Dynamic Spectrum Collaboration Between Radar and Wireless Communication: A Proposed Framework for the Simultaneous Optimization of Policy, Network, and Circuits

Charles Baylis[*(1)], Robert J. Marks II[(1)], Liang Dong[(1)], Andrew Clegg[(2)], Lawrence Cohen[(3)]
(1) Wireless and Microwave Circuits and Systems Program, Department of Electrical & Computer Engineering, Baylor University, Waco, TX, USA
(2) Google, Reston, Virginia, USA
(3) Naval Research Laboratory, Washington, DC, USA

Dynamic spectrum sharing and allocation is becoming necessary due to the shortage of available spectrum for pre-allocation. To make such allocation realistic, systems with reconfigurable transmissions and circuitry must be controlled by an adaptive physical layer and connected using ad-hoc networks, with flexible policies that allow pragmatic sharing. Fortunately, the developments in each of these disciplines is significant enough to support the idea of collaborative sharing within a System of Systems (SoS).

This presentation describes a top-down approach in which a future SoS could be optimized for useful coexistence between communication and radar systems in a given geographic environment. A dynamic spectral mask can be created for each spectrum user's transmission (Latham *et al.*, 2016 Texas Symposium on Wireless and Microwave Circuits and Systems) by applying dynamic spectrum decision-making through an ad-hoc network connecting all wireless devices within a given geographic region. Based on the allocations, an operating frequency or spectral mask can be communicated to each device through the ad-hoc network. The physical layer can be adapted to match the needed protocol, and the circuit and waveform of the radar or communication transmitter can be adapted to optimize performance while meeting the spectral mask.

An examination of presently existing policies shows that spectrum sharing has already been implemented in some bands. The 3550-3700 MHz band is an example of a three-tiered spectrum sharing framework. A significant missing piece of the framework in this band, however, is the adaptation of the incumbent government radar system in a manner that makes it more amenable to sharing. The ability of the radar to adapt will be needed in any band where sharing between radar and communications is planned. Physical layer adaptation has been demonstrated in the area of software-defined radio. Recent circuit optimization techniques (Fellows, *IET Radar, Sonar & Navigation*, 2015) bring radar closer to realistic spectrum sharing. The development of high-power reconfigurable circuit technology will be a significant next step toward radar frequency flexibility. An approach for developing new dynamic spectrum sharing policy for systems including flexible radars is discussed. Spectrum sensing and sharing optimization can be performed using game theory with spectrum sensing in guard bands (N. V. Khambekar, *Proc. IEEE Wireless Communications and Networking Conference*, Mar. 2007). The information would be communicated to each system through an ad-hoc network to each system, which would then optimize its circuitry.

This presentation overviews research developments and remaining roadblocks to be overcome at the policy, system, network, and circuit levels for collaborative dynamic spectrum sharing between radar and communication systems to become a reality.