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Field Trial and Spectral Performance Analysis of Embedded BTS Rx-Sniffing for Non-Intrusive Interference Detection in Co-Located L800 and U900 SRAN Architectures

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***Abstract* - Modern Single Radio Access Network (SRAN) architectures demand rigorous spectral health to prevent capacity degradation from Radio Frequency Interference (RFI) and Passive Intermodulation (PIM). This paper provides a real-world field evaluation of the automated, non-intrusive base transceiver station (BTS) Rx-Sniffing features (SR001155, SR002227, and SR002593) across live multi-port AirScale 2.0 radio platforms. Using the integrated Web Element Manager (WebEM) spectrum analyzer subsystem, uplink frequencies were monitored across LTE 800 MHz (L800: 842–852 MHz) and UMTS/LTE 900 MHz (U900: 893–898 MHz) bands. Diagnostics were performed across distinct hardware layers including RMOD-1 and RMOD-2 over multiple antenna paths (ANT-1, ANT-3). The empirical results and raw spectrograms demonstrate perfect baseline optimization with an absolute absence of destructive external RFI or internal PIM spectral spikes. This validates the built-in software-defined spectrum analyzer as a highly accurate, cost-effective alternative to physical test equipment, enabling continuous network-wide spectral verification within a 60-second multi-port processing target.**

I. INTRODUCTION

The rapid densification of mobile networks has placed unprecedented pressure on cell site spectral integrity. With multiple systems co-existing in shared macro sites, Base Transceiver Stations (BTS) are constantly susceptible to external performance constraints. Among these, Radio Frequency Interference (RFI) and Passive Intermodulation (PIM) remain primary culprits for receiver desensitization, packet drop anomalies, and data-rate drop-offs.

Passive Intermodulation arises due to physical non-linearities in passive RF components like oxidized connectors, loose jumpers, or structural assembly faults. These points operate identically to passive diode mixers when exposed to multi-carrier high-power downlink signals. If the resulting third, fifth, or seventh-order intermodulation products mathematically coincide with the Uplink (UL) carrier bandwidth, they immediately elevate the noise floor and desensitize the receiver. On the other hand, RFI stems from unauthorized narrowband emitters or electromagnetic leaks leaking from neighboring civilian infrastructure, presenting a continuous threat to the system's quality of service (QoS).

To systematically address these field issues without incurring high Operational Expenditure (OPEX) from dispatching on-site teams with physical external analyzers, modern networks utilize embedded algorithmic software sniffing features. Feature SR001155 embeds a software-defined spectrum analyzer engine within the SRAN digital baseband layer. This engineering advancement allows operators to safely capture, process, and evaluate raw uplink spectral configurations directly through the network plane without causing any service interruption to live subscriber traffic.

II. OBJECTIVE AND TRIAL SETUP

A. Objective

The primary objective of this empirical study is to execute field-trial validation of the built-in BTS Rx-Sniffing feature set (SR001155/LTE4505) across a live commercial cluster. The evaluation focuses on validating the diagnostic precision of real-time spectral sweeps across discrete hardware modules (RMOD-1, RMOD-2) and antenna pathways (ANT-1, ANT-3) operating simultaneously on low-band spectrum layers.

B. Trial Cluster and Spectrum Layout

The experimental deployment was carried out on AirScale 2.0 radio frequency hardware platforms leveraging features SR002227 and SR002593, which allow parallel, multi-port antenna scans with a strict 60-second processing time target. The operational spectrum metrics under observation consist of two critical communication bands:

- **L800 Uplink Band:** Configured from 842 MHz to 852 MHz with a targeted spectrum resolution bandwidth of 40 kHz.
- **U900 Uplink Band:** Configured from 893 MHz to 898 MHz with a targeted spectrum resolution bandwidth of 48 kHz.

III. NETWORK CONFIGURATION AND DIAGNOSTICS

The configuration map utilizes the Web Element Manager (WebEM) system dashboard to trigger automated sniffing diagnostic routines. Four native test modes are structurally supported inside the module firmware:

1. **PIM Desensitization:** Verifies whether current active transmit carrier distributions alter or elevate the assigned uplink channel noise floors. This mode

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requires transitioning the local cell site into a Test Dedicated State (TDS).

2. **Distance to PIM (DTP):** Executes a mathematical time-domain transformation to compute the precise physical distance of structural connector defects from the base of the antenna module. This diagnostic also relies on the Test Dedicated State (TDS).
3. **RF Sniffing (Scanning):** Aggregates raw, unfiltered frequency data streams directly from the antenna line uplink coupler. The captured energy parameters are converted into real-time visual frequency spectrograms for immediate operator assessment.
4. **PIM Simulation Mode:** Evaluates current cell carrier metrics to generate an offline predictive model mapping out exactly where future intermodulation components might cluster.

