Crowded Spectrum

A new DoD office is tackling problems of signal conflict and frequency allocation in an increasingly wireless world. It's one of the steps that the Pentagon is taking, both at the policy and operational levels, to mediate among competing demands for radio frequencies on the battlefield.

By Peter A. Buxbaum

When Marine Corps Lieutenant Colonel Stephen Sklenka commanded a combat service support unit in Iraq, he often confronted the potential for casualties from improvised explosive devices. In 2004 and 2005, when Sklenka served in Iraq, the IEDs were often detonated remotely with radio frequency devices.

Sklenka's unit was equipped with electronic jamming devices that prevented radio signals from reaching their intended targets. But the successful jamming of the IED triggering device had an unwelcome side effect.

"As soon as we turned it on, it would jam the radio frequencies back in the convoy," recalled Sklenka, who is still on active duty and currently doing research as a fellow at the Center for Strategic and International Studies. In other words, the use of radio frequencies to jam enemy weapons also impeded communications within Sklenka's unit.

This conundrum is emblematic of the spectrum management issues now being confronted within the Department of Defense. Wireless voice and data communications are of ever-growing tactical significance to a networked fighting force. But the introduction of increased radio-based capabilities also results in the greater probability that signals will clash with one another. The Pentagon is taking steps, both at the policy and operational levels, to mediate among competing demands for radio frequencies on the battlefield.

But the quest for access to the electromagnetic frequency spectrum is not limited to the military. Homeland security operations, first responders and commercial interests all have their growing needs for spectrum. In reality, the military competes for spectrum with these other users.

The Federal Communications Commission recently auctioned 90 megahertz of previously government-held licenses to commercial wireless concerns. The auction raised a substantial amount for the federal government, but also may have squeezed the supply of spectrum available for national security purposes. So the problem probably will have to be settled not at the DoD level, but in a national or international forum.

Spectrum Organization

The problems faced by troops like Sklenka's Marine unit are precisely the kind of issues being addressed within the Pentagon, according to Paige Atkins, director of the Defense Spectrum Organization (DSO), a recently organized unit within the Defense Information Systems Agency (DISA).

"Both tactical radios and electronic countermeasures operate through the electromagnetic spectrum, so they can sometimes interfere with one another," Atkins explained. "It may boil down to an operator having to make a choice. We want to prevent them from having to make a choice between critical functions and protecting lives."

In a similar vein, the availability and proper apportionment of frequency is essential for carrying out military missions, especially in today's network-centric environment.

"An air tasking order used to be developed over 72 hours," said Air Force Brigadier General Anthony W. "Bud'' Bell Jr. (Ret.), former director for command, control, communications and computer systems at the U.S. Joint Forces Command and currently a Burdeshaw Associates consultant. "With today's mobile targets, we fix, target, track and engage targets in near real time. Fighter aircraft get targets en route, and they get them through spectrum. If spectrum is not apportioned properly and available, the target may be lost."

Part of the Pentagon's answer to its spectrum management difficulties was to establish the DSO last April. Atkins, an engineer with extensive government and private sector experience who took over the helm in August, described DSO as a "center of excellence" for radio frequency spectrum analysis, planning and support.

DSO's mission, Atkins explained, is to ensure that troops have access to information and communications without concern over degradation from other systems. "We are trying to ensure that they have the right capabilities in place to do their mission," she added.

The DSO was formed through the merger of two other spectrum agencies: the Defense Spectrum Office, which focused primarily on policy and planning, and the Joint Spectrum Center, which dealt with operations analysis, support and information systems. "As we look toward the future, we need to address all issues of concern to spectrum," Atkins said. "Policies, planning, acquisition and operations are all very interrelated and interdependent. We want to create new levels of synergy across different levels of expertise in order to establish the right policy, and have those manifest themselves operationally."

Observers commented that the establishment of DSO is not a mere bureaucratic reshuffling. "It is a natural evolution driven by viewing spectrum as a joint resource for the services," said Bell. "The services have already worked a lot and well together to make spectrum a joint command resource. That has taken some attitude adjustment."

Bandwidth Demand

By any standard, Atkins has her work cut out for her. Electromagnetic interference on the battlefield could come from other U.S. military systems, but also from coalition, host nation, enemy or commercial systems. The demand for spectrum-dependent systems and the bandwidth they need to operate is skyrocketing in the commercial sector, she pointed out.

Part of the problem Atkins is facing is that the military does not have a single system to track the use of radio frequencies. DISA relies on several military databases to track frequencies in use, but not all of those databases are updated in real time. "This is an increasingly critical and challenging area from a DoD perspective," she said, "especially as it involves the transition from legacy systems and processes."

"Spectrum prioritization in theater is the responsibility of the combatant commander," noted Bell. "Just as he apportions forces, he apportions spectrum. To do that in a dynamic battlefield environment, you need tools to manage spectrum dynamically in real time. The troops in closest contact with the enemy need greater access to spectrum. This is becoming more and more important as the network becomes more and more wireless."

