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THINKING

FROM SEAD TO JOINT-SEAD

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The new approach to suppression of enemy air defences missions surpasses its traditional limits and opens new horizons, formalising new and innovative ways to intelligently combine military capabilities, be they land, sea, air or space based, kinetic or non-kinetic, lethal or non-lethal, manned or unmanned, providing as much freedom of manoeuvre as possible for own forces in the entire spectrum of operational domains (land, air, sea, space, electromagnetic and information).

The present study is intended to explain how or, more importantly, why the suppression of enemy air defences mission has evolved throughout time, permanently reassessing its effectiveness and seeking to strike the perfect balance between implicit expenses and military results. Since the direct effects of this mission are very difficult to observe and quantify, one of the most challenging tasks has been to assess it before deciding improvement strategies. Once this task has been acknowledged, theoreticians, practitioners and technicians involved in the planning and execution of enemy air defence suppression missions have come to the same conclusion: advanced technology has to be combined with intelligent innovation and ideas to engage future enemies while ensuring the survival of own forces and contributing directly to meeting the military objectives.

Keywords: suppression of enemy air defences, non-kinetic, lethal, electromagnetic environment, electronic warfare.

English version by **Diana Cristiana LUPU**.

INTRODUCTION

The article is a presentation of the concepts that have influenced the execution of *Suppression of Enemy Air Defences – SEAD* missions throughout time, a radiography of the changes they have undertaken during the past half of the century. The study is not intended to chronologically list the changes but to reveal the main ideas that mark the evolution of *SEAD*, as well as the factors generating, justifying and enabling these trends.

The concept of *suppression of defences* is not new. It has been acknowledged since the first moment the armed forces started to search for solutions to undermine the enemy capacity to defend. *Suppression of Enemy Air Defences* is only one of the most recent forms of manifestation of the old concept, and its application, preponderantly through the air power, as a fundamental element for the destruction of the enemy air defence capability and, at the same time, for the protection of own air assets, is the result of a long and natural evolutionary process.

The concept of suppression of defences is not new. It has been acknowledged since the first moment the armed forces started to search for solutions to undermine the enemy capacity to defend.

Moreover, the evolution of the way of conducting warfare has stimulated the technological process and accelerated the *SEAD* subsequent development, reaching parameters that are difficult to quantify. The influences of technology, environment and available resources, generated by military strategies and historical moments, have significantly marked what *SEAD* is today and, more importantly what it should be.

LESSONS LEARNED

To better understand the context of the conceptual and technological developments that have marked the mode of *SEAD* missions execution, the lessons learned from the conflicts in the past fifty years should be analysed, in terms of the binomial *SEAD – air defence.*

The Vietnam War (1965-1975)

The Vietnam War is considered the first military conflict in history in which air defence, through the emergence and proliferation of the surface-to-air missile systems, really marked the way of conducting military confrontations. The North Vietnam, supported by the USSR, benefitted from a dense network of surface-to-air missile systems. To survive, the North Vietnamese anti-aircraft defence used three main methods: planned manoeuvre of forces and means, camouflage and false positioning, as well as emission control by repeatedly coupling/decoupling the radar stations. The main tactic employed was the anti-aircraft ambush. In turn, the US forces took measures to adapt the employed techniques, tactics and procedures, the suppression of air defences being, in general, conceived having as main element the specialised means, namely the use in the fight of a type of aircraft specially equipped and armed to detect, localise and engage the radar complexes associated with the surface-to-air missile systems (such as the F-100 Super Sabre aircraft), that type of mission having the code name *"Iron Hand"*[1] and, subsequently, *"Wild Weasel"*[2].

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The Yom Kippur War (1973)

The Yom Kippur War was the conflict in which type 2K12 *"Kub"* (NATO code name SA-6 *"Gainful"*) surface-to-air missile systems made in the USSR were firstly used. The air defence strategy stipulated defence in depth, following several alignments of surface-to-air missiles and anti-aircraft artillery, surface-to-air missile mobile systems being especially used to gain local air superiority. Moreover, it was opted for barrage

[1] The Operation *"Iron Hand"* was a joint operation of the USAF and USN, conducted between 1965 and 1973 during the Vietnam War. The operation was a type of *SEAD* mission, having as main goal to suppress the surface-to-air missile systems provided to the North Vietnam by the USSR, as well as to neutralise the anti-aircraft artillery systems directed by radar. The term *"Iron Hand"* refers not only to the development of tactics and specific equipment but also to the numerous *"Iron Hand"* individual missions that accompanied the USAF and USN attack packages. Source: https://en.wikipedia.org/wiki/Operation_Iron_Hand, retrieved on 12.10.2018.

[2] *"Wild Weasel"* is a code name given by the US Air Force to any type of aircraft equipped with anti-radiation missiles that had the mission to destroy the radars and the surface-to-air missiles belonging to the enemy anti-aircraft defence. The concept of *"Wild Weasel"* was enhanced by the US Air Force following entering into service of the Soviet surface-to-air missiles and shooting down the US airplanes that executed attack missions in the North Vietnam. The programme was led by General Kenneth Dempster. Source: https://en.wikipedia.org/wiki/Suppression_of_Enemy_Air_Defenses, retrieved on 11.10.2018.

fire employing all the fire means capable of engaging aerial targets, a tactic proved effective in the first phase of the conflict (in the first six days, the Israeli air force lost about 70% of the combat aircraft). Meanwhile, the air space control was defective, 84 Egyptian aircraft being lost by fratricide (shot down by own SA-6 systems).

