# An Experimental Test-bed for Investigating Spectrum Sharing Strategies Between Passive and Active Users at a Prototype National Radio Dynamic Zone (NRDZ)

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The University of Colorado, Boulder (CU), has been collaborating with the Hat Creek Radio Observatory (HCRO) and UC Berkeley (UCB) to prototype a National Radio Dynamic Zone (NRDZ) which facilitates spectrum sharing between Radio Astronomy (RA), and active users of the electromagnetic spectrum.

We have previously reported (NRSM 2023, 2024) on the design, installation, and commissioning of auxiliary sensors, co-located with the Allen Telescope Array (ATA) at HCRO, in order to measure the local radio-frequency climate, and experimental deviations from this baseline (Tschimben et al, 2023a). Here we provide updates, and further observations from this monitoring system – focusing on persistent sources of spectrally static RFI in the vicinity around HCRO, and the utilization of these signals for vicarious system health checks.

The team has also continued to develop a Satellite Spectrum Data-Base (SSDB) – cataloguing both orbital, and RF transmitter information of these sources of interference that can (and do) afflict even the remotest of terrestrial radio observatories (DiVruno et al, 2023b). We present salient details of the design of this database and solicit active community participation for its operational expansion. Experimental results of the use of the Satellite Orbit Pre-Prediction (SOPP) package, developed as part of the aforementioned suite, are also discussed – where overflights of the ATA by a designated satellite are 'validated' (and accuracy quantitatively established) via single-dish observations of the power spectral density over time. These measurements are compared to link-budget based models, seeded by various transmit/receive parameters from the SSDB. We also describe trials of the SOPP package by other stakeholders, and for tracking members of the exponentially growing NGSO (Non Geo-Stationary Orbit) satellite internet provisioning constellations, in order to compile statistics of satellite-free observation windows. Work is also being conducted on a common data-sharing standard to facilitate exchange of Radio Astronomy Operational Schedules (RADOS) between RA stakeholders and co-operating communication providers.

In addition, we are now also collaborating with the University of Utah, who have developed the OpenZMS (Zone Management System) on the POWDER-RDZ (Platform for Open Wireless Data-driven Experimental Research-RDZ), to broker Spectrum Access between ATA observations (RA as the incumbent), and three of their SDR (Software Defined Radio)-based transmit nodes, installed on location at HCRO (Johnson et al, 2024). These transmit nodes serve to emulate a co-operative, secondary active user (wireless communications) in the RDZ. Complete knowledge of signals transmitted via these nodes (transmit power, antenna radiation pattern, data-stream, encoding, modulation, polarization etc.) allows for simulation of the setup within an OpenZMS hosted Digital Spectrum Twin (DST), and with physical propagation models such as TIREM (Terrain Integrated Rough Earth Model), which can carve out additional parameter space for spectral co-existence. Experiments utilizing single-dish observations of the transmit nodes also allow for trialing rogue source geolocation algorithms, and furthermore: full control and information of the intentional interference signal also facilitates its excision from the RA observation pipeline. These study designs and outcomes are outlined herein.