supply pin of the Raspberry Pi 4 development board anode, and I connected the cathode in parallel with the VCC pin of the SIM-800L module. To make the connections with the Raspberry Pi 4 development board, I used jumper wires. I connected the GSM module's TXD pin to the RX pin of the TTL converter connected to the USB port of the Raspberry Pi 4 development board using a jumper wire, and I connected the GSM module's RXD pin to the TX pin of the TTL converter connected to the Raspberry Pi 4 in the same way. The USB-TTL converter is necessary because the Raspberry Pi 4 only has one pair of TX and RX pins, which are used for connecting to the GPS module.

To establish communication between our website and the location and tracking device I built, I will use an Application Programming Interface (API). To establish the level of real-time communication of the application that I want to implement, I chose the Pub Nub platform. This platform has global scalability, provides a real-time data stream network, is easy to use, and does not require additional costs. There is no need to upload the website to a server; it works and is open as an HTML (Hypertext Markup Language) page. The application uses a Pub Nub channel to send and receive data to change the position based on latitude and longitude modifications.

Creating a geolocation website includes using a web mapping platform. Therefore, I chose to use Google Maps to create the user interface of the website. I initialized the Google Maps API at the end of the code to ensure that the requirements and Document Object Model (DOM) elements are met. I initialized the process using a unique identification key called the Google Maps API Key, which helps me validate my request to use the Google Maps API server. To generate this unique identification key, I needed to create a Google account, then accessed the Google Cloud Platform and activated the Maps JavaScript API to generate the unique identification key that I needed.

Similarly, the Pub Nub library also requires unique identification keys, a channel name, and a User ID. For the two unique identification keys, I used the Demo Keyset.

The code was created to retrieve data from the GPS module using the serial ports of the Raspberry Pi 4 development board, and the received data is to be transmitted through the USB0 port to the GSM module, which in turn will emit the location message. The transmitted message is in the form of a link which, once requested, opens the digital map interface Google Maps with the data received from the GPS module. In case the GPS module does not receive a satellite signal, it will transmit a message in the form of "Satellite data unavailable".

## 5. INTERFACE CAPABILITIES

The GPS location and tracking device features an interface created using the JavaScript programming language and complemented by the CSS programming language. It features a START-STOP button for starting and stopping the device's location and tracking. For the interface to display data from the Raspberry Pi 4 development board. Running the code is done remotely using the PiTunnel web server. This web server allows remote connection with the Raspberry Pi 4 development board as long as it is connected to a network. To connect the development board, its IP address needs to be entered, as the web server will recognize it by this. For the final verification of the device, a real-time car trip was made. The starting point represents the final point, and as can be seen, the GPS tracking and location device created meets the expected objectives.

This GPS location and tracking device was created to reveal the applicability of this technology. Most people understand the global positioning system only as simple navigation in a car or on a mobile phone. This device demonstrates that locating a location and tracking a route can become vital elements. This device was designed for emergencies such as car trips, mountain trips, and trips to hard-to-reach places. Because GPS technology uses satellites to determine location, it becomes an advantage, as it can locate even the deepest or highest geographical areas. Adding a GSM module that uses base stations to transmit text messages ensures the discovery of the location, as it can be requested through a message. In case of unfortunate incidents, location can be requested through text messages.

Location and tracking also find their applicability in other areas, such as transportation, economy, etc., but the safety of people seemed to be the most important to me.

Exposing the importance of a GPS device and understanding its functionality are considerations that underlie the creation of this project.

## 6. FUTURE WORK

The future hardware objective is to implement a video camera that can capture photos or videos, while from a software perspective, the intention is to create a graphical interface and an application that can be used both on a mobile device and a personal computer. Additionally, there is a desire to create an alert system using the video camera, so that in case of any type of accident, whether it's a car accident or mountain accident, the last recorded location, along with the captured photo or video, can be sent to an emergency contact. This camera will provide more details about the location and its condition. For autonomy, from a hardware perspective, a solar charging system will be developed for the Raspberry Pi 4 development board and the modules used, along with a large enough Li-Po battery for continuous use for up to 8 hours.

## 7. CONCLUSIONS

This paper is an attempt to develop a system for real-time GPS tracking based on a Raspberry Pie 4 Module and a GPS NEO-6MV2. The hardware and software components used to construct the system are presented in detail. The functionality of the system was also evaluated in a driving scenario to demonstrate its applicability in different military and civilian usage scenarios. The designed system could prove its agility in reducing the likelihood of loss of life in accidents that are beyond our control. With the focus on location and tracking, the device user can cover various day-to-day life scenarios in different domains. This device can be further extended for applications, such as an anti-theft system for cars and bikes, tracking of valuable assets, to manage transport for transport companies.

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# ANALYSIS OF RADAR PERFORMANCE CONSIDERING VARIATIONS OF THE RADAR RANGE EQUATION'S PARAMETERS

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***Abstract:*** *Radar performance represents a subject of peculiar interest in the context of the continuous necessity of developing air surveillance means and strategies. Comparative analysis of the radar range and detectability performance, using modern methods of digital simulation, with respect to the proportionality relations between the Radar Range Equation's factors, can lead to a deepening of the understanding of the theoretical knowledge.*

***Keywords****: radar; digital representation; analysis; AR buildout.*

## 1. INTRODUCTION

Considering a solid knowledge basis, consisting of necessary definitions and mathematical formulae, the analysis of radar performance is proceeded to, using the Radar Designer App, part of the Signal Processing and Communications applications pack, in the MATLAB R2022b soft. Having briefly defined the Radar Range Equation, being the core of the whole scientific content, its variable factors are used to design a quasi-ideal detection situation for the vertical coverage pattern to be generated. In this regard, graphic representations of the mathematical relation between, for instance, the Signal to Noise Ratio and the probability of detection, or the maximum range can be easily displayed and interpreted. The materialization of the radar performance, the vertical coverage lobular design, later proves to be in perfect accordance with technical parameters, particularly to antenna height and beamwidth. Consequently, such visualization and application of theoretical aspects is intended to be exploited for educational purposes.

