

# A Comprehensive Analysis of Secondary Coexistence in a Real-World CBRS Deployment

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SPECTRUM

## INTRODUCTION

- CBRS, known as 3.5GHz mid-band cellular spectrum, operates over an unlicensed 150 MHz band from 3550 MHz to 3700 MHz [1].
- CBRS spectrum is divided into 15 channels, each 10 MHz wide, for a total of 150 MHz of spectrum.
- CBRS allows enterprises to own and operate their own private LTE/5G mobile networks without being tied to expensive/ complicated carrier contracts due to the unlicensed operation and its quick deployment.
- An alternative method of spectrum sharing is developed for the CBRS users, where three tiers of sharing are defined in the 3.5 GHz mid-band.

## Goal

- To understand how the spectrum is utilized in the CBRS band.
- To investigate the performance of Tier-3 users known as GAA, that utilizes CBRS channels whenever possible so as not to interfere with incumbents or PAL users.
- To investigate the impact of C-Band on CBRS

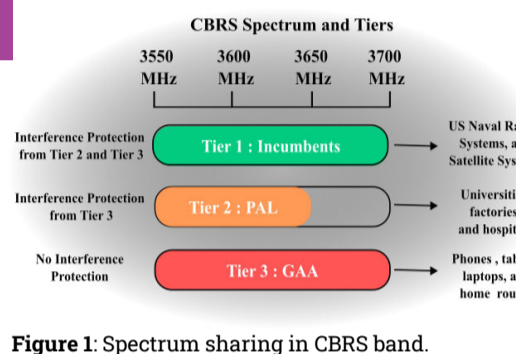


Figure 1: Spectrum sharing in CBRS band.

## Methodology

Table 1: Applications and tools used during the measurement campaign.

App./Tools	Features	Devices
SigCap	Operator, PCI, EARFCN, Band, Frequency, Altitude, Longitude, Latitude, RSRP, RSRQ, RSSI	1 × Google Pixel 5, 1 × Google Pixel 6, 1 × Samsung S21
QualiPoc	Operator, PCI, Band, Altitude, Longitude, Latitude, RSRP, RSRQ, RSSI, DL/UL Throughput	2 × Samsung S22
Handheld net. scanner & spec. analyzer	PCI, EARFCN, Frequency, Altitude, Longitude, Latitude, RSRP, RSRQ, RSSI	1 × Google Pixel 5 1 × Prism

Table 2: PCI and channel allocation usage by different base stations (BS).

Region	Height (m)	Channel Allocations (Center freq.)				
		3560 MHz	3580 MHz	3600 MHz	3670 MHz	3690 MHz
BS-1 (6 PCIs)	45		189	195	6, 150	169, 194
BS-2 (6 PCIs)	55		1		10, 200, 165	78, 69
BS-3 (4 PCIs)	33	14, 88	96, 26			
BS-4 (2 PCIs)	13		187, 46			

- Current deployment of CBRS technology in South Bend:

