

The electronic warfare maneuver



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Abstract

Beschleunigt durch das Wiederaufflammen von «peer-to-peer»-Konflikten auch in Europa, ist das Electronic Warfare (EW)-Manöver auf dem aktuellen Schlachtfeld eine entscheidende Fähigkeit auf taktischer Stufe. Es bildet eine wichtige Grundlage für erfolgreiche Kampfeinsätze und erfordert aufgrund der kontinuierlichen Überlappung von Topografie und elektromagnetischem Spektrum (EMS) eine umsichtige Planung. Das EMS enthält wichtige Informationen über entscheidende Aktivitäten des Gegners. Gleichzeitig ist es durch den zunehmenden Einsatz von Drohnen und Lenkwaffensystemen dicht belegt, weshalb robuste und intelligente Lösungen zur Nutzung der im EMS enthaltenen Informationen immer wichtiger werden. Der Artikel diskutiert die Problemstellungen und optimalen Taktiken für effektive EW-Operationen in modernen militärischen Konflikten.

Schlüsselbegriffe elektromagnetischer Wirkungsbereich; elektronische Kriegsführung; elektromagnetisches Spektrum; command and control; Spektrumdichte

Keywords electromagnetic operational sphere; electronic warfare; electromagnetic spectrum; command and control; spectrum density

Abstract

The Electronic warfare (EW) maneuver is critical in current battlefield tactics, catalyzed by renewed “peer-to-peer” threats in Europe. It underpins successful combat operations and requires careful planning due to the continuous overlap of topography and the electromagnetic spectrum (EMS). As the EMS hosts crucial information about enemy activities and is further congested by increasing drone and guided weaponry use, robust intelligence solutions are required to handle spectrum information effectively. The article discusses the complexities and optimal tactics for effective EW operations in today’s military conflicts.



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Context

The combat maneuver Maneuver warfare often brings to mind infantry combat movements for gaining an edge over opponents. As technology advances, elements like mobility, weaponry effects and troop protection have evolved, impacted by drones, cyberattacks, stealth and deception. However, Sun Tsu’s three enduring principles for successful combat still apply and are also pertinent to EW maneuvers:

1. concentration of efforts
2. freedom of action
3. economy of forces

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The electromagnetic spectrum (EMS) – a contested resource Combat maneuvers involve not only the terrain, but also the electromagnetic spectrum (EMS), a shared but limited resource among adversaries. Upon deployment, troops experience immediate confrontation in both dimensions, with their communication management dictating their EMS usage to support differing tactical scenarios.



Picture 1: Radio networking is the cement of the command and control function. (Source: Rohde & Schwarz)

Introducing the EW maneuver

The EW maneuver is a specific type of maneuver that aims to counter the adversary's communication management and to support one's own forces with actionable information and intelligence. Two major types of EW maneuvers can be distinguished:

1. *Direct EW support maneuvers*: The tactical EW element directly supports combat forces by producing timely combat information and early warnings based on leaders' needs. This necessitates integrating the EW maneuver with the combat maneuver while taking the EW element's mobility into consideration, which must align with the tactical mobility of the supported forces. For instance, a rapid reaction airborne brigade would have different mobility and agility than a heavy armored brigade.
2. *Multisensor maneuvers*: The tactical EW element is often embedded within an ISR (intelligence, surveillance, and reconnaissance) entity that is in charge of managing the collection of information. This maneuver aims at optimizing the collection process, for example, by combining various types of sensors. Hence it is more focused on interaction and cross-cueing between sensors of different categories and on the management of their tactical and technical complementarities.

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Both types of maneuver take place within the EMS, but also simultaneously on the terrain (because radio targets are geolocated), within the equipment (for example an adversary PMR communication network), and sometimes, in the case of deception operations, also in the adversary's perception.

Like combat maneuvers, EW maneuvers consist of movements, effects and protection, and must operate alongside friendly forces.



Picture 2: Jamming capabilities are essential to the EW maneuver. (Source: Rohde & Schwarz)

Movements can take place within the terrain and also within the EMS:

Movements within the terrain are about planning and deploying EW assets (sensors and effectors) on the battlefield, choosing the best positions for coverage of the terrain of interest (intervisibility, RF propagation, camouflage, deception) while the sensors' aeri- als must remain as invisible as possible.

