

From the JED Archives: NATO Confronts the Challenge of a Congested and Contested Spectrum

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By Richard Scott

Electronic warfare (EW) – as both a science and a military art – has been an ever-present consideration for the NATO alliance in the 72 years since its establishment. During the Cold War, there was a realization within NATO that the control and exploitation of the electromagnetic spectrum (EMS) was a vital and potentially decisive enabler, be it supporting strategic intelligence collection, providing tactical situational awareness, penetrating Warsaw Pact defenses or improving platform survivability. Equally, there was an understanding that EW technologies and techniques could be applied to disrupt or deny adversaries the ability to use the EMS for their own advantage.

Accordingly, the Alliance invested substantial sums in doctrine, equipment, and training in the full expectation that any confrontation with Warsaw Pact forces would almost certainly be in a dynamic, dense and hostile electromagnetic environment.

However, the two decades following the end of the Cold War saw NATO's EW capabilities and doctrines steadily atrophy. The Alliance found itself increasingly engaged in crisis response, counter-insurgency efforts and peace support operations in which NATO forces enjoyed a significant technological advantage without facing adversaries that challenged its use

of the EM environment. As a result, NATO's EW focus narrowed to concentrate on platform self-protection against specific and localized threats.

Yet all the while, the use of the EMS for sensing, communications, navigation, and targeting has become more important to NATO forces than ever before. Not only does access to the spectrum underpin virtually every kind of command, control, and communications, but it is also a prerequisite for sensing, precise navigation and timing, and enables the delivery of both kinetic and non-kinetic effects. Furthermore, collection and analysis of activity in the spectrum provides opportunities for information exploitation. In short, NATO's offensive battle networks, as well as its defensive battle networks, depend on its ability to access to the EM environment.

The last decade has seen a gradual awakening across the Alliance to the challenge posed by the emergence of increasingly muscular and assertive Russia. NATO has also found itself operating in a new operational realm – the “gray zone” – that sits in the blurred space between peace and war.

As a consequence, NATO is forced to confront a new set of operational realities – including potential challenges within the EMS – that are forcing its strategic thinking to evolve. So while the demand for spectrum access is increasing across the Alliance, so peer and near-peer adversaries have also developed their abilities to operate in, exploit and potentially deny NATO forces' access to the EMS.

According to Air Chief Marshal Sir Stuart Peach, RAF, Chairman of the Military Committee of NATO, the challenge facing the Alliance is to adapt to an increasingly complex and unpredictable security situation in which the EM environment is recognised as an increasingly important operational domain. “We need to understand the requirements better,” he told the AOC's EMSO leadership discussion series in early March. “We

need to understand the shortfalls, and how to work together to respond both across the boundaries together that sometimes we create ourselves.”

Air Chief Marshal Peach continued: “I would argue [that] EW is evolving rapidly, and should be increasing once more in prominence as nations look to sustain and gain an edge through the next generation of technology.

“The fight for electromagnetic spectrum superiority has been going on for long time. But the outcome of future operations will be decided by the protagonist who accomplishes this to decisive advantage.”

Another fundamental change is that the commoditization and proliferation of micro-electronics technology means that all manner of adversaries – both state and non-state actors – now have access to capabilities that were once restricted to advanced militaries. “EW is no longer the exclusive province of wealthy nations,” explained Air Chief Marshal Peach. “Smaller states [and] non-state actors can gain advantage within the electromagnetic environment with available components [which are] cheap, lower cost, and they’re being integrated into military designs.”

“Our potential opponents focus on EW,” he continued. “It’s low cost, it’s asymmetric, it is a good way to dominate in an operational domain. And in the 21st century, I think that trend will continue in either offensive or defensive operations. And in many gray areas, such as hybrid strategies, this is probably even more prevalent than it ever has been.”

Accordingly, freedom of action on the modern battlefield will require a degree of superiority in the electromagnetic spectrum to enable force commanders to gain advantage across the level of warfare. “In other words,” said Air Chief Marshal Peach, “EMS empowers us to communicate with confidence, navigate with certainty, perceive an operational area the best we can, and then engage with accuracy.”

