Winning the Airwaves
Regaining America’s Advantage in the Electromagnetic Spectrum

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c. The Electromagnetic Operational Environment

(1) As discussed in Joint Publication (JP) 3-0, *Joint Operations*, the OE is the composite of the conditions, circumstances, and influences that affect employment of capabilities and bear on the decisions of the commander. It encompasses physical areas and factors (of the air, land, maritime, and space domains) and the information environment (which includes cyberspace) (see Figure I-2). The joint force commander (JFC) defines these areas with geographical boundaries in order to facilitate coordination, integration, and deconfliction of joint operations among joint force components and supporting commands.

Figure I-1. The Electromagnetic Spectrum

The Electromagnetic Spectrum

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<tr>
<th>Non-Federal Controlled Spectrum</th>
<th>Federal Controlled Spectrum</th>
<th>Shared Spectrum</th>
<th>Selected Bands at Issue</th>
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- All military operations in EMS are elements of EMS warfare
- Not broken up into communications, sensing, and electronic warfare
- EMS a domain analogous to air, sea, and undersea
• Warfare areas evolve as long-term competitions

• Each moves through phases or “competitive regimes”
  – Driven by predominant operational concepts and technology

• Shifts in competitive regimes are coming
  – EMS warfare, undersea warfare, air warfare, strike, etc.

• The U.S. can advantageously position itself for next phase
  – This should be the focus of “offset” strategies
• WW I to mid-WW II: active comms/sensing vs. passive counters

• Mid-WW II through Cold War: active systems vs. active counters

• Late Cold War: a shift toward stealth, LPI/LPD, and passive

• Next phase: low power / passive sensors, comms, and counters

**EMS warfare drives the “hider-finder” competition**
**Phase 1: active networks vs. passive counters**

Before radar, the best long-range sensor was DF of enemy radio.

Slow speed of conflict allows enemy to wait out jamming.

Jamming possible; not used due to impact on friendly comms and greater benefit in exploiting enemy comms.
Phase 2: active networks v. active counters

One of four 2.5 kW/650 lb Jostle VHF communications jammers in bomb bay of B-17

Smaller, more powerful radars & jammers and speed of conflict made jamming of sensors/comms more advantageous
Defender does not need to be very effective to impose “tax” on attacker

“Virtual attrition” of strike power demanded a new approach
Phase 3: Passive/LPD networks & counters

DARPA Have Blue demo led to F-117 and showed ability to reduce RF signature in some frequencies and aspects

B-2 bomber built on Have Blue and F-117 to provide all-aspect stealth across wider frequency range

LO aircraft with LPI/LPD sensors and comms, and lower-power jamming reduce “overhead” for air defense suppression
• U.S. partially adopted low-to-no power EMS warfare
• Today’s force is a hybrid of stealth, LPI, LPD and active vs. active
• Will competition restart with today’s emerging threats?
• Adversary anti-access/area denial (A2/AD) improving
  – In capability & scope, including new players such as Iran and Syria
  – U.S. forces will operate at increasing range from enemy
  – Active sensors and countermeasures must operate at higher powers

• Adversaries have home field; can adopt new approaches first
  – Enemy can use larger, networked sensor arrays in A2/AD complex
  – Can operate at lower frequency, passive, and multi-static
  – Defender more likely to detect U.S. high-power active forces first

• U.S. EM capabilities are static and occupy defined frequencies
  – Adversaries targeting them as part of A2/AD with jammers and ECM
  – Enemy sensors and comms able to avoid U.S. countermeasures
• Need to move away from high-power active approaches
  – Unless they are carefully controlled to be LPI/LPD

• “Low-to-no power” detection (“finder”)
  – Use of low-power “probes” to stimulate enemy emissions
  – Multi-static sensors using friendly or enemy emitters
  – Passive geolocation of emitters in IR/RF
  – LIDAR and highly directional low-power RF sensors
  – Passive coherent detection using reflected ambient EM energy

• “Low-to-no power” counter-detection (“hider”)
  – Stand-in jamming of enemy’s active sensors and weapons
  – Reduction of EO/IR/RF signatures (i.e., expanded stealth tech)
  – Low-power decoy and deception
Passive and multi-static detection

