From the JED Archives: 'I Feel the Need – the Need for SEAD'

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By Richard Scott

The enduring and bloody conflict in Ukraine has provided a timely reminder to practitioners of air power as to the vulnerability of both combat and support aircraft to modern anti-air guided weapons, ranging from man-portable air defense systems to mobile "pop-up" surface-to-air missile (SAM) systems and more complex layered integrated air defense systems (IADS).

Aircraft losses suffered on both the Russian and Ukrainian sides, and the inability of either nation to maintain dominance of the air environment during the conflict have underscored the importance of suppression of enemy air defenses (SEAD). This has a particular resonance for NATO at a time when its European partners are confronting serious shortfalls in SEAD capability and capacity.

Moreover, there is an understanding across NATO that – given continued advances in complex anti-access/area denial (A2/AD) – future SEAD operations will be substantially different, and vastly more complex, than missions of the past. "A single aircraft against a single SAM [surface-to-air missile] system is an outdated concept, and not applicable in modern scenarios," Generalleutnant Günter Katz, Commanding General of the German Air Force Forces Command, told the AOC Europe 2023 conference in Bonn in May this year. "We have to adjust our mindset, our doctrines and our systems and transition to a networked force with high levels of integration [and] a new

concept of operations.”

NATO has now set in motion plans to rebalance and modernize SEAD capabilities within the alliance. The expectation is that future SEAD will embrace a holistic “system of systems” approach using a panoply of airborne electronic warfare (EW) platforms and systems to deliver diverse and coordinated effects across all domains. Furthermore, there is a recognition that the dynamic and increasingly data-driven nature of operations will require the implementation of advanced digital technologies and techniques — such as Cloud computing and artificial intelligence (AI) — if effects are to be delivered at the right time and place.

Airbus Defence and Space has proposed a stand-off jammer adaptation of its A400M Atlas airlifter as a potential solution for Germany’s luWES program. RICHARD SCOTT

DEFENSE SUPPRESSION

SEAD is an overarching term used to describe the methods and means to degrade, disable and/or destroy adversary air defense surveillance radars, surface-to-air missile (SAM) systems, and associated command, control and communications networks in order to achieve air superiority and freedom of action. In broad terms, suppression can be achieved in one of two ways. Airborne electronic attack (AEA), sometimes referred to as non-kinetic SEAD, uses jamming to defeat surveillance and fire control radars and disrupt communications nets, so as to open one or more pathways through the IADS screen and enable entry/egress through contested airspace. Kinetic SEAD refers to the use of anti-radiation missiles and/or precision strike weapons to destroy radar sites, SAM batteries, and command and control nodes. (Some organizations, such as the US Air Force, also refer to the lethal element of SEAD as destruction of enemy air defenses [DEAD]).

NATO forces have fielded SEAD capabilities for many decades, and the mission is well understood across the alliance. Today NATO recognizes that its current SEAD capabilities, especially among European air forces, have fallen well behind the curve. Professor Justin Bronk, senior research fellow for air power and technology at the UK-based Royal United Services Institute (RUSI), highlighted these deficiencies in RUSI's February 2023 report, "Regenerating Warfighting Credibility for European NATO Air Forces." In it, he points out that the SEAD/DEAD task "requires specialist aircrew training, weapons and sensors that no European air force currently fields at anything like the scale required."

This shortfall, he added, has not come about overnight. "Even during the supposedly European-led Libya intervention in 2011 against a largely static and completely outdated air defense system, other NATO partners were dependent on the US to conduct SEAD/DEAD before they could operate effectively,"

Bronk noted. “The challenge that would be faced from a near-peer such as Iran, let alone against Russian forces in Eastern and Northern Europe, is almost incomparably more serious, with layered long-, medium- and short-range SAM coverage provided by highly mobile systems linked to a range of multi-static and multi-frequency radar systems by modern C2 vehicles and communications architectures.”

According to Bronk, regenerating a SEAD/DEAD capacity at scale against modern, mobile SAM systems should be an urgent priority for NATO’s larger European air forces. If not, he warns, European NATO states “will be unable to establish control of the air in any scenario where the US is either unable or unwilling to commit major resources to doing so itself. This is not simply an issue for deterring Russian forces, but also for maintaining military options against near-peer states.”

Bronk’s RUSI paper advocates for investment in a broad range of non-kinetic and kinetic effects. In the former case, he points out that airborne electronic attack (AEA) – delivered from stand-off platforms, escort jammers accompanying a strike package, or miniaturized stand-in decoys/jammers – offer a highly responsive and cost-effective means of degrading the radar systems that provide situational awareness and guidance for hostile SAM systems.