## 2. FROM KNOWLEDGE BASIS TO RADAR PERFORMANCE DIGITAL ANALYSIS

### 2.1 Highly Generalized Hypothesis and Essential Terminologies

**The Radar Range Equation** describes the relationship between the transmit power, wave propagation, and reception of echo signals. It determines the maximum theoretical range of a given radar, given the receiver's sensitivity. **The Radar Cross Section**, on the other hand, is an aircraft-specific quantity that depends on various factors, including the target's physical geometry, surface composition, and materials used.

**Antenna Gain** is a parameter that describes the directivity and efficiency of an antenna, making it an easy-to-use measure. The vertical coverage pattern is a detection contour that shows the radar system's performance at a constant signal level, as specified

by the free space range. It takes into account the interference between direct and ground-reflected rays and refraction.

**The decibel (dB)** measures the input-to-output power ratio and is not an absolute value. It compares the intensity of an electrical signal's power level to a given scale. **The decibel relative to isotropic (dBi)** is a unit of measurement that quantifies how much power an antenna transmits in a single direction compared to an isotropic radiator.

**Mathematical formulae**

**Beam Factor = (D/λ)·(Beamwidth)**

$$R_{\max} = \sqrt[4]{\frac{P_s G^2 \lambda^2 \sigma}{P_{e_{\min}} (4\pi)^3}}$$

**FIG. 1** Radar range equation

- $R_{max}$ – maximum range
- $P_s$ – transmitted power [W]
- G - antenna gain
- λ – wavelength
- σ – radar cross section [$m^2$]
- $P_{emin}$ – minimum received power [W]

In order to carry out a radar range performance analysis, most of calculus uses the premises of free space. In the present context, free space implies that a spherical region of space, centered at the radar and extending to considerably beyond the target, is empty except for the radar and the target. In reality, this condition is never fully realized.

Using the Radar Designer App in the MATLAB R2022b soft, further analysis can be proceeded to. Shall we consider a non-ideal electromagnetic environment, where the atmosphere and surface are considerably different from free space, we will bear in mind the influence of the Earth's curved surface.

Having mentioned that most of the parameters that don't make a subject of interest for the intended analysis are adopted according to their predefinition, let us consider a target with the Swerling 0 or Swerling 5 model, defined as an idealized target, lacking any fluctuation of the Radar Cross Section of 4 $m^2$, a maximum acceleration of 14.4 $m/s^2$, accordingly to a supposed F-16 aircraft, at an elevation angle of 1 degree. Moreover, we shall consider a fixed, monostatic radar, working with the frequency of 3 GHz, having a peak power of 1.1 MW, a Pulse Repetition Frequency of 350 Hz and an antenna height of 10m. The horizontal polarized antenna transmits a directive array, having a concentrated beam of 1.5 degrees azimuth beamwidth and 5 degrees elevation beamwidth. Therefore, using the beam factor defined by: **Beam Factor = (D/λ)·(Beamwidth)**, where D is the antenna dimension in wavelength, a gain of 36.35 dBi will be obtained. Visualization of the scenario geometry:

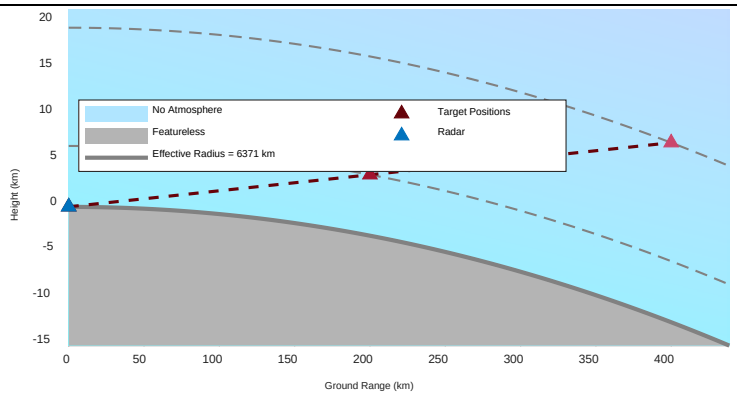


**FIG. 2** Designed radar- constant elevation angle target

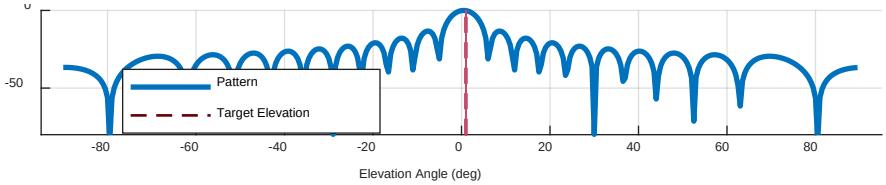


**FIG. 3** Antenna elevation pattern

From the point of view of metrics and requirements, the current configuration allows a probability of detection of 1, which is the perfect score. The SNR analysis proves good detectability since the curve of the designed radar's Signal to Noise Ratio in dB surpasses the objective detectability in the maximum range, hence the reflected signal level is greater than that of the noise.

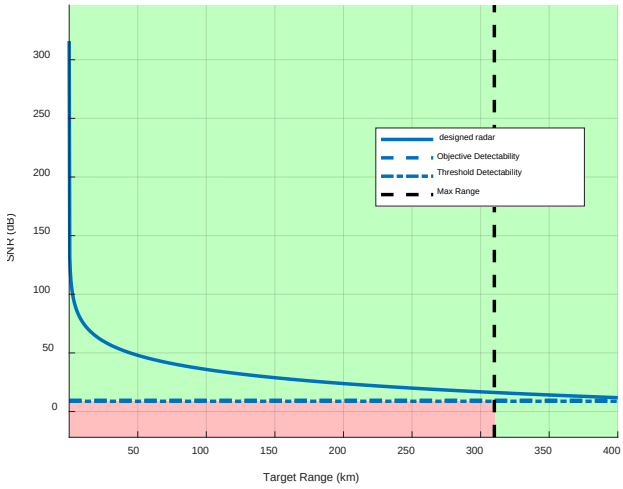


**FIG. 4** Signal to Noise Ratio

The designed radar requires a Signal to Noise Ratio of 9.61 dB for objective detectability. Performing a gains versus losses analysis, the single-pulse steady target losses slightly surpass the coherent integration gains. Furthermore, two other factors count in: a custom loss and a Constant False Alarm Rate loss, both constant and predetermined.