Movements within the EMS are about observing defined parts and bandwidths of the spectrum of interest simultaneously or sequentially, about the ability to skip from one band to another band of interest or to hop from one frequency to another frequency in order to follow so-called frequency hopping signals.

Effects are categorized into Electronic Support Measures and Electronic Counter Measures:

Electronic Support Measures (ESM) predominantly encompass the passive effects of electronic surveillance. They contribute to gathering information about the electromagnetic environment and the opponent's activities. This information is crucial for intelligence,

enabling the identification, locating and potential exploitation of the opposing forces' electronic systems, thereby giving military forces a substantial tactical edge.

Electronic Counter Measures (ECM) include all aspects of non-kinetic electronic attacks designed to deceive, disrupt, or neutralize adversarial electronic systems. ECM uses methods such as signal jamming, decoy emissions, or false radar images to confuse or misdirect enemy forces. These capabilities can interfere with adversary communications, navigation or other critical systems, thereby diminishing their effectiveness or operational capabilities in a combat situation.

Protection is provided by *Electronic Protective Measures (EPM)* that include both passive and active elements to safeguard friendly electronic systems by minimizing the enemy's ability to disrupt or exploit friendly electronic capabilities. Passive effects are often organizational measures, such as careful control of emissions or signal encryption. Active effects involve techniques such as protective jamming, where deliberate interference is created in the electromagnetic spectrum to impede adversaries' electronic systems.



Picture 3: Armored EW tactical vehicles embedded within the tactical maneuver (Source: Rohde & Schwarz)

As for any other combat maneuver, Sun Tsu's principles also apply to EW maneuvers:

1. *Concentration of efforts*, prioritizing the deployment of EW sensors and effectors to where the intelligence effort is assessed to be

2. *Freedom of action* within the electromagnetic spectrum
3. *Economy of forces*, securing sufficient endurance by intelligently partitioning the tactical EW assets according to the operational tempo, by ensuring a sufficient reserve of EW assets or by deploying a reasonable EW sensor network that will survive the inevitable combat attrition rate.

Importance of the environment at the tactical level

Tactical non-cooperative interception often involves a dedicated "modus operandi" governed by radio propagation aspects and environmental constraints.

For instance, HF wave interception at 3.5 MHz can be measured from thousands of kilometers away, while positioning within a range of a few kilometers is needed for Wi-Fi interception at 5GHz. Thus, an EW maneuver is always a compromise between a tactical and a technical approach.

Added value of the EW maneuver

The added value of the EW maneuver is indeed to wage war in the EMS at the same time as within the area of operations. Events happening in one dimension will always be noticeable in the other: Troops use radio communications for command and control purposes, therefore their tactical actions are mostly coordinated via the EMS, which in turn makes them detectable and attackable by EW systems.

Intelligence, jamming effects and protection are the three major added values of the EW maneuver.

Intelligence is probably the most obvious benefit of the EW maneuver, which can be further categorized into:

- *Combat information*, which is unevaluated data and derived from the early stage of collection, is perishable and critical to the decision-making process in dynamic tactical operations.
- *Electronic warfare support* are actions tasked by or under the direct control of an operational commander; the aim is to search for, intercept, identify and locate or localize sources of intentional and unintentional EM radiation for the purpose

of immediate threat recognition, threat avoidance, homing, targeting, planning and conduct of future operations.

- *Signal intelligence* comprises the knowledge of the adversary derived from spectrum monitoring information; the aim is to either detect and analyze tactical activities and build the intelligence picture of ongoing operations or to find out how the adversary is using the spectrum for further planning and conducting of their own EW maneuver.

Example: an EW operator working in an armored EW tactical vehicle during and alongside an infantry maneuver suddenly detects an emission that could originate from an artillery command post. Due to the importance of the adversary's artillery threat, he immediately passes the information on to the local tactical leader before carrying on with the signal processing in order to characterize the threat.

Jamming effects might enhance the disruption of adversary forces prior to, during or after a military operation. A wide panel of jamming modes is therefore critical to support offensive, defensive and protection use cases.

Example: Prior to an offensive action of one's own forces, jamming is applied to degrade the defensive coordination of the adversary forces. This degradation effect can range from a mere unpleasant nuisance to the full denial of the spectrum band used by the adversary's radios.

Protection measures serve one's own troops directly or indirectly, like:

- early warnings derived from a threat activity detection
- cover provided by jamming, while troops are closing in on a target
- control of one's own troops' radio emissions to minimize the adversary's detection and exploitation of the information so gained
- increased situation awareness.