However, while fully accepting the vital contribution of EA, Bronk argues that jamming “cannot create the conditions for lasting air access in airspace contested by modern air defense systems alone [and] must form part of the mix of SEAD capabilities that can open temporary access opportunities for key strike operations.”

Bronk asserts that only the destruction of a significant portion of the ground-based SAM threat “will provide Western airpower with the sustained access it needs with the majority of its conventional aircraft to attain control of the air.”

This will demand suitable stand-off precision strike and anti-radiation missiles “available in sufficient numbers to seriously attrite the multi-layered Russian IADS quickly, both in terms of overall stockpile, and carriage capacity per aircraft.”

THREAT LANDSCAPE

Part of the challenge for NATO’s air platform survivability community is conveying a message that while SEAD is essential to any offensive air campaign, the tools and tactics of the Cold War era are increasingly irrelevant to the current threat environment. Potential adversaries, with Russia and its security partners writ large, have invested in increasingly complex, coordinated and resilient multi-layered IADS that draw Red “threat bubbles” at ranges measured in hundreds of kilometers – and extending well beyond home borders.

A number of trends are apparent, with potentially significant implications for aircraft survivability. For example, counter-stealth radar systems operating in very low bands outside of conventional radar frequencies have eroded the advantage hitherto enjoyed by low-observable aircraft. Passive radar systems, employing multiple distributed sensing nodes, are proliferating, So too are a new generation of software-defined radars designed for rapid adaptation and upgrade with new and novel waveforms.

Thus, NATO planners and aircrew alike recognize that the future operations are likely to take place in heavily contested airspace, and the emergence of increasingly sophisticated and highly resilient IADS has fundamentally changed the risk calculous in the minds of campaign planners and operational analysts.

This new strategic setting has forced NATO to confront two uncomfortable truths: first, that the existing Alliance capability is unbalanced given an over-dependence on US

assets; and second, there is a need to develop a modernized, multi-faceted and credible SEAD capability able to deliver diverse and synchronized effects.

Going back to 2014, NATO's Wales summit agreed a defense planning package with a priority for demanding air operations in order to inform defense investments and to improve the capabilities available in allied national inventories. Vision papers for AEA and SEAD, both approved by the Conference of National Armaments Directors (CNAD) in 2018, identified four principal focus areas: diversity of effects; survivable delivery systems; coordinated information capture and exchange; and synchronization of effects. Concepts of employment were subsequently developed for both AEA and SEAD, with these being approved in 2020.

While the effective delivery of SEAD is very much back on NATO's agenda, there is still a misconception that SEAD is an operational effect that can be delivered through a handful of specialist fast jets armed with anti-radiation missiles, according to General Katz. The reality of the modern threat environment, he told the AOC Europe 2023 audience, is somewhat different.

"In the past, the threat consisted of a surface-to-air missile, with mostly analog technology, and big electronic countermeasures. Due to [the limitations] of old technology, there was an emphasis on early warning and air interception to mitigate the weaknesses of the surface-to-air missile defense system, which would usually be arranged as a SAM cluster protecting critical infrastructure.

"Blue forces were able to jam the early warning systems, and able to suppress the enemy air defense. Therefore, self-protection systems on 'Blue' force platforms were sufficient, and increased the probability of survival."

Advances in technology have, however, now rendered such

assumptions obsolete. “We now encounter a highly redundant and networked system of newer and older weapon systems,” said General Katz. “This means you have to change our mindset from a pure [one-on-one] ‘duel’ situation to an anti-access/area denial scenario.”

He amplified. “Today, the new threat is characterized through the [amalgam] of many different and modern system components, [such as] short- and long-range SAM systems, radars, and communications posts. The threat, as described in the NATO Suppression of Enemy Air Defense employment concept, is layered, decentralized, complex, frequency diverse, highly automated, and networked.”

This new threat landscape, characterized by increasingly advanced systems and high levels of interconnectivity, means that “conventional” SEAD tactics and technology are less effective. Instead, said General Katz, NATO needs to recapitalize and modernize its capability. “This means implementing long-range sensors, long-range weapons, long range reconnaissance/geolocation, modern cross-platform self-protection systems and a modern airborne electronic attack capability.”