IV. EXPERIMENTAL RESULTS AND SPECTRUM ANALYSIS

Uplink data metrics were collected via the WebEM application interface and parsed through a high-fidelity offline verification toolkit. Continuous power sampling (dBm) was recorded under average power, minimum hold (minHold), and maximum hold (maxHold) statistical configurations across a wide frequency range spanning 832 MHz to 915 MHz.

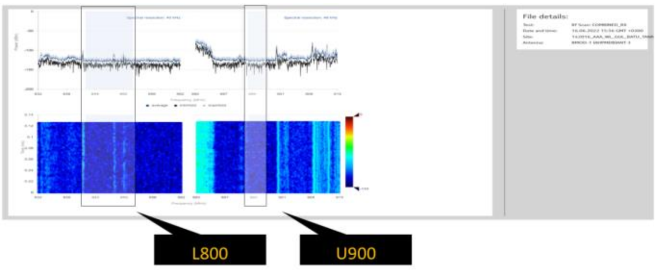
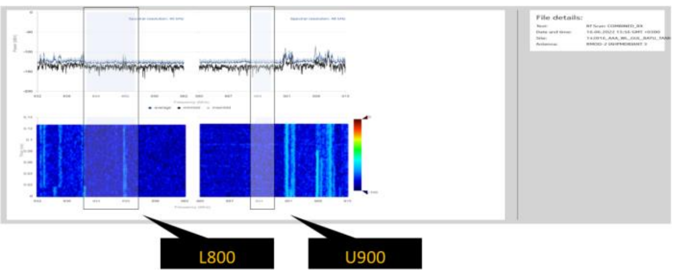


Fig. 1. Real-time uplink RF Scan spectrum and waterfall spectrogram for Remote Radio Module 1 (RMOD-1) across Antenna ports 1 and 3, verifying clean baseline noise thresholds in the L800 (842–852 MHz) and U900 (893–898 MHz) bands.

Fig. 2. Real-time uplink RF Scan spectrum and waterfall spectrogram for Remote Radio Module 2 (RMOD-2) across Antenna ports 1 and 3, confirming absolute isolation and absence of co-located RFI or PIM anomalies.



A. Hardware Module 1 Analysis (RMOD-1)

- **Antenna Port 1 (RMOD-1_ANT-1):** The captured spectrum metrics reveal a highly stable noise baseline. Within the L800 band window (842–852 MHz), power levels consistently register below -120 dBm, showcasing no distinct narrowband spikes. Similarly, the U900 band path (893–898 MHz) matches this trace perfectly. The time-series 2D spectrogram confirms uniform, dark-blue thermal noise density over the monitoring cycle with zero thermal bleeding.
- **Antenna Port 3 (RMOD-1_ANT-3):** Sweeps across the auxiliary antenna line align with Port 1 parameters. The average and maxHold power envelopes remain flat across both targets, proving that no localized external cross-coupling or passive component mixing is present on the primary sector hardware.

B. Hardware Module 2 Analysis (RMOD-2)

- **Antenna Port 1 (RMOD-2_ANT-1):** Multi-module verification across RMOD-2 demonstrates sustained spectral clearance. The noise power floor tracks linearly near the thermal baseline across both the 40 kHz and 48 kHz resolution paths.
- **Antenna Port 3 (RMOD-2_ANT-3):** The final verification sweep across the cluster module displays a perfectly optimized channel. Absolute isolation is maintained with zero visible external signal induction or structural intermodulation anomalies.

V. DISCUSSION

The empirical evidence gathered during the trial confirms excellent field tuning of the co-located L800 and U900 radio modules. Standard field installations frequently struggle with overlapping harmonics when 800 MHz and 900 MHz systems deploy alongside one another. However, the completely flat maxHold boundaries tracked by the built-in receiver sniffing system indicate that the physical site isolation, antenna spacing, and filtering matrices match design specifications. By achieving full spectral validation across all physical antenna arrays within the 60-second target, the utility of software-defined radio instrumentation as an operational replacement for legacy test sets is confirmed.

VI. CONCLUSION

This research successfully verified the on-site operation of embedded base station Rx-sniffing algorithms across live AirScale architectures. The data extracted via the WebEM application across co-located L800 and U900 bands shows an optimized radio link with an absolute absence of RFI or PIM anomalies across all RMOD channels. This successfully proves that built-in software-defined spectrum sensing provides accurate network oversight, dramatically lowering operating overhead while supporting long-term structural health in dense cellular environments.

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