Multi-Level Adaptive and Reconfigurable Wireless Systems for Spectrum Sharing

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As wireless spectrum becomes a scarcer commodity, a paradigm shift is needed for sharing spectral resources. Presently, wireless spectrum use is slowly evolving from rigid assignments to spectrum sharing in limited bandwidth areas. However, the present slow evolution toward spectrum sharing will not be fast enough to keep up with the rapidly increasing demands for bandwidth by new wireless technology. A holistic paradigm shift is needed at all levels, from the spectrum policy to the electronics that perform transmitter and receiver functions.

The concept of an adaptive and reconfigurable wireless system begins with spectrum policy: an adaptive policy is needed that can create and modify itself in real time based on the demands of the situation. Decisions about spectrum allocation must be made in real-time, not over years of debate and resolutions by international organizations. The political framework must be adapted to allow real-time, artificially intelligent allocation decisions.

Adaptive spectrum usage between similar and different types of systems must be investigated. Sharing between future-generation wireless communication systems, radar systems, and critical passive systems (such as radio astronomy, weather radiometers, and remote sensing) is tricky because of the special requirements of some of these systems. Radar systems transmit only part of the time, and passive systems do not transmit at all, making spectrum sensing, at best, partially effective in determining available spectrum. Security issues with military systems are important.

Finally, breakthroughs in capabilities for reconfigurable arrays, circuits, and systems are needed to technically enable high-performance adaptive systems. For example, circuit reconfiguration in transmitter power amplifiers can allow maximum performance over a high tunable bandwidth, whereas fixed broadband circuits limit the range that can be transmitted. Adaptive arrays with reconfigurable circuits also will allow maximum system power efficiency while maintaining beam fidelity through linearization of transmitter amplifiers, providing the capability of fast beam steering and unlocking space as an additional dimension of wireless coexistence. This is possible for array systems in traditional frequencies (such as radars) and also for millimeter-wave next-generation systems, where very large arrays can be fabricated with small footprints. It is possible that future adaptive systems will also have the capability of performing active interference cancellation to mitigate interference from various radiating sources and scattering centers.

The presentation describes the development of a national center for spectrum research that will enable simultaneous, multidisciplinary research initiatives enabling this new paradigm shift. The parallelization of research at all levels will exponentially speed the paradigm shift to share spectrum, unlocking new capabilities for all wireless users.