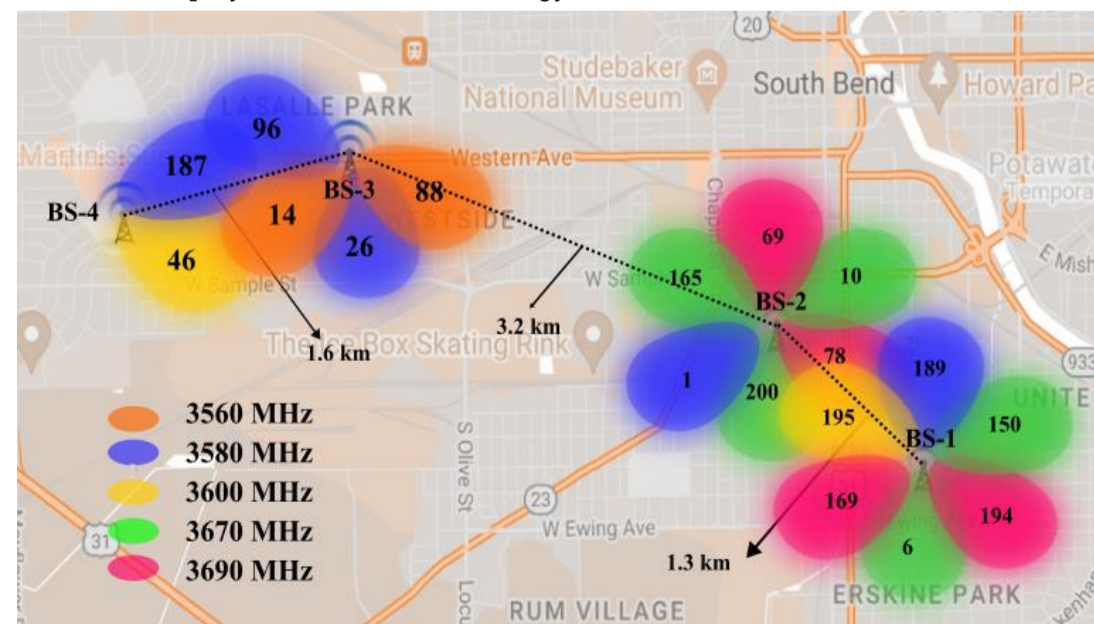


Figure 2: PCI and channel allocation for CBRS deployment in South Bend.

## MEASUREMENT CAMPAIGN

- In this work, an outdoor measurement campaign has been performed in South Bend, IN, USA for the existing three CBRS stations: 1) James Whitcomb Riley High School, 2) Ignition Park, 3) West Tower, and 4) Navarre Middle School.
- Driving measurement campaign with 20 miles per hour.
- Stationary measurements to evaluate adjacent channel interference (ACI) from C-Band to CBRS band.

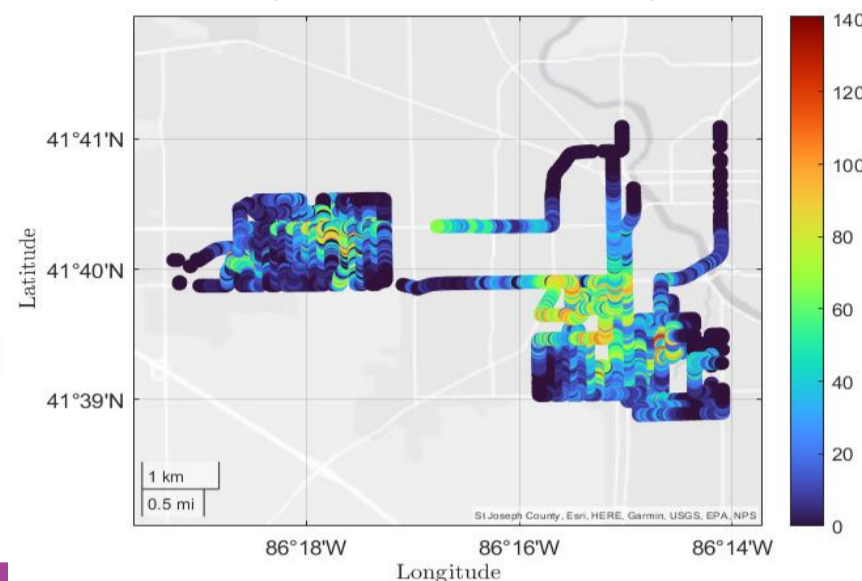


Figure 3: Throughput range for CBRS deployment in South Bend.

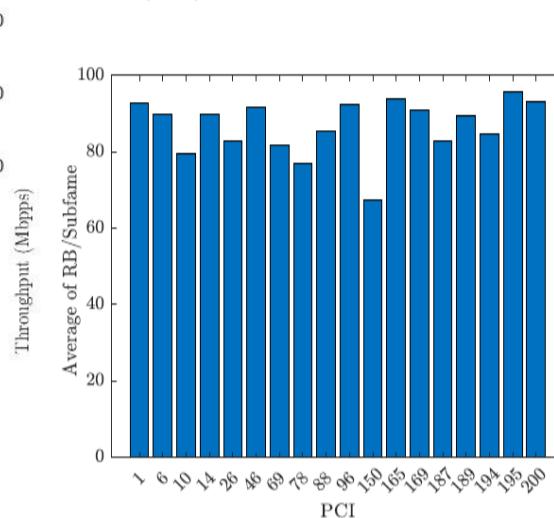


Figure 4: Average RBs/subframe per PCI.