The Bekaa Valley Conflict (1982)

The Syrian air defence consisted mainly of surface-to-air missile fixed systems and it was executed without obeying a strict discipline in terms of engaging air targets, without applying strict procedures in terms of Emissions Control – EMCON[3], without taking sufficient measures in terms of masking and without benefitting from technical maintenance capabilities in the tactical field. Moreover, the radar systems were not reprogrammed following the outbreak of the conflict, using the working frequencies specific to peacetime.

Operation *"Desert Storm"* (1991)

The Iraqi air defence was organised in an integrated manner, having a centralised command and control system. The urban centres were protected using medium and long range surface-to-air missile systems, while the own forces were protected using medium and small range (tactical) systems. The measures to protect the elements composing the air defence integrated system were not appropriate, especially in terms of electronic protection (jamming protection equipment and strict emission control measures), which resulted in their extreme vulnerability to the electronic attack actions executed by the coalition forces. As far as *SEAD* missions were concerned, the coalition forces (especially the US ones) were capable of adapting to the situation under the circumstances of an insufficiently mature doctrinal framework to allow for an integrated, multidisciplinary and proactive approach to the actions meant to suppress the air defence, approach that was focused on autonomous air operations.

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[3] EMCON (Emissions Control) represents the electromagnetic and acoustic emmision management. It is employed to prevent an enemy from detecting, identifying and localising own forces, as well as to minimise the electromagnetic interferences between friend systems. Source: https://www.globalsecurity.org/military/library/policy/navy/nrtc/14226_ch3.pdf, retrieved on 12.10.2018.

Operation *"Allied Force"* (1999)

The operation was the first military conflict in which all the previously acknowledged shortcomings were overcome by the Serbian air defence through protection measures and judiciously employed tactics. The air defence strategy was firstly aimed at preserving the combat capacity for an as long as possible period of time, the Serbs limiting to engaging facile air targets thus achieving economy of forces and means. The protection measures were complex (deception, false positioning, using electronic simulators and radars associated with missile systems etc.) and strictly implemented, especially by obeying emission control procedures and by employing tactics that stipulated short and sequential emissions, from different positions. In general, the Serbs implemented, in a coordinated and cumulative manner, an ensemble of innovative tactics to engage air targets (*"Hide, Shoot and Scoot"*[4] type): use of passive sensors, strict EMCON procedures, position masking, high capacity of technical repairs in the tactical field, dispersed and sequential use of radar systems, strict discipline in engaging air targets, use of air ambush, frequent manoeuvres of forces and means. The results confirmed the effectiveness of the strategy: during the entire NATO air campaign, about 61% of the 743 anti-radiation missiles (AGM-88 HARM) were launched in a pre-emptive manner (in the absence of the target radar station electromagnetic signal), so that only 12% of the Serbian surface-to-air missile systems were destroyed (3 out of 26 systems SA-6 *"Gainful"*)[5].

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Post-Cold War Period

The way in which the air defence of potential adversaries is achieved has undergone a process of adaptation to the challenges induced by *SEAD* capabilities in at least three dimensions: conceptual, tactical and technological.

Technologically, the majority of the air defence systems developed in the previous period and kept operational have undergone at least four modernisation stages: replacement of mechanic and electronic

[4] *"Hide, Shoot and Scoot"* is an artillery tactic through which fire is executed against a target and then it is immediately manoeuvred in another position to avoid the counter-battery fire executed by enemy artillery. Source: https://en.wikipedia.org/wiki/Shoot-and-scoot, retrieved on 12.10.2018.

[5] Dr Carlo Kopp, *"Surface to Air Missiles Effectiveness in Past Conflicts"*, available online at: http://www.ausairpower.net/APA-SAM-Effectiveness.html, retrieved on 12.09.2018.

components, modernisation through digitisation of the components meant to process and analyse electromagnetic signals and to transmit data (e.g. Pechora 2A, S-200 Grudzindz, Tetraedr OSA-1T systems), increase in mobility (e.g. Tetraedr Pechora 2TM, Pechora 2/2M systems) and hybridisation[6], by replacing some vital components (radar, missiles) with new generation equipment (e.g. HQ-2B, H-200, Polish SA-6 *"Gainful"* systems with Sparrow missiles). More important than the modernisation of old systems is the fact that new surface-to-air missile systems have become operational, belonging to the so-called *"Two digits SAM"* category (SA-10 *"Grumble"*, SA-12 *"Giant"*, SA-20 *"Gargoyle"*), characterised by high mobility, long range action, high protection against jamming, and advanced capability to detect air targets (use of LPI[7] radar systems: complex wave forms, dispersion).

Tactically, the use of unconventional/innovative tactics in the *"Hide, Shoot and Scoot"* category has become the *"modus operandi"* in this period (Operation *"Allied Force"*).

Conceptually, given the advance in the field of information technology and computers (data processing/storage/transmission capacity), air defence is conceived in an integrated, flexible and modular manner, the multiple internal processes being facilitated by a multitude of options for secured communications, capable of putting into practice coherent and complex measures for passive air defence (inflatable equipment, engineer works, electronic simulators[8] etc.).

