The Future Landscape of Spectrum Technology

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The use of spectrum technology has fueled innovation in diverse environments for many years. In the wireless environment, the growing industry demand for increased spectrum access is challenging resources used by the Department of the Navy (DON) for spectrum-dependent equipment and systems. What does the future hold, and what will continued innovation require of all users of spectrum? This article provides an overview of the possible spectrum technology landscape 25 years from now in several operational environments: U.S. mobile cellular technology, unmanned aerial systems, autonomous/robotic technologies and, military operational capabilities. Future CHIPS articles will explore each of these environments in greater detail.

U.S. Mobile Cellular Technology

Mobile cellular technology is leading the way in global communication innovation. It provides a foundation to integrate various technologies, including several wireless technologies. The expanded capability of Long Term Evolution (LTE) is creating an evolving method of exchanging voice, data, and video teleconferencing to a variety of users. The commercial demand for U.S. spectrum continues to pressure national regulators, federal agencies and the DON to address the future growth of national broadband capabilities.

To facilitate cutting-edge wireless technology in the United States, a Presidential initiative announced a timetable to make 500 MHz of spectrum available to national broadband corporations. Though that effort generated $41 billion dollars in revenue, continuing to auction spectrum is not realistic or sustainable given the finite nature of spectrum and the military's dependence on it for mission critical systems/equipment. Thus, the current commercial broadband licensing and relocation efforts are unlikely candidates to support future wireless innovation.

A new model is needed. We must eliminate the idea that wired and wireless capabilities are separate networks. Even though most wireless services "ride" on a wired infrastructure, they are not fully integrated in a manner that will meet future requirements. They must evolve into a 100 percent shared architecture, including enterprise, data, transmission, telephony, and wired architectures.

Integration within a shared architecture will provide a foundation that allows every home to act as a communication node and will transition our highways into low-powered radio frequency

environments to support expanded mobile cellular access. In addition to other benefits, expanded mobile cellular access will develop the necessary capabilities to support unmanned aerial systems (UAS) integration into National Airspace Systems (NAS) (i.e., aircraft using U.S. airspace).

Unmanned Aerial Systems Integration

The expansion of U.S. wired and wireless technology integration provides the groundwork for unmanned aerial systems integration into National Airspace Systems because it requires a solid-wired infrastructure with capable wireless networks. Cellular providers' infrastructure may provide the needed coverage to incorporate unmanned aerial systems into National Airspace Systems with minor changes in the methods of employing their antennas' technology.

Today's limited antenna panel technology provides a capability primarily to ground-based cellular communications and remains a two-dimensional service-oriented architecture. To evolve and support autonomous operations, future antenna panel technology will need to support a variety of dimensions and will have to deliver radio frequency communications coverage on land and in the air. Because cellular technologies provide a solid network infrastructure to authenticate, track and update instructions to unmanned systems, successful antenna panel technology advancements will facilitate the integration of autonomous/robotic technologies, such as driverless car technology.

Autonomous/Robotic Technologies

Autonomous/robotic technology innovation will require a fully wired and wireless environment. Currently, we are failing to utilize the full capabilities of wireless communication capabilities. If we consider every home and every highway as a potential communication node, we could develop a solid infrastructure that has a low-powered capability to focus U.S. controlled radio frequency spectrum in specific areas.

Additionally, the innovation in white LED visual lighting communications research provides a valuable means of providing short radio wave support to a variety of communication systems in our neighborhoods. This would provide an efficient method to ensure autonomous technology capabilities have the ability to communicate anywhere we require lights, such as highways.

Sensors onboard autonomous vehicles will load balance the highway and aerial flight routes while appropriately adjusting to various environmental conditions, hence making the most efficient use of available space. Traffic jams and delays will be reduced significantly because software will be able to make decisions about the obstacles that lead to traffic congestion. The result will be autonomous travel becoming more efficient.

Additionally, these technologies will lead to greater innovation in solar technology that can deliver reusable power anywhere, such as along remote stretches of highway that do not have active power sources but could be outfitted with solar energy devices to power communication devices. The integration of autonomous vehicles and robotics will require radical changes in national spectrum-sharing policies, but such integration will transform the way we communicate.

Military Operations

Military operations will evolve to standardized software and hardware interfaces with full communication integration across all of DON networks, with the ability to transition over several frequency bands across several networks automatically, similar to the 4G technology used in cellular services today.

Even though the concepts of LTE-Advance and 5G cellular technology will be integrated into military radios, it will be important to maintain legacy capabilities that ensure older tactics, techniques, and procedures are understood for all possible military contingencies. A good example of a future innovative application of licensed spectrum is telephony switching software that will allow flash override capabilities, providing the ability to preempt a user out of a particular frequency band and into another if needed in an emergency situation.

This functionality will significantly enhance U. S. contingency operations, humanitarian assistance, and large-scale training requirements. Shared architectures with 20 or 30 wideband channels will not only provide the needed technology to employ the required future architectures of the Department of Defense, they will also provide multiple layers of network security from cutting-edge commercial and federal organizations.

Conclusion

Ensuring ongoing advancement in spectrum-dependent operational areas, such as those mentioned above, includes reevaluating the concept of spectrum licensing ownership and establishing methods to integrate U.S. cable and wireless capabilities. Full integration of wireless and wired technologies will provide the foundation to evolve mobile, unmanned systems, autonomous vehicles and military technology along with innovation in LED communications.

Shared architectures will not only facilitate innovation, they will also enable enhanced security by layering commercial and military security capabilities. By 2035, unmanned aerial systems will be integrated into National Airspace Systems. In 2045, autonomous vehicle technology will be fully integrated. By 2050, military software and hardware architectures will use multiple methods to mask their communications among several frequency bands shared across the common infrastructures, and they will be undetectable based on the multiple bands of operations.

To fully utilize the benefits of sharing spectrum, the DON will determine the pros and cons of using commercial bandwidth to complement its military nodal communication requirements. In any case, today's spectrum-related business processes will require updating to support the rapid growth in future spectrum-dependent technologies.

For more information about DON spectrum policy and initiatives, visit the DON CIO website: www.doncio.navy.mil