Effecting this change requires the adoption of a new cross-domain SEAD concept of employment (CONEMP) blending a mix of different but synchronized effects. “We must say goodbye to old doctrines, and adjust our mindset,” General Katz said. “To tackle the adversary’s network, we have to develop capabilities to deny, degrade or disrupt these networks. And in order to defeat the new threat, we need specialized aircraft, weapons and technology, with the integration of all aspects of modern electronic warfare, to saturate the enemy’s air defense systems.”

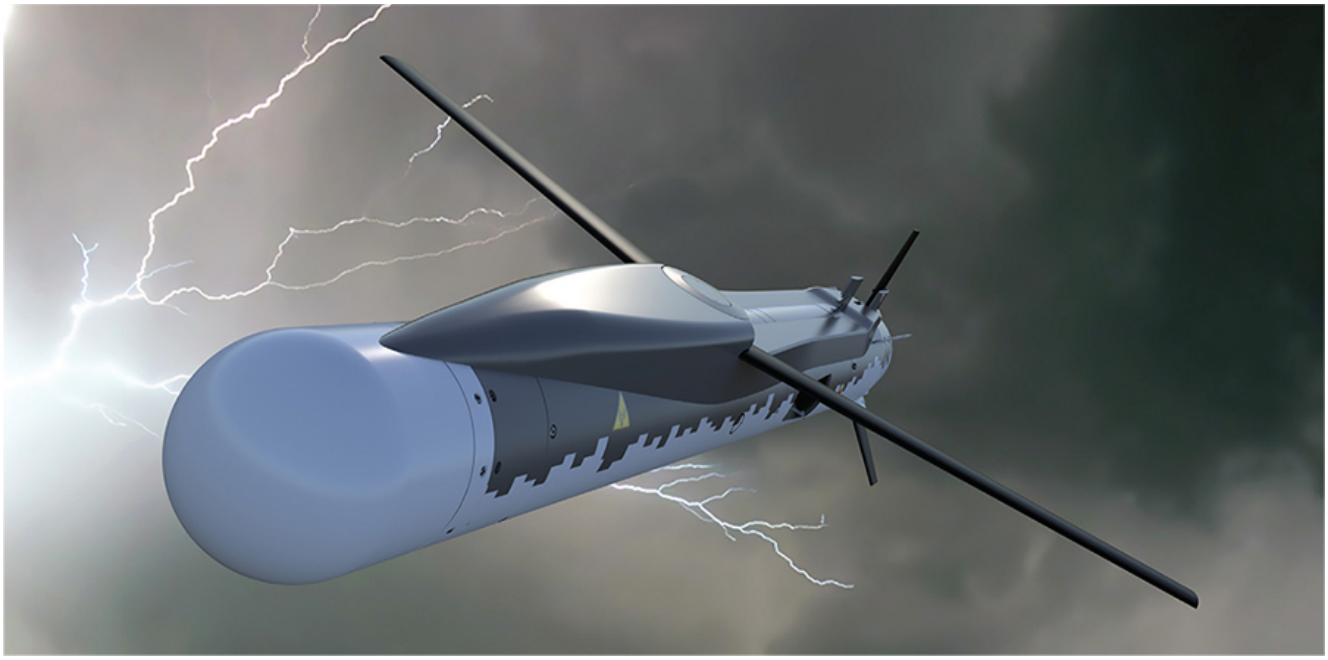
This will demand the development of a highly networked SEAD system-of-systems capability capable of delivering effects in all domains and dimensions. Moreover, these effects must be

flexible and tailored to the mission.

Germany’s own Luftgestätze Wirkung im Elektromagnetischen Spektrum (luWES) program breaks out the delivery of AEA effects into three complementary parts. Stand-off jamming, performed by a large non-penetrating air platform operating at a safe distance outside the “threat bubble,” is designed to “open a channel” in the IADS screen by suppressing long-range radars operating in lower frequency bands and disrupting IADS communications networks.

Escort jamming will be performed by penetrating aircraft which accompany the strike package into defended airspace in order to suppress fire control/missile guidance radars systems so that the force can survive once inside the missile engagement zone. Stand-in jamming – a relatively new addition to the SEAD armory – uses an unmanned and expendable air vehicle to deliver an EA payload close to a victim radar(s) so as to protect the following strike package as it approaches the weapons release area.

“We envisage that our [luWES] stand-off and escort jammers need to be coordinated with unmanned combat drones to saturate, attack and locate the adversary’s threat systems,” said General Katz. “Also, due to the expected high mobility of these threat systems, most of these effects need to be time-critical.”



