



Managing the Electromagnetic Spectrum

XIX

A Large-Scale Collective Action Problem for the 21st Century

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'Effectively, change is almost impossible without industry-wide collaboration, cooperation, and consensus.'

Simon Mainwaring

This year's JAPCC conference theme asks the community to address the issues of Synchronization, Human in the Loop, Harmonization, and Resilience. Each of these issues share a common, yet invisible, feature: 100 % dependence on access to the Electromagnetic Spectrum (EMS). The NATO community is prudently looking at technologies, capabilities, investments, and Tactics, Techniques, and Procedures (TTP's) to ameliorate these issues. However, the very canvas that hosts all these activities remains in the shadows, ever invisible to the human eye. Perhaps that is why it has been so systemically overlooked. The EMS is there, though, and it plays a vital role in NATO's military operations. NATO must begin to look at the EMS holistically if it is going to remain relevant in the great power competition. This paper seeks to highlight the most

compelling reasons why the EMS must be prioritized and brought into proper focus for NATO to be successful on the modern battlefield.

NATO's dependence on the EMS¹ goes far beyond the four issues called out in the JAPCC 2021 Call for Papers. It is safe to say nearly all military operations being planned today are 100 % dependent on access to the spectrum. And yet, ensuring that access is not being adequately addressed. Where are the Electronic Protective Measures (EPM)² taken on all EMS-dependent systems and the policies to drive those measures? Denial of Spectrum Denial³ would seem to be in play ('What do you mean I won't have access to the spectrum? The lightning bolts are right there on my OV-1.').

Peer and near-peer adversaries have been watching NATO operate for the last twenty-five years with virtually uncontested access to the EMS. They have been planning to deny NATO forces this precious access and they know it is our proverbial Achilles Heel.⁴ They have designed myriad systems to deny NATO access to the EMS and have already achieved some rewards. Russia took over the Ukrainian province of Crimea decisively; they employed Information Operations, controlled the civilian population's access to the EMS (i.e., Information Warfare), and rolled into that country with minimal kinetic actions or activity.

NATO has reared nearly two decades' worth of warfighters who have not experienced large-scale EMS denial. This situation naturally, but unfortunately, stems from the retired Cold War culture of awareness that the EMS is a bona fide target that can and will be denied. Even the IED fratricide episodes in the early and mid-2000s are fading into the rear-view mirror. This means that a large portion of the fighting force lacks an appreciation for, awareness of, and respect for operating in the EMS.

Finally, whether anyone realizes it now or not, the EMS is on its way to becoming a global public goods resource like clean water, safe food sources,

and responsible industrial waste management.⁵ A feature of a public goods resource is that it must be made available for everyone on the planet. Here's why the EMS qualifies: By 2030, there will be 5 billion users of the EMS and each user will have an average of 10 devices.⁶ With this omnipresent mantle of the Internet of Things, there will arise a social obligation to give every human being access to the EMS (right now, access to the EMS is reserved for those who pay for it). With this much demand, the current static allocation practice of owning frequencies will not render enough capacity to accommodate that demand. This means the EMS will become an unrenovable sustainable resource in the very near future.⁷ All of these issues point to a need for NATO to begin addressing the EMS holistically if it is going to be prepared for the future, both militarily and sociologically.

The confluence of disparate issues across a singular public good presents what is classically called a Large-Scale Collective Action Problem (L-SCAP).⁸ A future where all users can use the EMS as they wish lies in treating the EMS as an L-SCAP.

Large-Scale Collective Action Problems

L-SCAPs have been studied heavily in the social sciences. In fact, there is a Centre of Excellence at the University of Gothenburg called, 'Centre for Collective Action Research (CeCAR⁹)', which was stood up specifically to address the myriad issues that come with solving L-SCAPs. One main empirical finding from CeCAR's research is that the larger the problem, the more imminent the need to establish a neutral, third party to help solve it. If NATO were to set up such a third party, it could navigate these social challenges while simultaneously researching what is needed to maintain control of the EMS.

L-SCAPs are characterized by four conditions:

1. A large number of anonymous users—the current EMS users are virtually completely anonymous to one another, both in their identity and their various methods of using the spectrum.
2. Spatial distance—billions of EMS users are scattered across the globe.
3. Temporal displacement—the condition that outcomes and consequences of decisions we make today will not be made known for years to come.
4. Complexity—operating in the EMS presents NATO and our world with some of the most complex problems that modern civilization has ever faced.

In addition to these four explicit conditions, there are several underlying challenges with the EMS as an L-SCAP that make tackling the problem even more challenging.