In response to this changing landscape, Allied Command Transformation, as the NATO lead in NATO's Warfighting Development, has crafted an EMS Strategy that reflects a new era of operations in a contested and congested EM environment. The accent on the EMS – as opposed to just EW – is reflective of a more holistic approach to operations in the EM environment, and an acknowledgement that the EMS is a maneuver space in its own right.

NAILING THE CHALLENGE

NATO's Science & Technology Trends 2020-2040 report identifies the continued importance of the EMS to Alliance partners. It identifies the information domain – embracing cyber, EW and electromagnetic spectrum management – as a unique and evolving operational environment that is critical to operational success. At the same time, it is recognized that this is a domain where others are increasingly active.

The report's section on the importance of the EMS to big data and advanced analytics is instructive. Identifying control of the spectrum as “a necessary prerequisite to information dominance.” It continues: “The future will bring, among other things, faster, more reliable wireless/radio communications, electronic warfare resilience, secure streaming video and smaller deployed footprint. As a result, the EM spectrum is and will continue to be increasingly congested as military and commercial systems vie for bandwidth.

“The use of AI to support cognitive sensors (e.g., cognitive radars) and communications, which adjust in an agile fashion to maximize collection and through-put, will become essential to avoid conflict in the congested (and perhaps contested) EM spectrum. This will be especially essential for operations in urban environments.”

NATO's Science & Technology Trends 2020-2040 report also highlights the challenges to interoperability resulting from

an increasing number of users fighting for access in an ever more crowded spectrum. Governments have recognized the growing civil demand and economic value of the EMS, and have come under increasing pressure from the commercial sector to open up portions of the spectrum previously restricted to military use: this is most apparent with the rollout of 5G, where the major networks are targeting bands that have hitherto been overwhelmingly, if not exclusively, used by the military.

Spectrum allocation thus presents a conundrum. While NATO's spectrum needs are growing – driven by the proliferation of battle networks, higher data rates, the increased exploitation of unmanned vehicles and sensor payloads – demand in the civil sector is also increasing, notably in the spectrum below 6 GHz. As a result, the process of assuring spectrum access in the traditional sense is becoming more complex owing to the growth of high-data-rate cellular networks, such as 5G.

Furthermore, 5G presents an additional and significant challenge in that it raises the noise floor within which RF sensors must operate. The adverse impact this has on detection ranges has already become apparent in both operations and exercises.

So, NATO must grasp a thorny problem. Realistic training for operations is essential to operational readiness, and anticipating and adapting to changes within the EM environment is essential for operational advantage and freedom of action. However, any peacetime constraint to spectrum access makes the mantra of “train as you fight” difficult to execute.

“Although EW has been used since the beginning of the 20th century, the congestion and dynamic environment of the EMS demands a new approach,” Air Chief Marshal Peach told the AOC. “The more the world connects itself, the more scarce access across the electromagnetic spectrum becomes. The spectrum is bound by the laws of physics, so we can't just procure more. Which means we have to be careful about how we share available

spectrum with an increasing number of users. It can continue to constrain our ability to train in these bands, and makes achieving our proficiency a challenge.”

At the same time, adversaries and competitors are fielding capabilities that may challenge the Alliance’s ability to use the spectrum as and when it requires. The last decade has seen Russia undertake a significant modernization of its EW capability: the impact of this investment has been best demonstrated in both eastern Ukraine and Syria.

NATO nations and partners also have first-hand experience of EW effects in their own “backyards.” For example, in November 2018 the Norwegian government identified Russia as the source of GPS jamming in the Kola Peninsula during NATO Exercise “Trident Juncture.” In August 2017, cellular telephone networks in the west of Latvia were taken down. The Latvian government concluded that the disruption appeared to have originated during Russia’s Zapad exercise.

While Russia has consistently denied responsibility for such actions, it is increasingly clear that operations in the information space – both EW and offensive cyber – offer the Kremlin a convenient and effective means to disrupt the military and government activities of its NATO neighbors. In an era of growing mistrust and increasing tensions, this ability to deny the spectrum is a key component of hybrid warfare writ large.