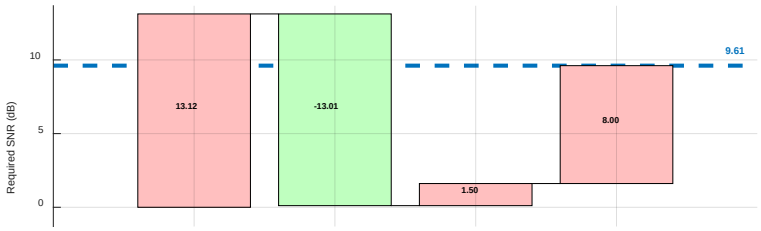


**FIG. 5** Gains and Losses rate (green for gains, red for losses)

The ensemble of the previously defined parameters comes together to finally generate the design of the vertical coverage pattern. The current designed radar proves to have the best detection performance for low altitude flying targets, using not only the free space vertical pattern diagram but also, the ground reflections effect.

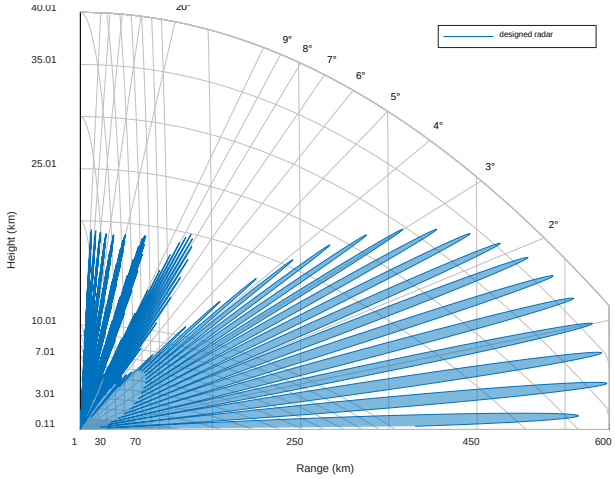


**FIG. 6** Vertical coverage pattern of the designed radar

Therefore, all the parameters of the radar range equation are tightly interconnected, and any variation determines changes in the radar's detection performance. The materialization of the latter can be viewed as the vertical coverage pattern. In this regard, different types of radars use specific technical and tactical characteristics, with consideration to the environment they are placed into and to their purpose in the air surveillance strategy.

When taking every possible factor of influence into account, many variables intervene. Shall we use a smaller wavelength for the designed radar, hence a higher frequency (1.5 GHz greater), the probability of detection considerably decreases to a value of 0.3239, much below the threshold value of 0.75. This is a direct consequence of the reflections at the Earth's surface and lobing, an effect that lower frequency band radars would use to maximize cover at low altitudes. Accordingly, analyzing the MATLAB R2022b designed radar, for even greater frequencies, the probability of detection shall decrease to 0. Consequently, avoidance of the lobing effects is a primary condition when choosing the location for a radar installation.

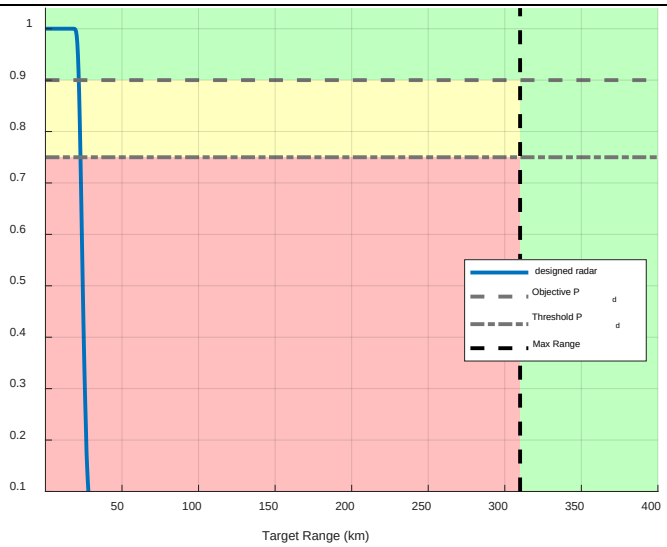


**FIG. 7** Probability of detection

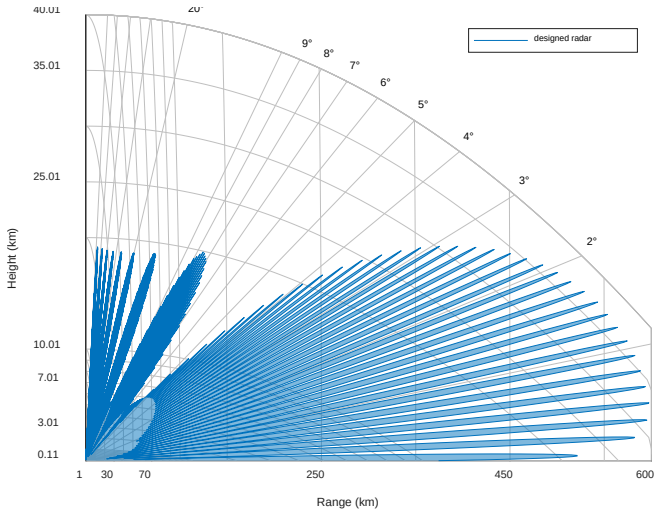


**FIG. 8** Finer lobing pattern of the vertical coverage

On another hand, the antenna height is likewise, a very influential factor, thus, increasing the antenna height makes the lobing pattern finer. The irregularities of the ground plane are responsible of filling in the fine-grained lobing structure. Comparison of the vertical coverage pattern for the designed radar for an antenna height of 3m with null probability of detection (Fig. 9), versus an antenna height of 13 m with unitary probability of detection (Fig. 10):

