

# WSRD Workshop IX

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## Radio Receiver Systems:

### R&D Innovation Needs and Impacts on Technology and Policy

*May 05, 2017, Arlington, VA*

## Workshop Synopsis

Principles of co-existence and interference tolerance are often overlooked and under-exploited in today's radio receiver systems. For example, a receiver's ability to accept wanted signals or reject unwanted signals impacts the quality of the information transmitted. The Wireless Spectrum R&D Interagency Working Group (WSRD) will hold a workshop, "Radio Receiver Systems: R&D Innovation Needs, and Impacts on Technology and Policy", on May 5, 2017, from 8:00 AM to 5:00 PM at the National Science Foundation, Arlington, Virginia. The workshop will address various signal reception topics including technology advances for receivers, transmitters, filters, antenna design, signal processing techniques, and policy issues.

Even as additional radio frequencies are being available in the U.S., such as the move to open up several millimeter-wave bands, the nation's radio spectrum continues to get more congested. With the continued proliferation of bandwidth hungry devices, including the IoT, the need for innovation in radio receiver technology is believed to be an important step toward making spectrum coexistence more successful. For example, recommendations have been made in reports coming out of the FCC's Technology Advisory Council, and the European Union recently published a new Radio Equipment Directive (RED) that includes guidance on receivers. The overall goal is to help build trust between Federal and non-Federal operators and spectrum users. Hence, co-existence within the spectrum bands and with adjacent bands, for both licensed and unlicensed users need to be effective, efficient and trustable. While focus has been on the transmitter side of the radio system in the past, focusing on the receiver systems early in the next generation technology development process has been identified as an important step in assuring interference tolerance.

This workshop will provide a forum for information exchange and the identification of relevant radio receiver systems research and development opportunities. WSRD members across multiple federal agencies will use information gathered from this workshop to develop recommendations for their agency-specific research agenda.

## Workshop Goals:

- Outline the wireless spectrum sharing receiver needs, scenarios and issues for the short-term and long-term.
- Discuss the technology and regulatory frameworks that can deliver appropriate receiver solutions, including those needed for emerging IoT scenarios.
- Identify innovative tools, techniques, experimentation, and recommendations for additional research.

## Workshop Panels

This workshop will have a moderated opening panel followed by three all-participants brainstorming sessions and a final moderated summary panel session to discuss the overall research recommendations. The opening panel will identify the need for receiver technology innovation and policy innovation, and identify the gaps for the workshop participants to explore. The brainstorming sessions will have three brief ice breaker remarks from pre-identified speakers to kick-start discussions. Facilitators will then guide the brainstorming and keep the discussions on track. The research recommendations generated in the brainstorming sessions will be presented at the summary session and will be used to formulate WSRD R&D recommendations and the workshop report.

### Session I: Characteristics Needed in the Radio Receiver System

Engineers must consider a wide variety of technical parameters when designing a receiver. Each of these involve various trade-offs to arrive at an optimal design for a particular radio environment and mission. This session will explore these technical characteristics to draw conclusions regarding what parameters are the most important and at what benefits and costs, in terms of the ability to receive only the wanted signals. These parameters include RF range, bandwidth, sensitivity, ability to reject unwanted signals (adjacent band, intermodulation, etc.), dynamic range, and noise figure. This discussion will consider the whole receiver system, which includes the antenna characteristics, new algorithms, policy management, associated transmitter characteristics, potential security issues etc. Key discussions could include:

- What are the limits of current receiver(s) technology? Consider licensed/ unlicensed, narrowband/ wideband, low-cost/high-cost systems etc.
- What gaps exist in receiver system characteristics that impact receiver systems design from a spectrum co-existence or sharing perspective?
- What are the implications of the various technical parameters in terms of receiver performance and costs, including IoT devices?

### Session II: Radio Receiver Systems Technology R&D

Radio receiver systems are constantly evolving to meet changing needs including operating in multiple frequency bands, implementing new and varied policies, new and expanding application environments. Building upon the discussions in session I, this session will explore technology developments already in progress across the government, industry and academia, and discuss further innovation needs:

- What are emerging technologies that will extend the current limits on receiver technology to include characteristics of antenna directionality, dwell times, selectivity curves, and interference thresholds?
- What are the roles of various receiving systems components? What are the state-of-the-arts in filter technologies? What improvements are likely to happen in the next five years?

- What technologies and toolsets should be developed in hardware vs. software? What are the implications in terms of performance and costs?
- What are the challenges and implementation considerations between wideband versus narrowband receivers?
- What technologies in the research pipeline may be commercialized in the near future?
- How can receiver performance improvement facilitate coexistence between multiple, diverse radio services?
- What are the types of security threats to receivers? What steps can be taken to mitigate them?

### **Session III: Implementation and Adoption of Radio Receiver Technologies**

Incentives beyond the technology aspects discussed in the first two sessions are needed to drive adoption of new receiver technologies. These may include research on policy needs, certification, enforcement, etc. This session will explore the engineering and institutional tools required to provide the proper incentives to foster user adoption from explicit receiver specifications to coexistence rules and trust therein. Key research and development questions include:

- What obstacles exist in the R&D pipeline hindering the use of these technologies, and how might they be overcome?
- What is the role of private sector initiatives and consortiums like standards bodies and multi-stakeholder organizations? Are any new standards, frameworks and/or guidelines required?
- How can test, certification and supply chain incentives be used to improve the interference robustness of receiver systems?
- What type of experimentation and verification may be needed to prove maturity, earn trust, and exhibit technology readiness? What type of metrics may be needed to make the case; from receiver degradation risk assessments and confidence intervals to measured interference thresholds and receiver sensitivities?
- What is the role of administrative incentives like directives and regulations? What kinds of rules, if any, would most effectively lead to desired outcomes?