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Defense Primer: Electronic Warfare

Electronic warfare (EW), as defined by the Department of Defense (DOD), are military activities that use electromagnetic energy to control the electromagnetic spectrum (“the spectrum”) and attack an enemy. The spectrum is a range of frequencies for electromagnetic energy. EW supports command and control (C2) by allowing military commanders’ access to the spectrum to communicate with forces, while preventing potential adversaries from accessing the spectrum to develop an operational picture and communicate with their forces. Some have argued that EW is a component of anti-access/area denial (A2/AD) campaigns.

Role of EW in Military Operations

Since the introduction of two-way radios, militaries have become dependent on the spectrum. This reliance has expanded over the past century to include nearly every weapon system. Applications include

- radio frequencies to communicate with friendly forces;
- microwaves for tactical data-links, radars, and satellite communications;
- infrared for intelligence and to target enemies; and
- lasers across the entire spectrum to communicate, transmit data, and potentially destroy a target.

Modern militaries rely on communications equipment that uses broad portions of the spectrum to conduct military operations. This allows forces to talk, transmit data, provide navigation and timing information, and to command and control forces all over the world. They also rely on this to know where adversaries are, what adversaries are doing, where friendly forces are, and what effects weapons achieve. As a result, modern militaries attempt to dominate the spectrum through electronic warfare. From the perspective of military operations, there are three broad divisions of electronic warfare

- **Electronic protection** involves actions to protect access to the spectrum for friendly military assets.
- **Electronic attack** uses electromagnetic energy to degrade or deny an enemy’s use of the spectrum.
- **EW support** identifies and catalogues emissions of friendly or enemy forces to either protect U.S. forces or develop a plan to deny an enemy’s access to the spectrum.

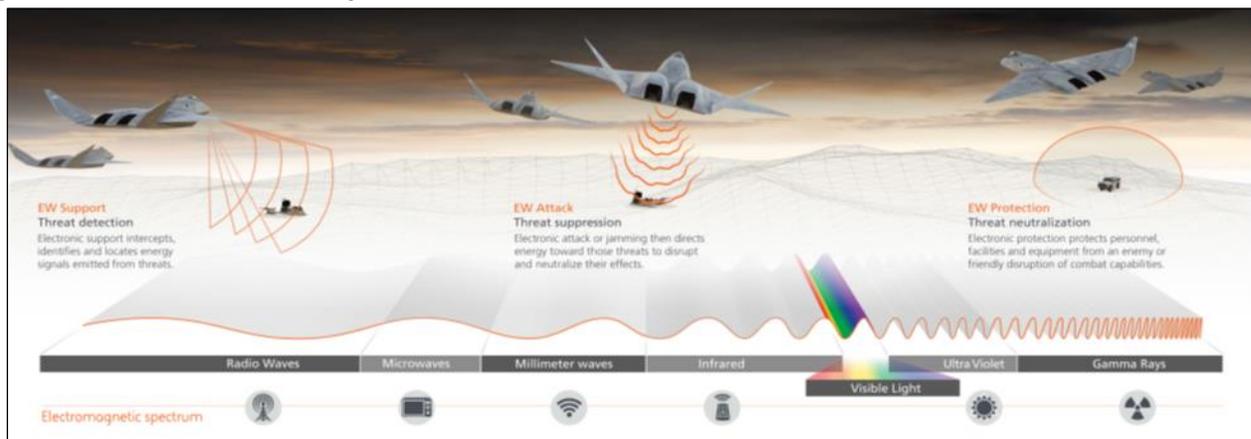
These subsets of EW often mutually support each other in operations. EW support uses equipment to assess both friendly and adversary electronic emissions. This information can then be used to develop a protection plan to maintain access to the spectrum or an attack plan to deny adversaries vital access. Radar jamming (electronic attack) can serve a protection function for friendly forces to penetrate defended airspace, and it prevents an adversary from having a complete operating picture.

In general, the more advanced a military adversary, the greater role EW plays in combat.

Types of EW Capabilities

As electronic warfare affects all military domains—land, air, sea, space, and cyberspace—each of the military services has its own EW capabilities and programs. EW capabilities are traditionally categorized into two distinct categories: terrestrial and airborne. Because each kind of EW has its respective advantages and disadvantages, multiple capabilities may be required to provide a desired effect. For example, airborne EW is used to intercept, decrypt, and disrupt communications, radars, and other C2 systems over a large area. However, these capabilities may be limited by aircraft endurance and are therefore unable to provide certain EW effects. Examples of airborne EW programs include the E-2 Hawkeye, the EA-18G Growler, the RC-135 Rivet Joint, and the EC-130H Compass Call.