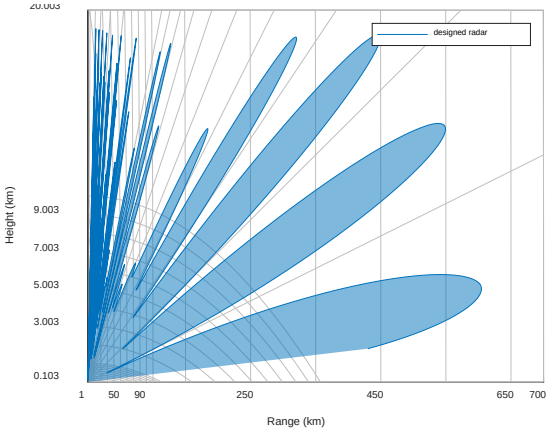


FIG. 9

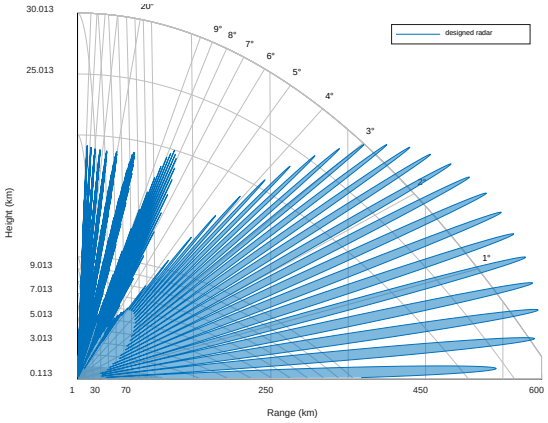


FIG. 10

## 3. CONCLUSIONS & ACKNOWLEDGMENT

Having taken into consideration the influence that the radar range equation parameters have on the radar's efficiency and the importance of visualizing the graphic representations in order to comprehend the phenomena that accompany factors variations, I suggest a deepening of knowledge trough AR representations, research direction that shall complete the already analyzed aspects.

AR representation of radar functionalities has a great academic potential, since experiencing the 3D projection of already assimilated theoretical aspects can clarify and fixate information. In this regard, the **further direction of research** is Augmented Reality Radar design in the Blender 3.4 soft. Two main subjects of development are a PPI (Plan Position Indicator) animation and a vertical coverage pattern for electromagnetic emission, which can both be visualized with the help of Microsoft HoloLens technology.

Further pursuing the acknowledgement of the hereby presented research paper could result in the implementation of AR representations into the teaching process.

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# THE ORGANISATION AND THE ACTIONS OF THE ROMANIAN AIR CORPORATION DURING 1-30 APRIL 1944

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***Abstract:*** *During the period of April 1944, the Romanian Air Corps played a crucial role in the events of World War II. As part of the Axis Powers, the Romanian Air Corps was primarily involved in supporting German operations on the Eastern Front, particularly against Soviet forces. Despite facing significant challenges such as limited resources and outdated equipment, the Romanian Air Corps continued to carry out bombing raids and ground attacks, as well as providing air cover for ground troops. Overall, the actions of the Romanian Air Corps during April 1944 reflected the difficult position of Romania during World War II. Despite being a relatively minor power within the Axis, the Romanian Air Corps played an important role in supporting German operations and defending Romanian territory. However, they faced significant challenges and ultimately proved unable to withstand the onslaught of the Allied forces.*

***Keywords****: Romanian Regal Aviation; World War II; Bombers; Mustang; Combat Operations.*

## 1. INTRODUCTION

During the Second World War, the Romanian Air Corps played a critical role in supporting Axis operations on the Eastern Front. As part of the Axis Powers, Romania was initially a reluctant participant in the war, having been forced to cede territory to the Soviet Union and Hungary at the outset of the conflict. However, following a coup in 1940, Romania joined the Axis and became a significant military force in the region. The Romanian Air Corps, in particular, played an important role in supporting German operations against the Soviet Union and defending Romanian territory from Allied air attacks.

Despite being a relatively minor air power, the Romanian Air Corps carried out a range of operations during the conflict. This included providing air cover for ground troops, carrying out bombing raids on enemy positions, and engaging in dogfights with Soviet planes. Despite facing significant challenges such as limited resources and outdated equipment, the Romanian pilots proved to be skilled and determined fighters.

During April 1944, the Romanian Air Corps was engaged in a range of operations on the Eastern Front, including defending Crimea against Soviet forces. This involved providing air support to the German forces on the ground, as well as engaging in direct combat with Soviet planes. Despite facing superior Soviet air power, the Romanian pilots were able to hold their own and inflict significant damage on enemy forces.

In addition to their combat operations, the Romanian Air Corps also undertook significant efforts to train new pilots and upgrade their equipment. This included sending pilots to Germany for advanced training and working to acquire more modern planes from the Axis powers.

Overall, the actions of the Romanian Air Corps during the Second World War reflect the difficult position of Romania during the conflict. Despite being a relatively minor power within the Axis, the Romanian Air Corps played an important role in supporting German operations and defending Romanian territory. However, they faced significant challenges and ultimately proved unable to withstand the onslaught of the Allied forces.

## 2. KEY MOMENTS DURING THE MONTH OF APRIL 1944

### 2.1 APRIL 4 – 1944

A black day for Bucharest due to the colossal bombardment from the Anglo-American aviation, this bombardment targeted key civilian areas with a general focus on the center of the Bucharest. Grivița district and the area around Gara de Nord were the main targets because by destroying these strategic points, the transports towards Moldova where the Soviet Army was headed, would be stopped.

