Managing the Air Waves: Dynamic Spectrum Access and the Transformation of DoD Spectrum Management

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The electromagnetic spectrum is a finite resource that enables the first tactical mile of the Global Information Grid. From radars that gather information, to networks that transfer the information and targeting for precision guided munitions; the electromagnetic spectrum is a critical resource that enables us to do more with less human capitol. Along with the Department of Defense's (DoD) increase in dependency on this resource, the commercial sector is also increasing its requirements for more and better spectrum access. As a result, the DoD is transforming its electromagnetic spectrum management capabilities to meet future demands.

The DoD is in the process of transforming its legacy spectrum management processes and capabilities to address the ever changing Global War On Terror and provide for net-centric military operations. This transformation envisions assured access to spectrum by warfighters anytime and anywhere, a prerequisite for the untethered, reliable, and ubiquitous wireless networking component of net-centric operations. To fully realize this vision, the DoD has focused on developing net-centric spectrum capabilities to help us plan and manage the following:

- On-the-move dynamic operations (which also require environmental awareness).
- Sustained growth of spectrum requirements by the DoD systems.
- Emerging commercial wireless systems and requirements for additional spectrum.
- Flexible policies and processes to support global deployments.
- Complete life-cycle, end-to-end, spectrum supportability processes and tools.

In response to challenges in operational, technical, and regulatory areas, the DoD spectrum community is updating spectrum management strategic plans and policies that will guide the transformation of DoD spectrum access. In 2006, the DoD stood up the Defense Spectrum Organization (DSO), which combines the Joint Spectrum Center (JSC) and the Defense Spectrum Office, to become the center of excellence for spectrum under Defense Information Systems Agency (DISA). The new organization is responsible for developing the comprehensive and integrated spectrum plans and long-term strategies to help DoD rise to the challenge. Additionally, the DSO provides the operational support center required by joint commands to meet their global missions.

The most important element of this transformation includes the development of improved tools, data systems, and services that support the entire range of spectrum activities including strategic planning acquisition support and mission operations. This capability is captured by a new system called the Global Electromagnetic Spectrum Information System (GEMSIS). The GEMSIS program will develop a suite of capabilities that will improve spectrum deconfliction in the operational environment, enhance integration of frequency assignment processes with mission planning, develop new spectrum services for the acquisition community, and provide the policy for dynamic spectrum access (DSA).

In order to achieve global access to spectrum for our networks in the new operating environment, DSA has emerged as a capability that has the potential to effectively address network spectrum resource challenges by allowing more dynamic, flexible, and autonomous spectrum access. DSA is realized through wireless networking architectures and technologies that enable wireless devices to dynamically adapt their spectrum access according to criteria such as policy constraints, spectrum availability, propagation environment, and application performance requirements. The basic concept of DSA is that spectrum-dependent systems can dynamically change their parameters to access multiple dimensions of the spectrum resource including frequency, space, time, and signal codes. This agility, coupled with enhanced distribution of spectrum data directly to spectrum-dependent systems, will enable these systems to share in near-real time the spectrum resource among a large number of users, improving the utilization of spectrum. Transforming from the current static spectrum allocation to DSA is analogous to the paradigm shift from the circuit-switched to packet-switched networking, where significant efficiency gain and improvement in interoperability can be realized.

DSA can be broadly classified into two categories: coordinated DSA and opportunistic DSA. Coordinated DSA requires a spectrum control and management infrastructure. One envisioned concept utilizes a set of control nodes (spectrum brokers) that are responsible to dynamically allocate spectrum within a geographical area to support a group of users. Opportunistic DSA adopts a distributed model where a group of devices autonomously sense the environment and access spectrum according to pre-defined policies. The system developed under the Defense Advanced Research Projects Agency XG (next generation) program implements an opportunistic approach to DSA. Regardless of form, DSA systems will require new data and knowledge representation constructs and software-based autonomous processing capabilities.

Effective DSA requires the full breadth of spectrum management to be brought to bare. First, the DoD must identify the spectrum bands that provide the best opportunity for global use from an environmental density perspective and a regulatory perspective. This can only be accomplished through the robust modeling and simulation of the electromagnetic environment that is envisioned in GEMSIS. Once the environment is defined, then the new DSA equipment must be supported through policy agreements both internationally and nationally. Accomplishing DSA-enabled networks is no small task and will require close partnership with industry and the DoD.

DSA-enabled networks can provide warfighters with improved net-centric performance globally. By integrating DSA with the other elements of DoD spectrum transformation assured spectrum access will enhance battlefield management of the electromagnetic environment and improve military operations in the net-centric environment.◆

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