The effort to keep closer tabs on what spectrum-dependent systems are operating in the combat zone, where they are operating, and what frequencies and domains they are using, is proceeding along a number of fronts. The Global Electromagnetic Spectrum Information System, a new database, is being developed with an eye toward getting the most out of the military's bandwidth, Atkins said.

DSO has also fielded an analysis unit to keep tabs around the clock on what systems are in use and to determine what interference they might cause to others. If the potential for

interference is detected, staffers tell warfighters how they can reduce or eliminate the problem. The unit's activities cover U.S. electronic warfare systems and communications systems as well as other systems and devices that operate over electromagnetic waves, including tactical radios, cell phones, radar systems and wireless computers.

Ultimately, the challenge is to find new ways for systems to share spectrum. "As the environment gets much more crowded, we have to find new ways of understanding when systems are not using pieces of the spectrum, to be able to more efficiently use them," she said.

Technological Solutions

Technology companies are already working on spectrum management devices. One such approach, known as cognitive radios, includes built-in intelligence that allows the radio to shift from frequency to frequency based on bandwidth availability and priority.

"Cognitive radios can identify areas of spectrum not currently being used until another device with higher priority comes on," explained Murat Bicer, product marketing manager for Mercury Computer System's Software Defined Radio Group. "The radio then shifts to another frequency until the original one becomes available again. These radios use artificial intelligence, game theory and pre-defined policies to continuously analyze what is around them and to decide which part of the spectrum is best to use at any given time."

Bicer added that spectrum management devices require more processing power than conventional software-defined radios in order to make frequency use decisions, as well as sufficient bandwidth to process available signals in real time. Cognitive radios also require policies to be written in specialized software language to support decision-making and reasoning. Mercury develops middleware for use in spectrum management devices.

"These software policies are a set of rules like those for running a business," explained Michael Kosmicki, director of business development for the Mercury software defined radio unit. "For example, the policy might give an organization the right to use military frequencies first. If those aren't available, it could switch to first responder frequencies and then to cellular frequencies."

The concept of spectrum sharing has come to the fore, not only because of the proliferation of spectrum-dependent devices, but also due to the reduced availability of spectrum to military organizations. DoD and other federal agencies have sold at auction 1,710 megahertz to 1,755 megahertz of spectrum to the private sector, yielding $14 billion to government coffers.

"The spectrum auctions, while well meaning as a quick way to generate revenue, did not understand the military implications, especially in the area of global positioning systems," commented Bell.

They do, however, point to the necessity to develop an approach whereby spectrum can be shared. Atkins acknowledged that the likely future approach will be to find a way to share spectrum with non-military users, rather than selling any more of it outright. That concept, in turn, suggests an approach that is national in scope—that coordinates spectrum on behalf of government and commercial users at all levels, rather than national security agencies alone.

"We need to look at the way we manage spectrum from a national perspective and ensure we have the right mechanisms in place to enable economic prosperity and innovation while protecting federal government interests and the national security," Atkins said.

"I speculate there will be a tug-of-war between corporate America, wanting to allocate radio spectrum to business and consumer applications, and U.S. defense agencies desiring to allot spectrum to military applications," said Greg Giaquinto, a senior analyst at Forecast International. "Business interests will deploy their lobbyists to justify why they deserve a certain amount of spectrum, and DoD will have to justify its needs. At the end of the day, they will all have to come to the table and make it work."

National Strategy

For Atkins, the prospect of protracted battle between national security agencies and the private sector over the control of spectrum also speaks to the need for a single national authority to develop and execute an all-encompassing spectrum strategy. "We can get to where we need to go within the department," Atkins commented, adding that the same needed to be done at the national strategic level.

A national chief spectrum officer "is going to need to be an honest broker, a renaissance man or woman who understands that spectrum is a critical resource and how manage and allocate it," said Bell. "[A national spectrum coordinator] from the Defense Department might gravitate to the armed forces. That person might act in the best interests of national defense but there may be other criteria to be considered. An argument can be made that spectrum management should be centered in the Department of Homeland Security, with FCC support."

Mercury's Kosmicki agreed that DHS is likely to play an important role in a national spectrum strategy. "There needs to be more coordination so that the military or first responders can use spectrum on a temporary basis during times of emergency."

The need to get such a national strategy going is only increasing, according to Kosmicki. "The wireless data communications explosion that was expected five or six years ago will be happening very soon and with it will come another bandwidth explosion," he said. "Everyone has a bona fide reason to be concerned."

At the moment, it appears the FCC is taking the national lead. That agency has developed draft recommendations for consideration at the World Radiocommunication Conference,

a gathering sponsored every four years by the U.N. International Telecommunications Union.

At the next WRC, planned for next fall in Geneva, the FCC is expected to present recommendations designed to protect portions of spectrum used by DoD and other federal agencies against encroachment from next-generation mobile wireless services.