The raids began in april, by the 15th Air American Army. They used Consolidate B-24 Liberator bombers which were escorted by numerous P38 Lightning and P51 Mustang fighter planes. England joined the operation with its 205 Aerial Group with Welington and Halifax bombers which took of from Foggia, Brndisi and Bari, situated in Italy.

And so, on the 4th of April 1944 around noon, a number of aproximately 220 bomber B-17 also knows as “Flying Fortresses” and over 100 B-24 Liberators penetrated the Romanian airspace coming from Italy’s Foggia Air Base and reaching Romania’s capital almost immediately.

In that very moment, in Gara de Nord there were a few hundred people, refugees from Moldova, they were supposed to pe settled in different places around Bucharest and other parts of the country. They were mostly women, children and elders and they were all beaten up after leaving their country and leaving behind their homes, waiting, starbing and tired. When the raid alarm started, the majority stayed in their train carts because they had no other shelter around and when dissaster struck, it was a total dissaster because almost all of them died under the heavy bombardments.

Thousands of houses were destroyed in the bombardments, districts such as Grivița, Grant, Giulești, Triaj, Chitila became unrecognizable, having suffered unprecedented damage. Historic buildings were also damaged, such as Splendid Hotel, the National Theatre, and the Romanian Athenaeum. The number of victims was high, the official account states that a number of 2942 people lost their lives, over 4000 were injured and over 55.000 people lost their homes. Contemporary conclusions say that this particular bombardment lacked any reason; defenseless civilians were targeted because Bucharest lacked any kind of strategic or economic areas with such a high value.

**FIG. 1** Aftermath of Anglo-American bombings, Romania Liberă (Aprilie 2005)

### 2.2 BOMBARDMENTS AND LOSSES

These events were followed by heavy attacks over Ploiești on April 5 1944, June 28 in Bucharest, 10 and 28 august 1944 in the petroliferous area (this was one of the biggest raids in the history of Romania, with around 800 bombers escorted by 300 fighters)

On the lenght of 4 months, american bombers aexecuted 41 aerial raids, 11 during the night and the rest during the day: April – 6 day raids and 1 night raid, May – 5 day raids and 2 night raids, June – 4 day raids and 1 night raid, July – 8 day raids and 4 night raids, August – 7 day raids and 2 night raids. Most of the hits were in the area Ploiești – Câmpina (30 attacks), followed by Bucharest (20 attacks), Brașov (7 attacks) and Giurgiu, Focșani, Turnu Severin (5 attacks reach).

Damage assessments revealed that the material losses of state departments and autonomous regions were around 186.076.839 .91 lei. Out of the 47.335 destroyed or damaged building, 46,523 were civilian buildings. The number of human losses caused by the bombardments rose up to 7.592 (562 were children) and there were also 7.661 wounded (603 were children).

Just like in 1943, Romanian and German aviation and artillery opposed the bombardments as hard as they could with the available resources, this led to Anglo-Americans losing 223 day bombers, 36 fighter planes and 18 night bombers and 2.200 people (deceased or imprisoned). In the heated air conflict between Anglo-American aviation and Romanian aviation, the Romanian aviation acted with a huge handicap due monumental difference in numbers (for example, on August 18 1844, the Romanians and Germans were able to send in battle only 46 aircrafts which were supposed to confront the 800 enemy aircrafts). This inferiority in resources led to marshal Ion Antonescu to ask his pilots to avoid any kind of dog fighting or air conflict.

### 2.3 A DARK DAY FOR ROMANIAN AVIATION. APRIL 19 – 1944

It is considered one of the darkest days of the Romanian Fighter Aviation, it is the day when the Romanian Regal Aviation, loses during a confrontation with the American Aviation 11 pilots form its 1,2 and 6th Fighter Groups. Other 10 aviators were hurt and several IAR-80/81 were either destroyed or severely damaged. This tragedy occurred due to the fact that on that day, the American Aviation decided to send in their best fighter plane created during the Second World War, the P-51 Mustang, nicknamed by Romanian

pilots the “The Indian with only 1 feather”. This particular plane proved to be the biggest threat for IAR-80/81 aircrafts because of the difference in technical performance and it was too much to handle.

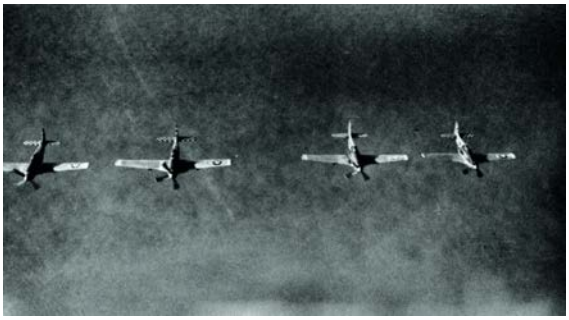

**FIG. 2** Formation of P-51 Mustang fighter planes, Historia (2021)

The fact that Romanian pilots were noticed too late about the escort that was accompanying the enemy bombers made the whole confrontation to turn into a disaster, the majority of the Romanian pilots being immediately shot down, being taken by surprise.

Most of the Romanian Fighter Pilots who were shot down on the day of April 21 were attacked by the 31st Fighter Group’s Mustang aircrafts. This American fighter unit (formed by squadrons 307,308 and 309) were part of the 8th and 12th American Airforce, executing a number of terrestrial operations all across West Europe and the Mediterranean Sea after which they were moved in the 15th Air Force and were dislocated in the South of Italy.

Here they received their new P-51 B Mustang aircrafts, replacing the old English aircrafts “Spitfire”. Their first mission over Romania took place on April 16 1944, when the 31st Fighter Group, accompanied by American bombers attacked Turnu Severin. All Mustang planes of this group had red stripes painted diagonally on their tail as a distinctive sign, knows as “Candy tails”.On the day of April 21 1944, the 31st Group successfully managed to confirm 15 takedowns on Romanian and German planes, 6 probable take downs and 4 damaged planes. For their exemplar performance, the 31st Hunter Group was decorated with the “Distinguished Unit Citation” (D.U.C).