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SEAD EFFECTIVENESS: ASSESSMENT METHODS AND ENHANCEMENT POSSIBILITIES

Based on own experience and the analysis of the lessons learned from the military conflicts that the US armed forces have participated in during the past 50 years, Lieutenant Colonel James R. Brungess identifies in his book – *"Setting the Context: Suppression of Enemy Air Defenses and Joint War Fighting in an Uncertain World"* – four central

[6] Dr Carlo Kopp, *"Hybridisation of Surface to Air Missile Systems"*, available online at: http://www.ausairpower.net/APA-NOTAM-180109-1.html, retrieved on 13.09.2018.

[7] A Low-probability-of-intercept radar – LPIR is a type of radar that uses a series of measures to avoid detection by the detection equipment of the passive radars while searching for a target or being engaged in following it. This characteristic is desirable for radar stations as it allows for detecting and following targets without alerting them about their presence, protecting, at the same time, the radar station against anti-radiation missiles.

[8] For example, KRTZ-125 2M ARM and Almaz Antey OU-1, which simulate SA-8 *"Gecko"* type systems (OSA AKM).

themes that dictate the conceptual and doctrinal framework for the execution of *SEAD* missions:

- *SEAD* is at the leading edge of the technological revolution the air power is undergoing, being highly dependent on technological progress;
- *SEAD* is expanding its traditional boundaries and it is gradually *"infusing"* itself into the basic day-to-day strategies and tactics of the air power;
- the traditional way of decision-making process and of measuring the effectiveness of *SEAD* missions should change;
- the planning of *SEAD* missions should be focused on objectives, joint cooperation among the services being necessary for the effective *SEAD* application in the future combat environment[9].

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Moreover, the author makes a complex and pertinent analysis of the way in which *SEAD* missions effectiveness can be measured, as well as of the factors that contribute to achieving the planned effects. The goal of the analysis is, in fact, to identify the evolution trends of the binomial *SEAD – adversary air defence*. For this purpose there have been considered four models of assessment (used throughout time): *historical model* (based on experience and lessons learned), *engineering model* (based on technical parameters), *"common-sense" model* (based on a personal specialised analysis) and *objective-based model* (that represents the sum of the previous models, showing new perspectives, based on the analysis of the way in which actions contribute to meeting the objective).

Given the *SEAD* character and the environment in such missions are executed, effects are often difficult to notice, many times not being proportional to the rate of the physical destruction caused by kinetic actions, namely not influenced by quantifiable factors[10]. Under such circumstances, the first three models of assessment have demonstrated their limitations in time: the historical model appeals to only quantifiable data (loss rate, destruction rate etc.), not considering situational elements, the engineering model focuses

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[9] Lieutenant Colonel (USAF) James R. Brungess, *"Setting the Context: Suppression of Enemy Air Defenses and Joint War Fighting in an Uncertain World"*, Air University Press, Maxwell Air Force Base, Alabama, USA, June 1994, p. XV, available at: http://www.dtic.mil/dtic/tr/fulltext/u2/a421980.pdf, retrieved on 11.10.2018.

[10] *Ibidem*, p. 53.

on parameters analysis rather than on that having an operational impact, and the *"common-sense"* model is highly subjective. Thus, it has become obvious that it is necessary to focus on the fourth model, which is cumulative, the objective-based one. The simple process of effectiveness assessment convinces the author that the remarked trend actually represents the evolution model *SEAD* should focus on in order to be able to permanently adapt to the new challenges in the combat environment *(Figure no. 1*[11]*)*.

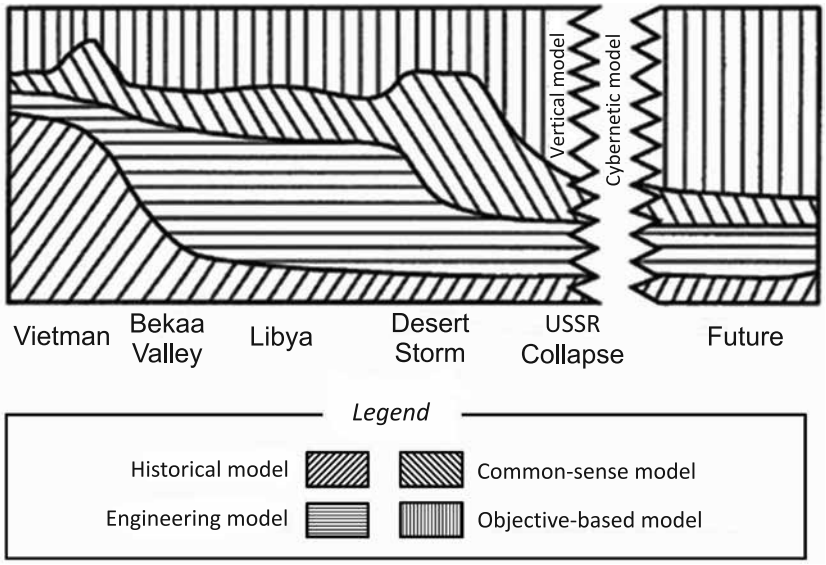

Figure no. 1: Evolution of SEAD missions models of assessment

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The objective-based assessment criteria, inspired by the cybernetic model presented by Karl Deutsch[12] (focus on projecting some self-adjustable mechanisms that concomitantly respond to a sum of factors to strike a certain balance), establish a direct relationship between *SEAD* mission and the degree of mission accomplishment thus introducing new possibilities to strike a balance between the two. In fact, they assess and provide self-adjustment solutions so that the relationship *action (SEAD) – result (military objective)* can strike the planned/expected balance.