It is not just peer and near-peer threats that pose concerns. The proliferation of technology and knowledge means that less advanced adversaries may employ existing dual-use or commercial technologies in innovative and dynamic ways. There is a recognition that, given NATO’s growing reliance on networks and sensors for operational advantage and speed of action, the EM environment is a space in which adversaries can seek an asymmetric advantage.

Thus it is critical that Alliance forces are equipped and trained such that they can operate, survive and prevail in environments where access to the spectrum may be degraded, or at times denied.

EMS STRATEGY

It is against this backdrop of an increasingly congested and contested spectrum that NATO has been developing its EMS Strategy with the aim of engineering increased coherence and synergy to its activities within and across the spectrum. At NATO Headquarters, the EMS Strategy is coordinated between the main stakeholders of the EMS; the C3 Board, the NATO Advisory Committee on Special Intelligence and the NATO Electronic Warfare Advisory Committee (NEWAC).

The EMS Strategy is aligned to, and builds on, NATO's Framework for Future Alliance Operations. This document, which informs and shapes both warfighting and warfare development, has identified the importance of maintaining freedom of action in the EMS, and the need for resilience in the face of adversary actions.

Throughout the post-Cold War era, there was a feeling by many in the EW community that NATO had lost sight of the importance that EMS has in its operations. Today, however, there is undoubtedly an increased awareness amongst NATO leadership of the criticality of the EMS. This in part reflects the direct operational experience of some military leaders now in the senior echelons of the Alliance, but is also a testament to a more deep-seated understanding of the universal importance of "spectrum-dependent systems."

According to NATO sources who spoke to JED, the EMS Strategy distils this intent into a more detailed framework that serves to articulate the criticality of operations in the EM environment, advocate for increased investment in EW and spectrum operations to redress current capability shortfalls, and pursue improvements across all lines of development

(doctrine, organization, training, materiel, leadership, personnel, facilities and interoperability).

EW AGENDA

Top of NEWAC's agenda is finalizing Version 12 of NATO's EW policy: this seeks to simplify NATO's approach into a series of succinct policy statements that set out the Alliance's "route map" in four key areas:

- challenges in a contested and congested environment
- interoperability, data sharing, and command and control
- the coherent integration of the EMS Strategy and EW operations
- education and training

As part of work aligned with (and complementary to) the development of the EMS Strategy, NATO revised its Spectrum Management procedures and associated data format in April and May 2019 respectively, while it also revised and promulgated its EW doctrine in March 2020. Also, the strategy leverages and blends doctrines and policies previously developed by NATO members: the overriding aim is that while each partner may apply its own subtly different national strategy, all should follow a common vector.

Accordingly, the NATO allies are learning from one another to create an identifiable NATO route map. The US and the UK are heavily involved, bringing a rich library of lessons learned from their own process of policy and doctrine development in the EM environment and cyberspace.

One key part of this work is defining common terminology to ensure a single frame of reference across NATO. This is important not just to achieve alignment between partner nations, but to also agree a common taxonomy across the various communities of interest (such as EW, spectrum operations and SIGINT). Various corresponding NATO communities are heavily involved in this area, and JED understands that

the process of defining a common terminology is advancing well.

SPECTRUM STRATEGY

After being endorsed by the NATO Military Committee, the EMS Strategy itself has now been approved by NATO's North Atlantic Council, signaling buy-in from NATO's political leadership, and is informing the NATO Defence Planning Process. Bringing together various strands of work undertaken within the Alliance, it promotes a coherent, harmonized and coordinated framework for activities in the spectrum. And the message is clear that it is an EMS Strategy – not an EW, radio frequency or spectrum management strategy.

One key output is the need for greater coordination in the use of the spectrum. The encroachment of the commercial/civil sector into what were previously reserved parts of the frequency spectrum demands that NATO thinks carefully, and acts appropriately, regarding spectrum sharing. There is an attendant imperative to develop agile, resilient and spectrally efficient planning methodologies and technologies to enable the spectrum to be accessed and exploited while minimizing regulatory spectrum risks and avoiding accidental disruption to civil users. In this vein, NATO's Science & Technology Office continues to explore new areas of EMS related research, such as full-duplex radio to increase spectral efficiency for military applications.