In exchange for these victories, the 31st Group lost in the Romanian territory a number of 3 P-51 B Mustang planes piloted by Roland Height Jackson (shot down over Ciorani), Edward McLean Lyman and John Jay Willian (both shot down next to Pârlita forrest, next to Poenarii Burchi). The latest 2 managed to save themselves thanks to the parachute and were taken prisoner by Romanian forces. These losses on their side were a result of the German Fighter forces that managed to destroy 5 P-51B Mustangs.

On the same day, over Romania there were P-38 Lightning aircrafts from the 14th Hunter Group that were escorting American bombers on their way to Bucharest. Based on the mission reports, pilots from this unit came across around 35-40 fighter planes, both German Me-109 and Romanian IAR 80/81, and shooting down 8 confirmed aircrafts, 4 probable aircrafts and damaging 4 other aircrafts.

If the American fighter aviation had a big success, things are quite the opposite for bombing groups that circulated the Romanian sky. Out of their many objectives, only Bucharest was hit, but their targets inside Bucharest have been missed, a high number of bombs fell around different villages outside Bucharest. Police department reports state that over 100 bombs fell next to Bobești and just as many fell at Pâlsari.

Others fell on the range of villages situated on their flight route such as: Vârteju și Cornetu – over 30 bombs, Vakea Dragului – 6 bombs, Cățelu and others; all these resulted in the loss of civilian lives and structures. The bombs dropped in Bucharest by the 456, 459, 461 and 451 Bombing Groups destroyed a number of 125 houses and damaged other 111, killing 87 people and hurting 129.

The bombardment of Turnu Severin by the 460 Group resulted in other victims and losses. It was reported that over 50 bombs fell in the city and more than 100 people were found dead. Among the many victims, general Lambru was heavily hurt and the mayor of the city, Colonel Emil Folter deceased.

After a damage assessment, it can be said that the strategic mission from April 21 1944 was a failure for the 15th Air Force since none of the key objectives were hit. At Ploiești, American bombers did not reach the designated targets and in Bucharest only a few bombs touched, the ground and those also missed their intended targets. Even with the bombardment delivered at Turnu Severin, where the damage done was considerable it is clear that the American Aviation did not fulfill the primary objective. And in contrast to the failure of the bombing missions, for the American fighter planes it was an astounding success.

The heavy blow delivered to the Romanian Regal Aviation printed a scar and stood as a reminder for the following events. Since that day, Romanian pilots who were flying the IAR-80/81 understood clearly that they were up against not only a more numerous enemy but a more advanced one as well. The plane that the Romanians proudly flew was no match for the Mustang and this lead to a decrease in pilot morale since they were well aware of this fact.

The losses suffered by the Romanian Aviation in the day of April 21 caused distress even among the higher ranks of the Romanian Regal Aviation. After receiving the report regarding the losses from that day, General Gheorghe Jienescu wrote a disturbing resolution: „Disaster! At this rate we won't need more than 2 attacks to be crushed...".

**FIG. 3** The remains of a IAR-81 fallen next to the Crivina train station, Historia (2021)

Even after all this, fighter units of the Romanian Regal Aviation, which were operating the IAR-80/81 aircraft, continued to heroically fight against the American aviation. At the start of July 1944, when due to the heavy losses, they were withdrawn, leaving the defense of the territory in the hands of Fighter Groups 7 and 9 that were operating the Messerschmitt Bf-109. The cost was heavy, in only 3 monthis of fighting the Americans; the IAR-80/81 groups lost 30 pilots and 34 planes.

## 3. CONCLUSIONS & ACKNOLEDGMENT

In conclusion, the Romanian Air Corp played a significant role during the period of April 1944, which was a critical time in the country's history. The air force had a complex organization and structure, with several operational units and different types of aircraft.

During this time, the Romanian Air Corp faced numerous challenges and difficulties, including the lack of resources, training, and equipment, as well as the need to operate in an increasingly hostile environment. Despite these challenges, the air force remained a key player in the Romanian military strategy and demonstrated remarkable resilience and dedication in carrying out its mission.

One of the most significant actions of the Romanian Air Corp during this period was its participation in the battles of Iasi and Kishinev, where it played a critical role in supporting the ground forces and providing air cover. The air force's efforts contributed to the successful outcome of these battles and helped to secure important strategic objectives.

Moreover, the Romanian Air Corp also undertook several other notable actions during this time, including reconnaissance missions, air defense operations, and bombing missions against enemy targets. These actions demonstrated the air force's versatility and adaptability in responding to the changing needs of the military situation.

Overall, the Romanian Air Corp's actions during April 1944 highlight the crucial role that air power can play in modern warfare, particularly in supporting ground forces and providing tactical and strategic advantages. Despite facing significant challenges and limitations, the air force demonstrated a high level of professionalism, skill, and bravery in carrying out its mission.

In conclusion, the study of the Romanian Air Corp during the period of April 1944 provides valuable insights into the role and importance of air power in modern warfare, as well as the challenges and difficulties faced by military organizations during times of conflict. The lessons learned from this study can be applied to current and future military operations, highlighting the need for well-trained, well-equipped, and highly skilled air forces to support ground operations and achieve strategic objectives.

