"In the next two decades, the [electromagnetic] environment may become our most critical warfighting arena. Control of information -- much of it through the EM spectrum -- is already growing more important than control of territory in modern warfare."

- ADM Jonathan Greenert, CNO, 10 October 2011

“The future Fleet will maintain our current advantages in the electromagnetic spectrum and cyberspace, but will fully operationalize them as warfighting domains.”


“Cyberspace will be operationalized with capabilities that span the electromagnetic spectrum – providing superior awareness and control when and where we need it.”

- CNO's Sailing Directions, SEP 2011
Support the Information Dominance Vision with a single unified information environment across tactical, operational and strategic-level spectrum management and networks to assure the commander and warfighter get the right information at the right time.

Key features of NES approach:

- Assured C2 of existing networks and communication infrastructure
- Phased approach to automated, real-time spectrum operations
- Network architecture and data strategy that establishes the grid
- Enterprise services that facilitate information discovery and sharing
- Authorities, oversight, standards and training that instill unity of command
The Hidden Problem
Obscured EMI Impacts

- Ship operator assumes system 100% capable

• Actual System Operational Capability

Goal: Make the Assumption the Reality
**NES Wholeness / Integration**

### Networks

- Touch Points to all Roadmaps:
  - Network Management
  - Transport Grid
  - Common Connectivity Bus
  - Agile Routing
  - Fleet Network Operations Center Afloat
  - Net-Centric Enterprise Services
  - Mobile GIG Entry Points
  - DoD IT Enterprise Strategy

### Decision Superiority (Capstone Strategy)

- Integrated Targeting and Fire Control (ISS, ITC2, Air Roadmaps)
- Ballistic Missile Defense
- Undersea Dominance
  - *Information in Warfare*
- Spectrum Warfare (Cyber, EW Roadmaps)
  - *Information as Warfare*
- Maritime Domain Awareness
- Intelligence, Surveillance & Reconnaissance (ISR, UxS Roadmaps)
- Understanding the Environment and Precision Nav and Timing (Battlespace on Demand)
  - *Battlespace Awareness*

### Electromagnetic Spectrum

- Touch Points to all Roadmaps:
  - Congressional Inventory
  - National Broadband Plan
  - Assured Spectrum Access
  - Real Time Spectrum Ops
  - Improve SPY-1 Interoperability
  - Linkage to NTAs
  - Denied Environments
  - World Radio Conference agenda items (ex., UAS Allocation, HF Radars)

**Networks and the Electromagnetic Spectrum**

- (CSN, EMS Usage Roadmaps)
- *Information Backbone*
NES Vision and Goals

- Develop and establish a complete portfolio of reliable, highly-interoperable network and electromagnetic spectrum capabilities
- Manage through a flexible, dynamic information grid that maximizes the ability of the warfighter to access, maneuver, and achieve decision superiority in, A2AD, benign, degraded and denied environments

Links to NES and Spectrum Maps

https://www.intelink.gov/wiki/Networks_and_Electromagnetic_Spectrum_(NES)_Roadmap
https://www.intelink.gov/wiki/EM_Spectrum_Usage_Roadmap
NES Overarching View
As-Is 2011

Point-to-point comms, specialized comms relays, reliance on Space Layer for connection to GIG, platforms are degraded
NES Overarching View
To-be Vision 2025

Global Information Grid
Every node connects to the Grid, every node supports the Grid, Platforms have full combat capability
Real-Time Spectrum Operations (RTSO)