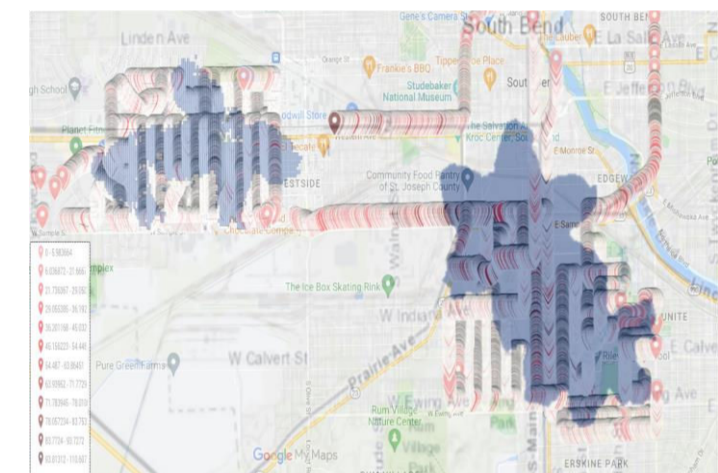


Figure 5: Predicted throughput coverage vs Observed throughput coverage.



Figure 6: The distance of measurement loc. from the BS-1 and nearby Verizon BS.

- We show statistical analysis of RSRP, and DL throughput. Specifically, cumulative distribution function (CDF) plots have been obtained to evaluate signal propagation and system throughput at different locations from the base-station.

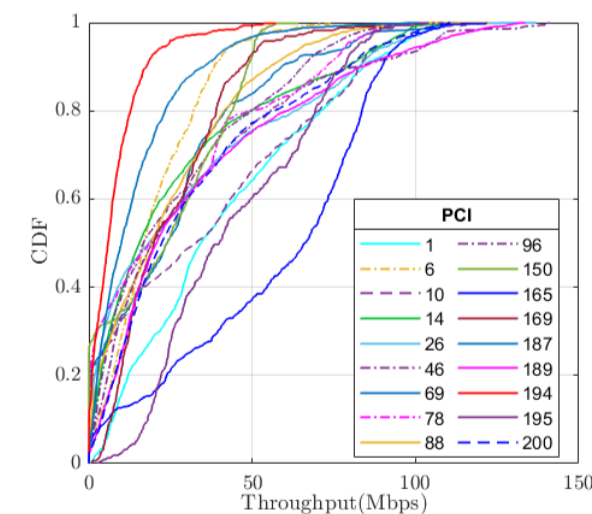


Figure 7: CDF of throughput for each PCI.

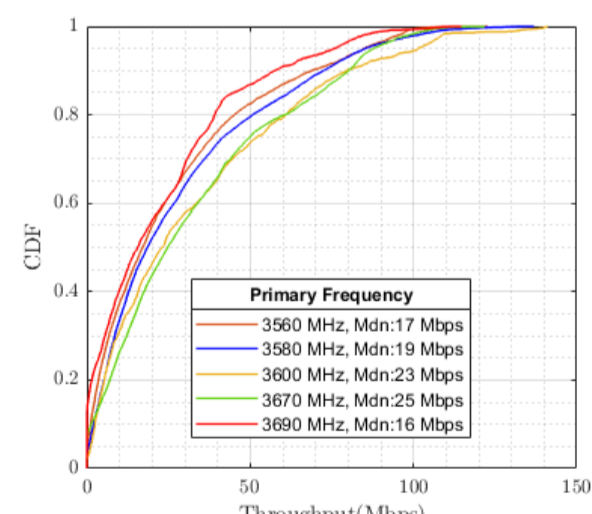


Figure 8: CDF of throughput for each frequency.

- New: Verizon's CBRS and C-band deployment in South Bend. CBRS channels being used overlap significantly with South Bend Potential adjacent channel interference from C-band into CBRS

## Acknowledgement

This work was made possible by the cooperation of the South Bend Community School Corporation and Motorola Solutions.