Figure 1. How EW Affects the Spectrum



Source: <https://cyberdefense.com/spectrum-warfare>.

Terrestrial EW sensors and jammers—which can be located on land or on ships at sea—are limited by the amount of power available; these capabilities are also limited due to variance in the terrain in which they operate. Ground EW capabilities traditionally focused on intercepting and jamming radios and artillery radars. Recent uses include jamming improvised explosive devices (IEDs).

Representative ground EW capabilities include the vehicle-mounted Counter Remote Controlled IEDs (CREW) Duke system and the Thor III dismounted CREW system.

Modern-day military operations also rely on satellite-based EW capabilities, including for broad area surveillance and early-warning, communications, command and control.

Specific programs include

- Space Based Infrared System (SBIRS) constellation;
- electronic intelligence by satellite (ELISA) electronic intelligence satellites; and
- space-based radar systems.

DOD EW Policy

The National Defense Strategy, released in 2022, continued the emphasis on return of great-power competition, reflecting China's and Russia's ongoing efforts to modernize their forces to counter U.S. military advantages. In addition, the congressionally mandated National Defense Strategy Commission, which independently evaluated DOD strategy, stated that the United States is losing its advantages in electronic warfare, hindering the nation's ability to conduct military operations against capable adversaries. The commission recommended increasing EW investments and developing new concepts to regain U.S. military advantage. Each service has incorporated EW capabilities into platforms and combat systems and is currently working to modernize its existing capabilities.

Army

The Secretary of the Army and the Chief of Staff of the Army testified this year that developing new EW capabilities and programs was the Army's fourth most important modernization. The Army plans to invest in both airborne and ground-based EW programs aimed at making the service more competitive with peer adversaries. This investment includes standing up a new organization devoted to the EW mission, procuring long-endurance, unmanned airborne EW systems, and unit-level training.

Marine Corps

The Commandant of the Marine Corps has testified since 2017 about requiring modern EW capabilities for expeditionary maritime operations. The Marine Corps continues to sustain and modernize its radio battalions—units specifically designed around signatures intelligence and electronic warfare—alongside additional aviation programs, including the F-35B Lightning II aircraft. Another initiative outlined in the most recent Marine Corps' concept is signature management, which aims to limit emissions to prevent adversaries' access to precise locations of about U.S. forces.

Navy

The Navy has several new operational concepts it intends to use to counter adversaries, including the Naval Integrated Fire Control-Counter Air (NIFC-CA) concept, designed to help the carrier air wing to better counter adversaries in denied or degraded environments. The Chief of Naval Operations, in his 2018 posture testimony before the Armed Services Committees discussed investing more in EW capabilities for the surface fleet. The EA-18G Growler aircraft, which is the backbone of the Navy's EW programs, continues to receive funding to modernize its capabilities, including funding for the Next Generation Jammer.

Air Force

The Air Force's concepts of air superiority and multidomain command and control require assured access to the spectrum. The Secretary of the Air Force and the Air Force Chief of Staff stated during their 2018 posture hearing the need to maintain EW capabilities to support the Air Force's future development. Thus, the service is upgrading EC-130H Compass Call EW payloads and procuring EC-37s, with an intent of purchasing new 10 aircraft. Six aircraft are already on contract.

Organization of EW

DOD has several organizations responsible for developing and maintaining EW capabilities. The EW Executive Committee—led by the Deputy Secretary of Defense—is tasked with synchronizing and integrating EW across DOD components by sharing tactics, techniques, procedures, and technologies. The EW EXCOM also establishes DOD EW policy. The FY2019 National Defense Authorization Act directed the creation of an Electromagnetic Spectrum Operations Cross Functional Team to develop an electronic warfare strategy, including assessments of vulnerabilities and capability gaps, leading to an acquisition plan. The Electromagnetic Spectrum Superiority Strategy was published on October 29, 2020.

CRS Products

CRS Report R44572, *U.S. Airborne Electronic Attack Programs: Background and Issues for Congress*, by John R. Hoehn

CRS Report R45919, *Ground Electronic Warfare: Background and Issues for Congress*, by John R. Hoehn

CRS In Focus IF11155, *Defense Primer: Military Use of the Electromagnetic Spectrum*, by John R. Hoehn

CRS In Focus IF11882, *Defense Primer: Directed-Energy Weapons*, by Kelley M. Sayler and John R. Hoehn

Other Resources

DOD. Electromagnetic Spectrum Superiority Strategy, October 29, 2020

Joint Pub. 3-85, Joint Electronic Magnetic Spectrum Operations, May 22, 2020.

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