NSF supported Workshop Series on National Radio Dynamic Zones

Executive summary based on the first six months of the initiative

Prepared by Mariya Zheleva and Christopher Anderson

The National Radio Dynamic Zones (NRDZ) workshop series began with a kick-off event on November 10, 2020[1] to bring together the community to explore the key research topics necessary to fulfill the vision of an NRDZ as well as inform quarterly workshops for a deeper technical dive around issues concerning the NRDZ design, collaboration and publication of research ideas and results. The kick off meeting was followed by a Lean Coffee event on January 7, 2021[2], which gathered input from the community to inform our first workshop. We held our first workshop on March 16-17, 2021 on the topic "Passive/Active communities working together: Understanding each other's needs, concerns, and capabilities"[3].

Our activities so far have focused on understanding key stakeholder spectrum needs and investigating how these needs can be accommodated through technological development and experimentation in an NRDZ. Following the kick-off meeting and the Lean Coffee event, it was clear that one of the most pressing issues is the NRDZ support of coexistence between scientific users and commercial broadband technologies. In response, our first workshop hosted (i) tutorials from scientific spectrum users aiming to educate the active communications community on topics around scientific spectrum use; (ii) a fireside chat between active and scientific spectrum stakeholders, (iii) a panel discussion and (iv) breakout room discussion and brainstorming. Some of the key findings from out efforts so far include:

- Coexistence across disparate technologies. The demand for increased spectrum is two-way: commercial broadband services are seeking to expand into new spectrum and passive scientific services increasingly sense outside of their exclusively allocated bands. An NRDZ should foster research methodologies to enable coexistence across the broader RF user community and support test, evaluation, and demonstration of those techniques. These efforts should consider all coexistence degrees of freedom -- time, frequency, space, and geometry, along with unique user needs. For example, coexistence issues with Radio Astronomy (RA) are different from those with Earth Exploration Satellite Service (EESS): while RA traditionally explores spatial exclusion zones, this approach is not feasible for EESS. In addition, coexistence between scientific and commercial spectrum users should accommodate for the large difference in the sensitivity levels between commercial and scientific technologies. An NRDZ will allow development and evaluation of coexistence techniques in a carefully controlled and monitored environment.

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[1] The kick-off was attended by over 50 participants from academia and government agencies. More information about the agenda, summary and recordings can be found on the event website: http://www.cs.albany.edu/nrdz-ra/meetings/kick-off/

[2] The lean coffee event was attended by 15 participants mostly from academia. The participants brainstormed on the theme and technical questions to be tackled during the first workshop.

[3] The first workshop was attended by over 50 participants mostly from academia and the industry. More information about the agenda, summary and recordings can be found on the event website: http://www.cs.albany.edu/nrdz-ra/meetings/workshop1/

- Cross-community education on existing capabilities and needs. Cross-education across spectrum stakeholders is key to the success of an NRDZ, as all users must understand each other's needs and capabilities as they work out ways to share a common resource. For example, active users would greatly benefit from a deeper understanding of the sensitivity levels, and temporal properties of scientific applications' spectrum use and instrumentation operation. Similarly, scientific users would benefit from understanding current commercial coexistence mechanisms, such as the 3.5 GHz CBRS and 5.8 GHz DFS systems. In both cases, stakeholders could utilize an NRDZ to explore how existing and future techniques would either enable or impact passive/active sharing.

- Building trust. Trust among disparate users of spectrum inside an NRDZ will be essential to the viability and success of the NRDZ. The NRDZ infrastructure must facilitate the exchange of data between entities with potentially contradicting interests and varying resource availability. Furthermore, the NRDZ will need to incorporate privacy-preserving data sharing mechanisms, RFI data benchmarks, and adequate policy frameworks. Technologies with vastly different resource capabilities and communication protocols will need to interact with the NRDZ control infrastructure. Legacy users may not have the resources to adapt to a new implementation/coexistence structure; techniques to bridge this gap should be available. Additionally, data types and incentives for the sharing of data across disparate technologies will need to be developed and implemented with best practices to ensure data accuracy, reliability, non-repudiation, privacy, and message integrity. An NRDZ can also be used to build trust on the effects of RFI from commercial services to the performance of important scientific spectrum applications. Finally, as technical mechanisms for sharing spectrum are developed, an NRDZ can be used to build and develop trust that wider deployments of these mechanisms will be viable.

- Perceived advantages of an NRDZ and necessary resources. A key advantage of an NRDZ will be to quantify and characterize radio frequency interference (RFI) and the net harm from out of band and in-band emissions to all users. An NRDZ could also help "ground truth" the effects of RFI by controlled injection of interfering signals into scientific measurements. Having such a ground truth can have positive effects on establishing scientific-commercial spectrum sharing. In particular, it could be possible for scientific users to request and receive "quiet" sections of spectrum outside of their dedicated and allocated bands. Further, an NRDZ will facilitate the exploration of scheduling methodologies to allow automated coexistence between scientific, commercial and defence spectrum users. These technologies can then be integrated into a system for spectrum sharing across all users, everywhere and at all times.

- Size of an NRDZ. While the topic of NRDZ size needs further exploration, many stakeholders have widely varying size requirements. Low-power active users may require a fairly small region, RA and EESS-type systems may need vast geographic areas[4]. Also, testing or evaluation of commercial-scale deployments or aggregate RFI effects will require very large geographic areas. These disparate needs may mandate different tiers of spatio-temporal coexistence and multiple NRDZs.

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[4] For example, the footprint of an L-band EESS sensor is 50x50km.