Conflicting Interests

Users involved in an L-SCAP scenario organically want to maximize their expected benefit. In the EMS, it is undeniably true that all users, regardless of origin, want unfettered and ubiquitous access 100 % of the time. But users want this outcome for themselves at the expense of the greater good. This natural human penchant motivates users to ‘want what they want when they want it,’ so much so that they will all defiantly ‘sit in the same boat’,¹⁰ risking its seaworthiness, not caring if they all go down with the ship. In other words, people will risk losing their joint resource unless they start cooperating. There is currently no incentive for the billions of anonymous users, their commercial/industrial overlords, and the world’s military powers to join together to look at the EMS holistically. The large number of anonymous users makes it difficult to see that the ‘Collective’ would be better off if they begin to cooperate now.

Pareto Inefficiency

There is an economic consequence called Pareto Inefficiency inherent in L-SCAPs. An organization is said to be Pareto Efficient when its resources have been maximized such that any additional investment in products would result in a reduction in services, or any additional investment in services would result in a reduction in products. Organizations are able to operate on this curve when the responsibility, authority, and ownership of the process falls under one umbrella. L-SCAPs are perceived as being Pareto Inefficient because responsibility and authority rests among many powerful players. If any one player were to invest in standing-up a global EMS authority, because of a social norm known as free-riding¹¹, they would run the risk of being left to do it by themselves. This is why no entity has stood up yet, not even the US's Department of Defense (DoD). In the case of ubiquitous management of the EMS, responsibility is spread across the DoD, NATO Allied governments, the civilian telecom industry, the power industry, and the cybersecurity industry. This situation presents a palpable barrier for any single existing authority to stand-up and take charge of the problem.

Technological Innovation

Pockets of innovation and technology alone, even the most compelling advances in capabilities, will not do the trick nor will they do it in the time frame needed. If a future of effective EMS utilization is to be realized, autonomous dynamic EMS access schemes will need to be designed and built into every EMS-dependent system. Even if, and when, scientific efforts in artificial intelligence and machine learning come to maturity and enable autonomous dynamic EMS access capabilities, there is still the matter of EMS allocation priorities and schema that need to be discussed, vetted, adopted, ratified, and then disseminated to NATO countries. This challenge falls solely into the sociological realm of discussion,

collaboration, negotiation, mediation, and compromise. To add to the challenge, these conversations must occur among disparate user groups. No advanced technological system or strategy is going to ameliorate that.

Pockets of Cooperation

Perhaps NATO is hoping that pockets of cooperation will naturally emerge to navigate the challenges associated with operating in the EMS. However, there is a latent barrier to spontaneous cooperation among users associated with a L-SCAP:¹² anonymity (mentioned previously). This introduces inherent stressors that have been shown to prohibit spontaneous cooperation.¹³ In 1740, David Hume proclaimed in his work, *A Treatise of Human Nature*, 'Although two neighbours agree, ... a thousand neighbours becomes a matter too complex to execute.'

The Information Superhighway

Managing the EMS holistically is going to require a significant culture change. Users are scattered so far and wide across the globe, using the EMS in so many different ways and residing in so many different pockets of industrial, municipal, communal, and military operation that they do not share a common understanding or belief system for using the EMS. To bring this point home, let's consider the basic vehicle driver. There are countless numbers of them, and they all share the road peacefully. They are able to do this because every driver has an understanding of three things: a recognized set of rules, basic knowledge of how their vehicles work, and respect for one another's use of the same highways. The Information Superhighway, heavily dependent upon the EMS, will need its users to possess similar qualities. Without a fundamental culture of understanding, awareness, respect and compliance, a future of peaceful coexistence is out of reach for operating in the EMS.

Summary

In order to address the more socially charged and very specific issue of EMS management that is an integral part of 21st century military operations, it would behoove NATO to consider establishing a neutral third party to investigate the social as well as technological challenges associated with managing the EMS. Such an entity could establish a set of standards, similar to the aforementioned driving laws, that work for the entire community, be they from defence, commercial, municipal, or other operating groups.

Technology, capabilities, and strategy alone will not solve the issues coming in the EMS. NATO's mission should include a focus on achieving a strong culture of awareness, respect, and basic knowledge of the opportunities, vulnerabilities and challenges associated with operating in the spectrum. The reason has been summed up often by Dr William Conley, former Executive Secretary of the Electronic Warfare Executive Committee for the US DoD, 2016–2019. 'In five years, I want to be out of a job. Everyone [in the DoD] needs to be treating the EMS like they treat Air. It will be lived and breathed by everyone who has a part in this fight. Then, we won't need the services of an EW EXCOM.'

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Endnotes

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