[11] *Ibidem,* p. 71.
[12] Karl W. Deutsch, *"The Nerves of Government: Models of Political Communication and Control"*, The Free Press, New York, 1963, p. 56.

The use of this model of assessment and of its associated criteria, concomitantly focused on process and objective, allows for the realistic analysis of future threats/targets for *SEAD* missions (increasingly technologically sophisticated, more powerful and more complex), in a self-adjustable manner, depending on the context in which they are executed and the characteristics of the threat, being capable of providing solutions for the aggregation of a complex of tactics and armament systems (beyond the traditional model) in order to meet the planned objective. The changes in approach have radical effects on the paradigm of using *SEAD*, thus marking the transition from the reactive (protection) approach to the proactive/preventive one, meant to meet the general objective.

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Moreover, to demonstrate and substantiate the general characteristics and the trends in employing *SEAD*, they were approached considering four evolutionary parallel levels (continuums):

- piecemeal/integrated;
- need-based/resource-based;
- threat-based/capability-based;
- defensive/offensive.

The piecemeal/integrated level emphasises the way *SEAD* means have been used throughout time. The piecemeal model, focused on means, reactive, was specific to the situation in which there were a lot of resources and each air formation could be defended at the expected level by an adequate *SEAD* package. When the resources were insufficient, to avoid the situation in which *SEAD* protection was provided in different proportions, only to certain air missions and depending on priorities, commanders had the option of an integrated, offensive, approach, namely the intelligent exploitation of means in *SEAD* missions with extended effects. The two situations also exemplify the defensive/offensive level, the former being characterised by reactivity, *SEAD* providing protection for other air missions meant to meet the military objective, the latter being characterised by proactivity, *SEAD* mission as such contributing to meeting the objective.

The need-based/resource-based level presents two different approaches, namely, given the military objective, what means are needed to meet it, or, given the available resources, how they could be used to meet the objective. The approaches answer the questions *"What ?"* and *"How ?"*, the former being specific to the period in which there were a lot of resources, and the latter characterising

the situation in which the resources are not fully correlated/adapted to threats, especially in an environment marked by uncertainty. The latter approach is based on intelligent combinations of traditional and non-traditional means, whose cumulative effects meet the goal of the mission.

The threat-based/capability-based level is also directly influenced by the resources and the threat characteristics. If, in the past, the operational particularities of *SEAD* specialised means were directly dictated by the characteristics of potential threats, the two developing in parallel, in a continuum *action – reaction*, the modern battlefield and the access to technology have substantially changed the equation, triggering the necessity to develop some multirole *SEAD* means, a fact that represents a challenge for those who design operational and technical capabilities *(Figure no. 2[13])*.

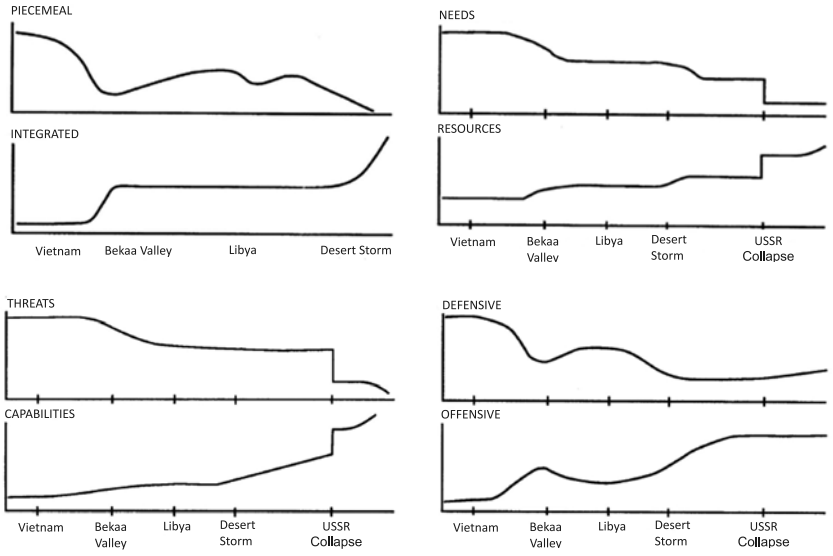

Figure no. 2: Trends in the use of SEAD in combat

In a general framework, these trends demonstrate the fact that, in the early '90s, *SEAD* had already undergone a transition process, from its traditionally defensive characteristic, having a role in protecting own forces, to a complex status, being simultaneously an air power

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[13] Lieutenant Colonel (USAF) James R. Brungess, *"Setting the Context: Suppression of Enemy Air Defenses and Joint War Fighting in an Uncertain World", op. cit.*, pp. 82-88.

defender, in general, and an offensive means per se[14]. The same transition process entailed renouncing the exclusively traditional approach, using highly specialised and technologized means, in favour of the *"intelligent"* approach, finding innovative solutions to meet the operational requirements of such a capability and, simultaneously, being used in an integrated approach, generating operational effects.

The transition process not only establishes the parameters for the development of the air component but also emphasises the necessity to find some integrated methods of using *SEAD*, thus being the starting point for the joint approach of such missions, namely introducing the concept of *"Joint SEAD" (J-SEAD)*[15].