Example: Electronic masking is the controlled radiation of electromagnetic energy on friendly frequencies in such a manner as to protect the emissions of friendly communications and electronic systems

against enemy electronic warfare support measures/ signal intelligence without significantly degrading the operation of friendly systems.



Picture 4: The ability to dismount the EW CESM sensor from the tactical vehicle enables the mission to be carried out on foot. (Source: Rohde & Schwarz)

Evolution of the EW maneuver

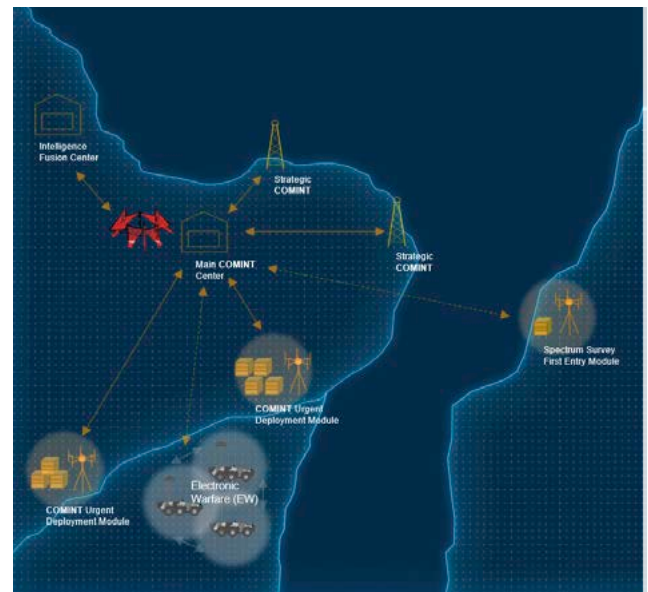


Figure 1: Example of a modern electronic warfare ecosystem. (Source: Rohde & Schwarz)

EW maneuver in the era of collaborative combat

Until recently, traditional collective combat was led quite sequentially, from reports to orders, along the chain of command with its vertical succession of decision-making processes.

In the meantime, the digitization era has brought modern command and control tools to the battlefield and has thus widely contributed to the emergence of collaborative combat.

Collaborative combat is based on shared situational awareness, which allows forces to synchronize operations effectively, identify targets and respond swiftly to rapidly changing circumstances. Battle management systems are the kingpin of this concept, which is now the de facto standard in all modern armed forces.

Impact of technological evolution The increased reliance on information and communication in society and military applications has led to a dramatic rise in signal density. Along with this, the technologies used in EW maneuvers are seeing shorter life-cycles, impacting the frequency and pace of military procurement programs.

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Modern EW systems must now accommodate a much broader real-time bandwidth and a higher frequency range in order to process large volumes of signal data and analyze high-frequency communications. In order to address the above stated challenges, key is the analysis and jamming of frequency hopping signals, a method used to evade detection and interference. As these signals rapidly switch frequency channels, identifying and disrupting them is critical to preventing compromised communications and gaining an advantage on the battlefield.

Conclusion Recent conflicts in Europe reveal that the EW maneuver has become essential for peer-to-peer warfare in today’s digital era. Modern command and control systems as well as the tactical mobility of troops and unmanned assets all necessitate seamless network connectivity. Hence, they rely on the dom-

inance of the EMS which, due to rapidly advancing technologies, is increasingly harder to achieve.

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Although EW capabilities have been recognized as essential to support the tactical maneuver for some time, it is now obvious that the EW maneuver, as an art of its own, has so far been underestimated in tactical exercises and operational deployments. To address this deficit, adequate EW capabilities must be implemented in combat units down to the lowest tactical levels. This in turn implies fundamental changes in all areas, including doctrine, planning and action processes, adapted OB (ordre de bataille) with new specialized functions, as well as speedy procurement of state-of-the-art assets requiring adapted training, maintenance and logistics. In the case of Switzerland, such capabilities must additionally be fulfilled with processes and systems compatible with militia troops.

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Through a close reading of the study “Konzept Elektromagnetischer Raum” released in 2021, it can be deduced that the Swiss Armed Forces and, more precisely, the new Cyber Command have clearly recognized this priority and that involved actors are accepting the tremendous challenge posed in striving to stay on top of developments related to the dynamic evolution of the EW maneuver. ◆