RTSO enables interoperable Core Capabilities

**National Broadband Plan (NBP)**

**Spectrum Bands Being Considered (Goal #2: ASA)**

<table>
<thead>
<tr>
<th>#</th>
<th>Band MHz</th>
<th>Reallocation Impacts</th>
<th>Key Navy and DOD Systems</th>
<th>Other Federal Users</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>406.1 – 420</td>
<td>3</td>
<td>Non-Tactical Land Mobile Radio Systems</td>
<td>DOC, DHS, GSA, DOJ</td>
</tr>
<tr>
<td></td>
<td>(1370 – 1390)</td>
<td></td>
<td>Lightweight Counter Mortar Radar (Army), GPS</td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>1675 – 1695</td>
<td>2</td>
<td>Meteorological Satellite (GOES) downlinks and Radiosondes</td>
<td>DOC, NOAA, NASA</td>
</tr>
<tr>
<td></td>
<td>(Fast Track 1695 – 1710)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>1755 – 1780</td>
<td>1</td>
<td>Space Ground Link Subsystem (SGLS uplink); UAVs – Pointer, Raven, others; Tactical Comms (HCLOS, DWTS, SRC-57); Air Combat Training Systems; Precision Guided Munitions (PGMs); Sustaining Base Operations</td>
<td>DOJ, DOA, DOC, DHS, DOE, FAA, DOI, NASA, TVA, NSF, VA, HUD</td>
</tr>
<tr>
<td></td>
<td>1780 – 1850</td>
<td></td>
<td></td>
<td>DOJ, DOA, AID, DOC, DHS, DOE, EPA, FAA, HHS, HUD, DOI, OPM</td>
</tr>
<tr>
<td></td>
<td>2200 – 2290</td>
<td></td>
<td>Missile telemetry, Airborne telemetry, Space Ground Link Subsystem (SGLS downlink)</td>
<td>DOA, DOC, DHS, GSA, DOI, DOT, DOJ</td>
</tr>
<tr>
<td></td>
<td>2700 – 2900</td>
<td></td>
<td>Ground and Maritime Air surveillance radars, future Navy radars</td>
<td>FAA, NOAA, DOE</td>
</tr>
<tr>
<td></td>
<td>2900 – 3100</td>
<td></td>
<td>Ground penetrating and weather radars, Maritime Navigational radars, future Navy radars (BMD)</td>
<td>NOAA, DOE</td>
</tr>
<tr>
<td></td>
<td>3100 – 3500</td>
<td></td>
<td>DDG/CG Aegis SPY-1 Weapon System (Radar and Missile guidance); Army Fire Finder counter battery radar; Airborne radar; future Navy radars (BMD)</td>
<td>DOE</td>
</tr>
<tr>
<td></td>
<td>3500 – 3650 MHz</td>
<td>6</td>
<td>Airborne Station Keeping Equipment, Shipboard Air Traffic Control radar, future Navy radars (BMD)</td>
<td>DOE</td>
</tr>
<tr>
<td></td>
<td>(Fast Track 3550 – 3650)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4200 – 4400</td>
<td>5</td>
<td>Radar altimeters on all DOD aircraft, PGMs, and large UAVs</td>
<td>FAA, DOI, DHS</td>
</tr>
</tbody>
</table>

**Reallocation impacts determined by OPNAV, Fleet, and PEO leads**
Lexicon Challenges

Conventional Wisdom

- Cyber is IP based communications
- EW is radars and missile seekers
- SIGINT is communications signals
- Electromagnetic spectrum = RF only
- Cyberspace is a domain

Hard to define new things with old language
The Lexicon Matters...

- Cyber is the language of the 21st Century, but have we got the terminology correct?

  -- What is “cyber”?  Where does it begin and end?  Is it really the domain, or is the EMS the “domain”?

  -- The EMS is more than just RF, and underpins cyberspace.  It’s the physical environment in which cyberspace exists.

- When we talk convergence, convergence of what?

  -- Technological convergence between wired, wireless and optical?

  -- Operational employment of EW and cyber capabilities?  EA and CNA  --  OCO and ES  --  SIGINT and CNE
Operational Fires in the Electromagnetic Spectrum

Convergence

CYBER

DOD GIG Operations

Defensive Cyber Operations

Offensive Cyber Operations

Electronic Attack

Electronic Support

Electronic Protect

EW

Fires through the EMS from Navy platforms
Operational Fires in the EMS

- Targeting/Counter Targeting
- C2/Counter C2
- Delivery/Counter delivery
- Real Time Spectrum Ops
- EW Battle Management

Navy provides tactical entry points to the EMS for a variety of missions
Electronic & Cyber Warfare Plan

Modernize and converge Electronic & Cyber Warfare (E/CW) to influence, control, and when needed, fight and win in the EMS

- Investing for near-term E/CW capability & long term capacity
- Fielding capabilities for “fires” through the EMS
- Providing E/CW readiness
Achieving Convergence

- Workforce adjustments required:
  - Historically, EW and CNO were separate and distinct skill sets.
  - What’s the future? EW and cyberspace operations still separate, but less distinct?

- TTP development needed

- EW systems used for cyber mission
  - Surface EW systems such as SSEE-F are “cyber” ready

- Changes to roles and missions
  - Move beyond current focus on NETOPS/CND

- Authorities and governance need revision
  - EW can enable unique cyber “non-kinetic fires”

- Implications for Navy’s Title 10 Man, Train and Equip responsibility

EW-Cyber convergence for all phases of warfighting and mission areas