At a broader level, the EMS Strategy serves to underpin the ongoing modernization and reinvigoration of NATO's EW and EMS capabilities. This includes, among other things, introducing a new generation NATO Emitter Database, exploring alternatives to SATCOM and investigating the development of a deployable passive electronic support measures tracker for NATO air command and control. NATO has also canvassed industry to explore new technologies to improve situational awareness of the EM environment, to generate and share the electronic order

of battle, and to enhance a commander's ability to plan, direct, monitor and assess EW activities.

NATO also continues to research, develop and test novel technologies and to trial new tactics, techniques and procedures. As an example, 13 nations participated in the NATO Electromagnetic Operations (NEMO) trials held off the south coast of England in late 2019. Sponsored by NATO's Above Water Warfare Capability Group, NEMO is an annual event for NATO partners to perform electronic warfare trials and data gathering. Over a six-day period, the NEMO 19 participants executed a series of trials to evaluate the effectiveness of a range of anti-ship missile defense (ASMD) countermeasures. Infrared and radar signatures were measured to reduce the susceptibility of ships to hostile radars and missiles, and tactical data exchanges between participating ships, as well as reversionary voice procedures, were put to the test.

TRAINING AND READINESS

One key area where NATO has prioritized investment is EW training and readiness. "We must greatly improve our proficiency in the electromagnetic spectrum...to ensure forces understand how to operate in a congested and contested environment," Air Chief Marshal Peach acknowledged in his AOC discussion. "We need to make exercise environments tough and challenging just like we did back in the Cold War, because when NATO deploys on operations we can expect any enemy to disrupt our radars, GPS, communications and weapon systems. Therefore we must train realistically – we must experience these effects and practice how to counter them. In the next few years we are really focused on this."

NATO has already committed to a major recapitalization of its Joint Electronic Warfare Core Staff (JEWCS) equipment inventory. Based at RNAS Yeovilton in Somerset, England, NATO JEWCS is a multinational training and subject matter expert organization best known for providing "adversary" EW support

to tactical and operational level training and exercises. Its wider portfolio includes support to current and future NATO operations; management, maintenance, and support of the NATO Emitter Database; the provision of the Allied Command Operations' core EW staff function and subject matter expertise; and the provision of support across all of NATO for the delivery of NATO EW policy, doctrine, concepts, and experimentation.

Deploying from its base at RNAS Yeovilton in Somerset, UK, JEWCS supports between 25 and 30 exercise events annually, comprising a mix of NATO, national and NATO EW Force Integration Programme exercises. In this role, the organization is tasked to exercise, train, and evaluate NATO forces in the disciplines of electronic surveillance, electronic countermeasures, and electronic protection measures in both the radar and communications domains across the air, land and maritime environments.

Much of NATO JEWCS current equipment inventory is technically obsolete, and increasingly difficult to support (reflecting its early 1980s origins with the erstwhile NATO Multi-Service Electronic Warfare Support Group). To address this, an industry team led by Leonardo was, in December 2018, awarded a contract worth approximately €180 million to deliver a capability package comprising airborne pods, land/maritime EW cabins, and "smart" pods to realize a new NATO Anti-Ship Missile Defence Evaluation Facility (NASMDEF). NASMDEF will provide a capability to assess the effectiveness of soft-kill decoys for ASMD.

The NATO JEWCS Capability Package will roll out over the next three years. In parallel with its introduction, NATO is working to identify where gaps exist in the EW training and education process. The Alliance is also working to incorporate EW in all exercise as a means to strengthen interoperability across all allies and partners.

WAY AHEAD

There is significant activity ongoing within NATO to develop and improve its capability to act in the EM environment. "NATO understands the opportunities, challenges and threats faced by the resurgence of EW and the dynamic element of the electromagnetic environment," Air Chief Marshal Peach told the AOC audience. "We must re-set to make EW in NATO a higher priority. We must improve our edge in the EMS. We must improve...the situational and institutional awareness across the leadership of realistic training, realistic exercises, realistic scenarios to support the strategies we're building."

Above all, the need to enshrine interoperability remains paramount. "That's the way forward from our perspective for EW," he explained. "Putting our resources and all of our efforts into interoperability pays dividends for us all. An interoperable NATO is greater than the sum of its parts."