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# A PILOT IN THE SERVICE OF GREATER ROMANIA, CAPTAIN AVIATOR VASILE NICULESCU

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***Abstract:*** *The present study is a research of a historical event of aviation during Romanian's Great Union. At that time, our flying personnel performed many flights in order to support the national ideal. Thus Romanian's Air Force distinguish themselves in those days that preceded the great national act from December 1st. Analyzing in greater depth, this article explores the participation of Vasile Niculescu at Romania's unification. Captain Aviator Vasile Niculescu is a symbol less known of Romanian aviation from the period of The War of National Integration, who flew above the holy ground of Transylvania and brought with him from Moldavia the hope of Greater Romania.*
*This hero of military aviation, a pilot in "Farman 4" Squadron, Group 2 Aeronautical from Tecuci, was a fearless military man who accomplished a famous mission in 23 November 1918 flying from Bacău to Blaj and carrying important documents for the Romanian Government into the plane's cockpit.The purpouse of this documentation is to inform us about the life and herioc deeds of the captain aviator Vasile Niculescu and to remind us that, on the stage of history will always be people who risked their life as a contribution at national asspirations, people who deserve to have their story known by everybody, people who inspire us to protect what we have as a simbol of respect for what they achieved, people who ussualy die as anonymus.*

***Keywords:*** *Great Union, pilot, aviation, mission, hero.*

## 1. INTRODUCTION

Traian Vuia, Aurel Vlaicu and Henri Coandă are considered to be The Holy Trinity of romanian aviation, their contibutiont to the evolution of this branch beeing undoubtedly an distinguished and important one. However, we should not adress all of our prayings to this three parents of aviaion but, to include all personalities, more or less important.

This type of personality who deserve completely a place next to the greatest heroes of romanian air force, is the captain aviator Vasile Niculescu. Even if is designated "the pilot of the Great Union", just a few people heard about the heroical actions he realised.

Today, 105 years after the Great Union, is our duty to commemorate the events from Blaj, events which had Vasile Niculescu as the main caracter.

His path towards the pilot career, the courage to offer himself as volunter for Blaj mission, the heroical flight, the solemn image of all propaganda documents flying above Transylvania's land, the patriotical feelings that he had next to all romanians from Blaj on The Field of Liberty, the emotions felt in all coferences in Transylvania and the enthusiasm of the crowd when they found out what decision was taken about the union are, in a great measure, the key moments of the life of Vasile Niculescu.

Still, after all his historical actions, the hero of Greater Romania lives his life under a sad anonymity.

## 2. VASILE NICULESCU: THE TRANSITION FROM THE DREAMERYOUNG MAN, TO THE PILOT, TO THE HERO OF GREATER ROMANIA

18 November 1918: it was quiet. A few minutes away from Mărgineni, the Carpathians

refused to make their appearance, hiding behind of the heavy clouds.

In this environment which preceded a storm, the feeling of peace of the Group 1 Aviation, situatig on the flying land, is disturbed by the arrival of an order from the General Staff: „Prepare an airplane which will land at Blaj. The passager arriving, will give you further informations".

To be trained in long distance flights and to have the ability to operate the aircraft in visual flight, are the two minimal criteria which the pilot must fulfill.

From all voluntaries, the Major Atanase Enescu chose Vasile Niculescu from observation squadron F4. Through of the accomplished missions on the Mărășești front, Vasile Nieculescu gain the experience that put him on the list of favorites for the mission at Blaj.

Additonally, the importance of mission led to ignoring the fact that the lieutenant that is assigned to fly the plane, will celebrate his 27th birthday in the day of leaving.

Vasile Niculescu was born in Moldavia, at Fălticen on 21 november 1891. His parents, Grigore and Irina Niculescu guided him to the profession of priest therefore, after he finished the first eight years in school, attended the theological seminary. However, his destiny takes him in other directions.

In 1911, participatig at the military demonstrations, he saw for the first time an airplane Farman III. This is the turning point in his life, the moment when the wings of Romanian aviation remain forever into his mind and his soul. „The flight always was one of my passion since I was a kid. I saw for the first time an airplane at military demonstrations which had place in our zone, in autumn 1911"~Vasile Niculescu.

He starts his historical journey when he joins the army as a soldier on 24 January 1915. The first step towards air force is made when he volunteered to become a pilot.

After the courses at Pilot School from Băneasa he obtains his military pilot's license on August 15$^{th}$, 1915.

He is assigned to the Air Force where, by order of the Minister of War, is advanced.

Romania join the Fisrt World War in 1916 and in 1917, Vasile Niculescu (advanced know to the second lieutenant rank) go to the front on demand, in the F.4 Squadron from Group 2 Aeronautical Tecuci.

Second Lieutenant Vasile Niculescu has a history characterized by numerous mission, especially on Mărășești front. At the end of the august 1917, he sumed up a number of 29 hours and 45 minutes of flights, fulfilling 26 fighting missions.

One mission that reveal the courage of the fighter pilot is the one from August 13$^{th}$, 1919.

Flying between Făureni and Pătrășcani, Niculescu launched eight bombs on enemy lines. The German 105 mm batteries returned a violent attack and 50 shells exploded around the Farman 40.

Due to the acquaintance and talent as pilot, Vasile Niculescu succeeded to fly the plane so well that no shrapnel touched the aircraft.

However, among all the missions that this emblem of Romanian aviation performed, the most important remains the flight to Blaj.

## 3. THE FLIGHT TO BLAJ

Preparations begin for the flight that would acquire great historical importance.

The plane chosen for the execution of the mission is the Farman 40 because it is considered the aircraft with the best technical condition.

Victor Precup, the delegate of the General Staff "brought from Iași all the necessary clarifications on the mission that had to be accomplished", meets with Lieutenant Vasile Niculescu on November 22.

Everything is ready for departing: the plane is loaded with a considerable number of propaganda documents printed by the General Staff, the flight path is determined, an additional tank is installed therefore the aircraft can remain in the air for a long time, and the machine-gun is dismantled due to the character of the mission. The only impediment was the weather, which began to improve on the morning of November 23th, the day on which, following the last preparations of the crew, the Farman 40 plane blastoffs at around 10:30.

At this "exciting departure full of danger, but also full with patriotic pride" participate "the Group commander and all airmen from the air base".

The flight route follows his way from Bacău to Moinești, and after that to Asău. Flying at approximately 2500 m altitude, the crew sees easily the Ceahlău Peak, on the right side, and "to the left, suddenly opens, wide and smiling, the basin of Bârsa". From that height, the Romanian lands appear under a thick blanket of snow that did not allow a glimpse of life beneath it. Here and there, the chimneys of the houses emitted a thin trail of smoke, as evidence of the presence of life, somewhere under the white sea of snow.