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DOCTRINAL CONSIDERATIONS

Apparently, the development process of the US *SEAD* strategy has been intuitive, at least in its first stage, having as a milestone the Operation *"Desert Storm"* that, as it has been previously mentioned, met all the criteria and set the ground for the objective-based approach, the coalition forces succeeding in applying innovative tactics aimed at the enemy information denial strategy. The idea is suggested by Lieutenant Colonel James R. Brungess, who analysed the answer given by General John Corder, Chief of Operations for Central Command Air Forces and Commander of the USAF Tactical Air Warfare Center during *"Desert Storm"*, to the question: *"Iraqi radar-directed air defenses proved singularly ineffective. How much of that was attributable to electronic warfare (EW)?"*. *"Well, if you think electronic combat, not EW, I would say that it all was ... because we went out and we did everything. We did SEAD ... we did C³CM[16] and we had our own on-board self-protection EW. We set about in a very deliberate manner to take that thing apart as the first order of business, the price of admission. That's what you do. So we bombed all the operations centers, we jammed everything we could on the first day. We knew the jamming would be very effective early, but we knew that you couldn't rely on that for the whole war. So we went into a very aggressive campaign to beat up on all [the] EW GCI[17] sites we could find (I'm talking about direct attack).*

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[14] *Ibidem*, p. 86.
[15] *Ibidem*, p. 88.
[16] C³CM – Command, control, communications countermeasures – set of actions in NATO Counter Command & Control Warfare, more recently included in INFOOPS.
[17] Early Warning (EW) Radar; Ground Control Intercept (GCI) Radar for fighters.

… We sent A-10s out the first day and the A-10s just had a field day on a lot of EW GCI plants, which were essentially undefended, and just really blew them apart. So we took away much of the EW GCI that way. Of course, Compass Call[18] (EC-130H) was doing its thing in the command and control business to keep [those Iraqi assets] under control until we could bomb the communications facilities and the other stuff that they needed to communicate with. To me, it was a classic campaign, not really a lot different from those we practice in a microcosm out at Nellis during Green Flag"[19].

Somehow contrary to General Corder's comments, Lieutenant Colonel Brungess argues that the statement itself is a testimony to the evolutionary process. Even presented distinctly, as separate tactics, without emphasising the change in strategy or doctrine, the statement actually cements the progress towards the objective-oriented, integrated approach to the enemy air defence capabilities. According to Lieutenant Colonel Brungess analysis, the statement includes five clear ideas that demonstrate the mentioned progress as follows:

1. Even mentioned and treated separately, C³CM, SEAD and EW were considered in relation to achieving the military objective.

2. It was proved that, as long as the air defence system was organised as a set of interconnected entities, an attack against any of them had effects over the others.

3. SEAD plan was a deliberate effort to take apart the integrated air defence system in a sequenced, iterative manner.

4. The choice between disruptive means (jamming, harassment, deception) and destructive ones (anti-radiation missiles, cruise missiles and ground/bombardment attacks) was based on a logical criterion: what was most effective at that time and place considering what was available to perform the task.

5. SEAD missions were effective since the early stages as the forces were specially prepared through "Green Flag"[20] exercises (integrated approach was already exercised).

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[18] Compass Call – indicative of one of the US airborne electronic warfare means, using C-130 Hercules as platform.

[19] Lieutenant Colonel (USAF) James R. Brungess, *"Setting the Context: Suppression of Enemy Air Defenses and Joint War Fighting in an Uncertain World", op. cit.*, p. 181.

[20] *"Green Flag"* exercises, conducted at Nellis Air Base (Nevada, USA), contributed to training the US forces (air crews, intelligence officers, members of Air Operations Centres) for combat in a highly technologized electronic environment.

To continue his argumentative logic, the author concretely focuses on the electronic combat[21] aspect of *SEAD*, arguing that, with the exception of nuclear and spatial component, the use of the electromagnetic spectrum for military purposes represents the most important technological progress in the past period and, therefore, *SEAD* should be compliant with the principles and forms of manifestation of the actions in this spectrum. In the future, the main objective of *SEAD* missions will be to degrade the internal information network of an integrated air defence system before it could react, and to keep it inoperative until the objectives of the air power can be met[22]. To achieve this desideratum, it is absolutely necessary to closely cooperate, by synergistically integrating into the operation of at least three distinct domains of offensive actions in the electromagnetic environment: SEAD, EW and C³CM *(Figure no. 3[23])*.

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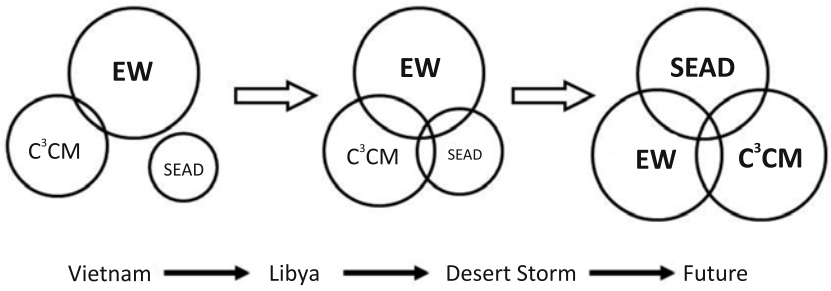

Figure no. 3: Evolution of SEAD, EW and C³CM integration

Moreover, in our opinion, even if the suppression of enemy air defences within the framework of *"Desert Storm"* was achieved by jointly engaging the means belonging to several services, it did not succeed in acquiring those characteristics that provided the viability and the added value specific to a really joint approach to *SEAD (Joint SEAD – J-SEAD)*. In fact, there were put into practice paradigms of conducting warfare specific to any service to meet joint objectives.