- Radar waves bounce off adversary platforms in EMCON
- Reflected energy picked up by passive sensors
- Expendable/unmanned radar emitters provide active EM source
- Emitting enemy platforms located passively
- LIDAR detection or multi-static laser detection
Detection with reflected ambient noise

Adversary maintains EMCON

EM transmitters of opportunity

Passive systems monitor EM environment for returns of Interest

Networked systems fuse returns from multiple perspectives
Broken communication links

Passive IADS

Higher noise area

False targets
(created by UUV/USV decoys)
Conducting strike operations

Decoys disract IADS

Long-range narrow beam jamming

Decoys stimulating passive IADS to emit; anti-radiation homing weapons in same salvo attack IADS

Decoys from XL UUV confuse air defenses

Decoys mixed with weapons to distract point defenses

HPM attacks on IADS

Lead weapons find targets, share target information with following weapons

Standoff munitions
• Networked

• Agile and maneuverable

• Multifunction

• Small and less expensive

• Adaptable
Networking essential to new concepts

Passive coherent location and lower frequency detection requires multiple geographically dispersed receivers

Multi-static detection using expendable illuminators networked to UCAV receivers

Passive geolocation of IADS using multiple networked UAV receivers

Passive sensors find radar; stand-in jammers confuse it; both pass info to weapons

Passive sensing, decoys, collaborative weapons, and LPI/LPD jamming require platforms and payloads to be connected
Maneuver in frequency, power, time, beam direction, & beam shape to protect friendly EMS operations while denying those of enemy.
Each platform and payload must participate in EMS warfare network; multifunction arrays reduce the number of separate systems needed
New concepts:

- Use more expendable EMS warfare payloads
- Incorporate almost every manned or unmanned platform
- Employ multiple RF and EO/IR arrays per platform

EMS emitter/receivers need to become commoditized to enable every platform and payload to participate in network
Today’s systems react to recognized situations w/ pre-planned responses; future systems must assess EMS and develop & refine COAs to best exploit it

Examples include ONR REAM and NEMESIS and DARPA ARC and BLADE programs

EMS Warfare Operating Cycle

- Assess threats, opportunities and previously attempted EM effects
- Review & adjust EM requirements based on commander’s intent and current environment
- Develop COAs using modeling and simulation
- Allocate EM operations by function
- Schedule tasks to EM systems
- Tasks to EM systems
- Generate EM effects

Examples include DARPA RadioMap and Navy OFM programs
• Lack of new operating concepts
  – Needed to drive requirements & acquisition structure

• Acquisition process and organization
  – Focused on programs, vice capabilities

• Funding aligned to R&D, not acquisition
  – Only S&T orgs and labs can look holistically
Today’s CONOPs constrain innovation

- Don’t exploit new tech
  - Networked emitters/receivers
  - Adaptive EMS systems
  - Agile EO/IR/RF operations
  - Multifunction arrays & controllers

- Remain system v. system
  - Pre-planned techniques
  - Library of threats and responses

- Keep “high-power” approach
  - Unsustainable vs. A2/AD threat

- Delay requirements changes
• **Dependent on requirements**
  - DoD generates new documents for each program
  - Limited options to shorten requirements process

• **Organized by hardware**
  - PMs for individual missions (radio, EW, RWR, radar, SIGINT)

• **No incentives for cooperation**
  - Multifunction EM systems cross multiple PMs and PEOs
  - Increases programmatic risk
• RDTE funding rising
  – Technology rapidly maturing
  – Or transitioning w/out requirements

• Procurement falling
  – Completion of E/A-18G
  – Will rise with NGJ, SEWIP
  – No programs for new approaches

• EW EXCOM focused on PB
  – Not yet exploring new EW or EMS warfare approach
  – Should be driving new approaches and tech transition
• **EW EXCOMM** establish “pull” for new EM technologies
  – Set priorities for implementing low to no power EMS warfare

• **Services develop new EMS warfare operational concepts**
  – And establish requirements for low to no power capabilities

• **Services / CCDRs expand EMS warfare demonstrations**
  – In near-term to field new capabilities & inform requirements

• **Congress and DoD refine acquisition process**
  – Reduce new requirements analysis for payloads (vs. platforms)

• **Services promote integration between EMS warfare PMs**
  – Through capability area PMs & incentivizing integration
Questions