After approximately two hours, the captain Victor Precup make a quick and enthusiastic gesture with his hands, indicating the Blaj. Vasile Niculescu understands the message of his partner and, looking over the cockpit, he sees the Blaj, a city which in that historical moment, seems to be, truly, a holy land, a realizable dream for the pilot Vasile Niculescu.

A wide turn is executed and, a few moments later, it starts to snow over the city with the documents printed by The General Staff.

Afterwards, the Farman 40 plane lands on The Field of Liberty, a place associated with many historical moments of Romania, moments that from that day included the one in which Vasile Niculescu is the main character.

## 4. ON THE HOLY LAND OF TRANSYLVANIA

Right after the moment when the aircraft makes its presence felt on the holy lands of Transylvania, The Field of Liberty, transformed in aerodrome, was crowded by people who came to meet the crew.

Without knowing the actual reason why the airplane landed on their lands, the feeling of belonging to the same nation and the presence of the same romanian blood in their veins, determined everyone who was present on The Field of Liberty to welcome airmen with a strong exclamations of enthusiasm, followed by a shout in one voice: "Long live Greater Romania!"

For an hour, there were passionate manifestations of the faith that united 18 million people that day. In a first moment of silence, the Prof. Phd. Macavei and the Phd. Precup, addressed the greeting of "welcome" of behalf of all Transylvanians.

Vasile Niculescu and Victor Precup were assured that they can leave the aircraft on The Field of Liberty because it will be guarded by 18 romanian students, every single one having a machine-gun.

Subsequently, the crowd went towards the city. The Blaj is at that moment full of cheerful noises. Morover, as if by magic, the colors of the Romanian's flags, together with the people dressed in traditional clothes, gave the city's streets a lively aspect.

The first meeting has place at 18 o'clock. In this meeting the Phd. Vasile Suciu, the president of Romanian National Comitee from Blaj, gives information about the purpose of the mission of Vasile Niculescu and Victor Precup, information that enlighten the importance of the flight and of the documents brought from Iași. Furthermore, it is mentioned the fact that, the crew is going to take with them back to Moldavia, the response about the union of all Romanians.

During the night has place another meeting. This time the session is fill with emotion and patriotic spirit. At the end, is decided unanimously: the union of Transylvania and of the Banat with Romania and the existence of a great assembly at Alba Iulia on 1 December 1918 where the union with the Motherland will be officially proclaimed.

The next day, Vasile Niculescu and Victor Precup returned to the airplane, having with them the documents attesting the decisions taken. Here, the people were waiting four them with a joy even stronger than the one they greeted them with, as they now knew the decisions made about the union. After so many hours of waiting for the verdict, the reaction of the Transylvanians were characterized at that moment, more by relief than excitement.

The aircraft, which now represents in the eyes of the people a solemn symbol of the realization of the dream of the nation's integration, was filled with the signatures of those present, along with wishes, prayers, messages, and blessings. The ladies filled the plane's cockpit with flowers.

Overwhelmed by the emotion of the historic moments they had just experienced, the crew uttered final words of thanks before departing.

The return flight took place in optimal conditions and, a few hours later, the General Staff came into possession of the decisive documents.

In exchange for his heroic actions, the aviator Vasile Niculescu was supposed to be decorated with the Order of "Mihai Viteazu" 3rd class, but it was not so. However, he continued to execute the missions entrusted to him.

A mission with a less felicitous end, but worth remembering, is that of June 23, 1919, when, during a reconnaissance in Transnistria, due to a technical failure of the plane, it landed behind the Bolshevik lines. Here, Vasile Niculescu was taken prisoner, staying in Odessa for a month. He is later released following a prisoner exchange.

Between 1920 and 1923 he was a pilot in Group 1 aviation.

By High Royal Decree, 24 October 1923, the pilot of Great Union was promoted to the rank of captain. He was transferred on 1st October 1924 to the Aeronautical School Command.

He did a training course in the Czechoslovak aviation, between March 1 and September 1, 1925. Here, the Romanian pilot was appreciated by the aeronautical staff in Czechoslovakia due to the piloting technique he master perfectly.

He leaves the air force on request and is transferred by order of the Minister of War to the Recruitment Center in Rădăuți.

Thereafter, he is transferred to the 96th Infantry Regiment on October 1, 1930.

On October 31, 1937, he transferred to the reserve with the rank of captain as a result of his resignation.

His retirement from the army was determined by the refusal of the General Inspectorate of Aeronautics to advance him in rank and position, even if Vasile Niculescu met all the requirements given by the military laws.

After leaving the military uniform, Vasile Niculescu lived to be 90 years old, working as a watchmaker.

The pilot of Greater Romania died on April 24, 1981, in a sad anonymity.

## 5. CONCLUSION: ANONYMOUS PORTRAIT

The geopolitical context in which we find ourselves today is characterized by a dynamic and unpredictable state. The tensions that are intensifying at our borders and the unpredictability of events are giving us a state of national alertness, or at least it should.

What do all the events taking place now at the global level make us understand?

Surely their purpose is to make us aware that eminent dangers are at our every step and it is only our duty to defend our territory. Only in this way can we show our sincere appreciation to those who risked their lives to unite all the provinces ruled by Romanians under the wing of the Motherland, Romania.

Hero of the nation's integration, now a symbol for those whose duty it is to protect the united land, Vasile Niculescu appears to us as an anonymous portrait. You look at the image of the pilot and see how his face is contoured with sacrifice, with bright tones given by his courage and flying qualities.

The national ideal represented for the aviator captain Vasile Niculescu a creed that he repeated in his mind every moment spent at the control wheel.

Today, 105 years after the fulfillment of this national ideal, our creed is composed of the heroic deeds of all our ancestors, deeds that constituted the foundation of today's Romania.

"Long live Romania! Long live aviation!"

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