That is why we consider that *Joint SEAD* will be different in the future, under the circumstances in which the strategic paradigms,

[21] Doctrinally, *SEAD* was considered a type of *"electronic combat"*, distinct from the broader concept of *"electronic warfare"*.

[22] Lieutenant Colonel (USAF) James R. Brungess, *"Setting the Context: Suppression of Enemy Air Defenses and Joint War Fighting in an Uncertain World", op. cit.*, p. xvii.

[23] *Ibidem*, p. 103.

doctrines and tactics specific to each service have already become convergent. *J-SEAD* should overcome the limits of the classical strategy *"destroy and jam"* that was successful in the period when there were plenty of resources, when US *SEAD* technology, personal training and fire power surpassed, without doubt, the possibilities of any USA potential adversary. In the process of transition from the approach focused on kinetic strikes to the one focused on information *J-SEAD* should increasingly consider the idea of setting as main objective to deny information to the enemy. The rapid transition from the kinetic strike-based approach to the information denial-based one opens the path to new possibilities to make the modern structure of the integrated air defence system of the enemy more vulnerable, namely to paralyse the enemy by denying its possibility to access, process or transmit data[24].

In general, in an extremely comprised manner, Lieutenant Colonel Brungess recommends that *J-SEAD* missions should be planned and executed considering two main lines of effort:

- disruption of the vital components of the enemy integrated air defence system by non-lethal actions (degradation, neutralisation and deception) against the processes that ensure their function, namely: air target detection, localisation and identification, tracking, armament allocation and engagement, the objective being information denial[25];
- adaptation of the way *SEAD* is executed, concomitantly aimed at three main characteristics: variation (flexibility in choosing tactics, focusing on SWEEP-type autonomous operations), different combination of the means that may generate *SEAD* effects and innovation (out of traditionalism, especially by considering emergent domains: cyber and directed electromagnetic energy)[26].

NATO PERSPECTIVE ON SEAD MISSION

During the past years, NATO policy regarding *SEAD* has been rethought from an innovative perspective, in the attempt to make the transition from the resource-based approach, specific to the Cold War period, to the objective-based orientation, integrated and joint, innovative, capable of meeting the new NATO strategic concept.

We consider that Joint SEAD will be different in the future, under the circumstances in which the strategic paradigms, doctrines and tactics specific to each service have already become convergent. J-SEAD should overcome the limits of the classical strategy "destroy and jam" that was successful in the period when there were plenty of resources, when US SEAD technology, personal training and fire power surpassed, without doubt, the possibilities of any USA potential adversary.

[24] *Ibidem*, p. 167.
[25] *Ibidem*, pp. 170-190.
[26] *Ibidem*, pp. 190–200.

ROMANIAN MILITARY THINKING

The declared goal in NATO Policy regarding the suppression of enemy air defences was to facilitate "the effective, coordinated and interoperable use of the Alliance SEAD capabilities to create the conditions for the successful conduct of operations and missions, including the proper protection of own forces".

The declared goal in NATO Policy regarding the suppression of enemy air defences was to facilitate *"the effective, coordinated and interoperable use of the Alliance SEAD capabilities to create the conditions for the successful conduct of operations and missions, including the proper protection of own forces"*[27].

In this context, the document substantiates the complex role *SEAD* missions play in ensuring the freedom of movement in five operational domains: air, land, sea, information and electromagnetic. *SEAD* missions will not thus limit to the direct protection of an air attack formation or the creation of some air favourable conditions (satisfactory control over the air space) but they will substantially contribute to blocking the enemy actions (land, air and sea) by denying its access to information (information domain), its possibility to effectively use its electronic means (electromagnetic domain/environment) and by disrupting its capability to efficiently achieve the command and control of own forces.

SEAD, in an objective/effect-based perspective and in the general framework of operations in the electromagnetic environment, is illustrated in *Figure no. 4*[28].