SPEAR-EW is being developed by MBDA to meet UK requirements for a stand-in jammer. MBDA

ENABLERS

The challenge is to engineer a next-generation SEAD system of systems, underpinned by integration and networking, that will enable tailored, flexible effects to be delivered in all domains and dimensions. One potential enabler for this future capability is Cooperative Electronic Support Measure Operations (CESMO), a digital protocol adopted by NATO (codified under STANAG 4658) to allow participating units – air, land or maritime – to share information on emitters.

Germany acts as a framework nation for CESMO in NATO, and the Luftwaffe's Tornado ECR force is serving as a technology development asset for the capability. "CESMO uses all data networks, like Link 11, Link 16 and Link 22, and provides the collected information from any unit to all participants in the network," General Katz explained. "It improves situational awareness by allowing each unit to find, fix and track emitters in near-real time outside the range of their own sensor suite."

A proposed evolution of CESMO, known as CESMO++, is already looking at an extension of the current message set to incorporate additional capabilities – for example, reporting hyperbola and hyperboloid data (hybrid geolocation); joint restricted frequency bands; and meaconing, intrusion and jamming.

Dietmar Thelen, head of Electronic Warfare Military Air Systems for Airbus Defence and Space, explained: "Right now CESMO is like a Link 16 for SIGINT. The next step is to coordinate non-kinetic effects – jamming, spoofing and deception. Historically, we fed jammers with [threat] library data. But today, we need to be more dynamic [and] measure the received signal as it appears. We are seeing changing [RF] patterns and modulations in real-time – we can no longer rely on empirical emitter libraries. In CESMO++, we will start to implement this process. It will be essential to choregraphing the delivery of effects."

Two other enablers are seen as critical to realizing the SEAD system of systems vision. First, the implementation of some form of 'Combat Cloud' to enable decentralized and disaggregated command and control of SEAD effects. Second, the introduction of advanced AI techniques – not just for ultra-fast data mining, but to also provide instantaneous reaction if and when a threat switches to a "war mode" or emits previously unknown signals not in the EW system's threat library.

The Italian Air Force completed operational testing of the AGM-88E AARGM missile from the Tornado ECR in April 2018. NORTHROP GRUMMAN

NIAG STUDY GROUP

The alliance established a NATO Industrial Advisory Group (NIAG) earlier this year to explore AEA/SEAD concepts and technologies that could meet NATO's needs for 2030 and beyond. Chartered through the CNAD, the NIAG Study Group 286 (SG-286) on SEAD Capabilities held a kick-off meeting in May. The study activity, lasting for approximately 18 months, will deliver a capability audit against NATO's previously drafted AEA and SEAD CONEMPs.

Speaking at AOC Europe 2023, Alex DeFazio, NATO's capability area facilitator for AEA and SEAD, said the capability audit process was intended to evaluate what sort of capabilities were feasible by the end of the decade, and to inform and influence the NATO defense planning process. "Based on what we say we need in 2030, [we will ask ourselves] what do we

currently have now in hand," he said. "Then we will compare those results and do a gap analysis [and then] we will figure out how we get the stuff that we don't have right now."

DeFazio added that SG-286 – involving over 40 companies from 12 nations – was now beginning to review capabilities against the CONEMP. "We've asked those industry experts what they think is in realm of the possible by 2030, and what have we missed in the CONEMP that could be relevant as we move this roadmap forward.

"We want their recommendations on what capabilities we should be pursuing. And then we'll take on board those recommendations to try and [influence] how we do our NATO defense planning process."

SG-286 is due to complete its work at the end of 2024. Alongside the NIAG study, a team of subject matter experts largely drawn from the NATO Air Force Armaments Group is providing NATO EW support to SEAD (NEWS) input to the capability audit. A key part of this work is examining integrated threat environments, and different technology options with regards to platform types, weapon concepts and jamming techniques.

"The next step will be the gap analysis," said DeFazio. "The NEWS team will be part of that, [and] we'll use modelling and simulation being offered from the United States to try to help the NATO defense planners fine tune their assumptions when they do the stress testing of the minimum capability requirements. We will also look to industry to help us with solutions that address areas highlighted in the gap analysis."

The outputs of the capability audit study will also inform further updates to policy and doctrine. "That's starting to happen already," said DeFazio. "We've seen changes in NATO SEAD doctrine, changes in our policies [and] we now have a new NATO Electromagnetic Spectrum strategy. All that came out of

the questions arising from the CONEMP and vision paper.”