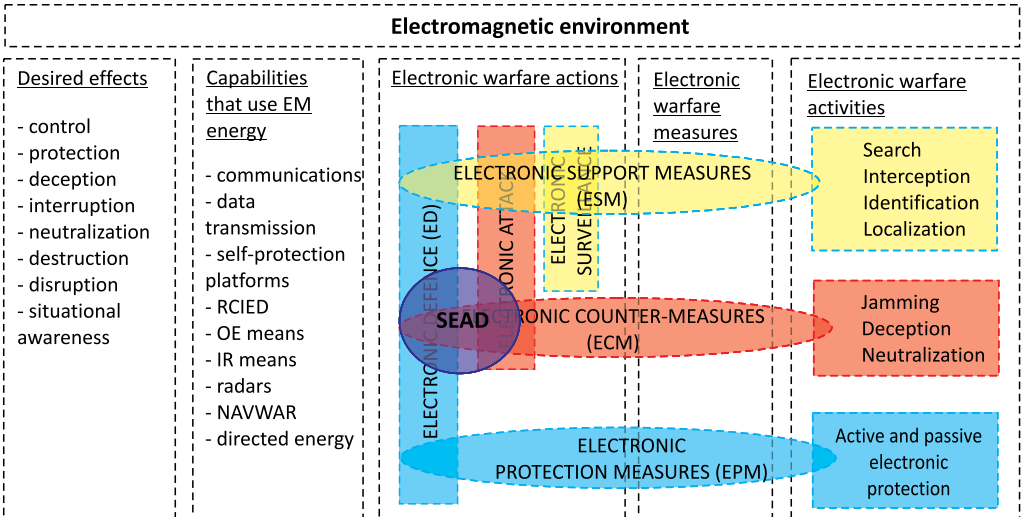

Figure no. 4: SEAD in the context of EMO

[27] ***, *NATO Suppression of Enemy Air Defences (SEAD) Policy*, 2014, p. 114.
[28] *Ibidem*, p. 178.

Concomitantly, it is formally introduced the term *Joint SEAD*, supported by three fundamental principles that guide the planning and execution of this type of missions as well as the process of future capabilities development:

- *SEAD* is an integrated element of operations in all operational domains, the current situation requiring the synchronisation up to integration of combat actions in all domains. *SEAD* missions transcend all these domains considering the fact that all forces can contribute to the accomplishment of *SEAD* missions in order to ensure the freedom of manoeuvre for own air force, surface forces benefitting, in turn, from the full direct support provided by air means, in a coordinated and synchronised manner;
- *SEAD* has the incontestable attribute of potentiator for the other elements of the joint force;
- *SEAD* missions are *de facto* joint and multinational. As long as all the armed forces services have available suppression of air defence capabilities, their coordinated execution entails concomitantly using capabilities belonging to many services and many countries.

SEAD traditional effects can be also achieved by using means other than traditional ones (namely specialised air means), thus becoming necessary to take into consideration other military functions for the effective and synchronised planning of Joint SEAD missions.

Given all the operational requirements imposed by the current combat environment taken into account when *SEAD* missions are conceptually reconsidered, we appreciate that the combat means participating in this type of missions should be capable of also generating types of effects other than those traditionally associated with their role (an example being the execution of electronic attack missions using AESA technology[29]). Moreover, *SEAD* traditional effects can be also achieved by using means other than traditional ones (namely specialised air means), thus becoming necessary to take into consideration other military functions for the effective and synchronised planning of *Joint SEAD* missions.

The following figure presents the way in which traditional combat means can be complementarily used in order to obtain effects that concur to the temporary inhibition of a complex air defence system, in an approach that is mainly aimed at obtaining/maintaining the freedom of action in the electromagnetic spectrum *(Figure no. 5*[30]*)*.

[29] Active Electronically Scanned Array – an advanced generation of radars, see details at http://www.alab.ee.nctu.edu.tw/wpmu/ywang/files/2017/11/AESA-System-20170922_hardcopy.pdf

[30] Electronic Spectrum Denial. Source: *NATO SEAD Policy, loc. cit.*, p. 74.

SEAD represents "the ensemble of activities intended to neutralise, temporarily disrupt or destroy the enemy surface air defence systems by using certain destructive or having disintegrator effect means that contribute to ensuring the own forces freedom of manoeuvre in the combat environment".

We emphasise that SEAD missions do not cover the range of offensive missions against the enemy fighters, as an air defence integrated armament system, being limited to the complementary actions of electronic attack (against the surface-air and air-air communication links they use or against the enemy airborne interception radar).

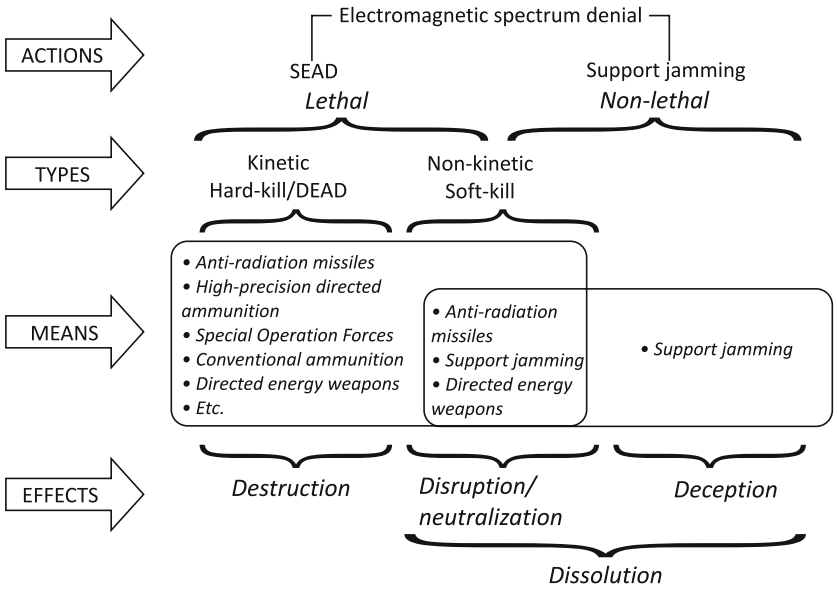

Figure no. 5: SEAD in the context of ESD

In essence, the conceptual revisions in recent years have resulted in the reformulation of *SEAD* definition, which, in compliance with the new NATO policy in this field, establishes that it represents *"the ensemble of activities intended to neutralise, temporarily disrupt or destroy the enemy surface air defence systems by using certain destructive or having disintegrator effect means that contribute to ensuring the own forces freedom of manoeuvre in the combat environment"*[31].

The new definition deliberately uses terms that allow for the participation in *SEAD* mission execution of a complex of land, air, sea and even space means, kinetic or non-kinetic ones, manned or unmanned, to suppress the enemy air defence systems by direct/indirect actions against its ground- or sea-based elements, in order to ensure the own forces freedom of manoeuvre in all the five operational domains (land, air/space, sea, electromagnetic and information). However, we emphasise that *SEAD* missions do not cover the range of offensive missions against the enemy fighters, as an air defence integrated armament system, being limited to the complementary actions of electronic attack (against the surface-air and air-air communication links they use or against the enemy airborne interception radar).

[31] ***, *NATO Suppression of Enemy Air Defences (SEAD) Policy*, *loc. cit.*, p. 114.

More explicitly, to obtain the effects subsumed under *SEAD* general objective, namely the suppression of enemy air defences, own forces have the possibility and flexibility to use, in a proactive manner, and more rarely under the current circumstances, a reactive one, any combination of the following capabilities (the following list is not exhaustive):

- anti-radiation armament, used in a passive manner (detection and/or deterrence means) and active/kinetic one, to destroy radar stations, jamming sources and, potentially, directed-energy weapons;
- high precision ammunition (guided by GPS, laser or, in the terminal phase, electronic-optic/in infrared/by radio frequencies), used to execute kinetic strikes (hard-kill); it can strike systems that do not radiate electromagnetic energy but necessitates precise data related to the position of the target made available by other support elements;
- directed-energy armament that can be used against the entire set of subsystems of the enemy integrated air defence system (including against the operating personnel), in a lethal or non-lethal manner;
- electronic attack used to disrupt, neutralise and deceive the enemy integrated air defence system, in a non-lethal manner, having as effect denying information access, directly, through offensive actions, and, indirectly, through deterring the adversary to use electronic means. The main methods employed are jamming, radar and communications, deception, through imitation/simulation (induction of false targets, physically, by dipoles, and electronically, by DRFM[32] technology, spoofing);
- conventional armament systems in the inventory of land forces (land artillery, ground-to-ground missiles) to execute kinetic strikes against *SEAD* targets in their range of action. Their advantage is that they can work for longer periods of time, not being limited by the aircraft flight time/tactical range as well as that they, in principle, have an unchanged degree of vulnerability;

[32] Digital Radio Frequency Memory is an electronic method employed to digitally capture and retransmit the frequency modulation (FM) signal. DRFMs are usually used to block the radar; however, their application in cellular communications are increasingly frequent, see http://electronica-azi.ro/2001/03/08/transmisia-radio-a-informatiei/

- specialised means or conventional armament on board of military ships (on-board guns, cruise missiles) that can execute kinetic/hard-kill strikes against *SEAD* targets on board or deployed in the coastal area, by specific naval fire support actions;
- Special Operations Forces (SOF) capable of executing a wide range of missions having *SEAD* effects, in a lethal or non-lethal manner, including direct support to direct PGM[33];
- information technology means that could be theoretically used to disrupt, neutralise and disorganise the command, control and communication system of the enemy integrated air defence system;
- information support capabilities of NNEC (NATO Network Enabled Capability[34]) type, necessary to rapidly, dynamically and precisely obtain data regarding air defence threats such as[35]:
  - multi-platform geo-positioning by MSR (Multi-Ship Ranging) solutions;
  - presence warning and positioning data using CESMO (Collaborative Electronic Support Measures Operations) solutions and data regarding the Electronic Order of Battle (EOB), by the Common Operational Picture (COP)[36].

CONCLUSIONS

The directions of evolution are not essentially elements of novelty for any of us, each of us becoming aware of them in line with the evolution of the environment in time and the transformations in the political, social, military and especially technological fields. The intelligent exploitation of resources in a multidimensional framework in order to maximise results is no longer an exclusive attribute of visionaries but a daily requirement for each of us.

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[33] PGM – Precision Guided Missile.

[34] NATO Network Enabled Capability (NNEC) Programme represents the Alliance ability to join capabilities at different levels (military – from the strategic to the tactical level – and civilian) in a single information infrastructure. Source: https://www.nato.int/cps/en/natohq/topics_54644.htm, retrieved on 12.10.2018.

[35] www.theavionist.com/tag/multi-ship-ranging.pdf, retrieved on 12.10.2018.

[36] Marius Șerbeszki, Florin Ignat, *"SEAD or Joint SEAD – A NATO Perspective"*, volume PROCEEDINGS of the International Scientific Conference *"STRATEGII XXI"*, XIIIth edition, 27-28 April 2017, Editura Universității Naționale de Apărare *"Carol I"*, București, 2017, pp. 430-436.

Such an approach provides the Romanian Armed Forces with the opportunity to establish a viable *SEAD* capability by including these new principles related to the execution of suppression of enemy air defences in doctrines and tactical manuals. The establishment of such a capability is necessary for any air force worldwide as it is the only one capable of ensuring the conditions for the air power to meet its goal, namely to provide the necessary control of air space at a satisfactory level at least.

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