## References

- [1] Wireless Innovation Forum, Spectrum Sharing Committee, "Definitions Related to Commercial Operations in the U.S. 3550-3700 MHz Citizens Broadband Radio Service Band" available at: <http://www.wirelessinnovation.org/fcc-definitions>.
- [2] RP-170804 New W: LAA/eLAA for the CBRS 3.5GHz band in the United States, available at: <https://www.atis.org/wp-content/uploads/3gppdocuments/Rel15/ATIS.3GPP.36.790.V1500.pdf>
- [3] M. M. Sohel, M. Yao, T. Yang, and J. H. Reed, "Spectrum access system for the citizen broadband radio service," IEEE Commun. Mag., vol. 53, no. 7, pp. 22–28, July 2015.

## RESULTS & DISCUSSIONS

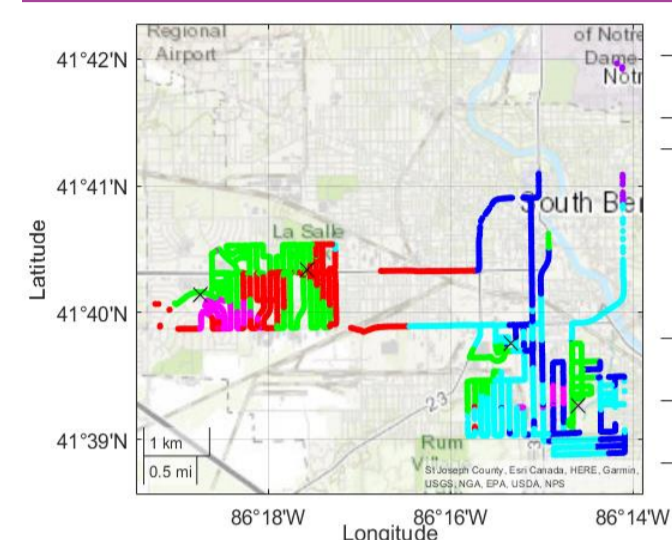


Figure 9: Frequency regions for CBRS.

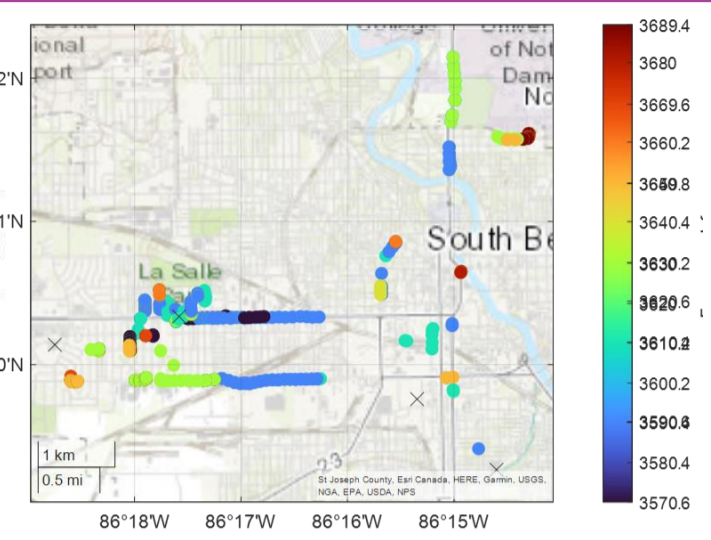


Figure 10: Frequency regions for Verizon CBRS.

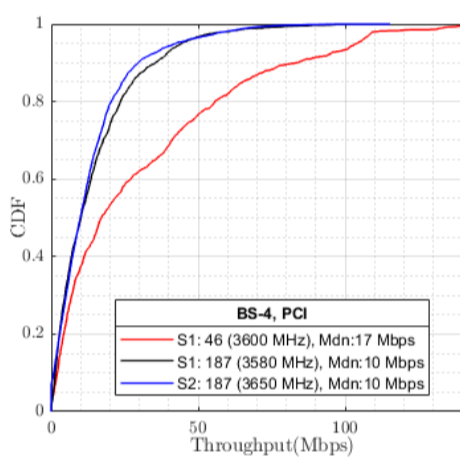


Figure 11: CDF of throughput for BS-3.

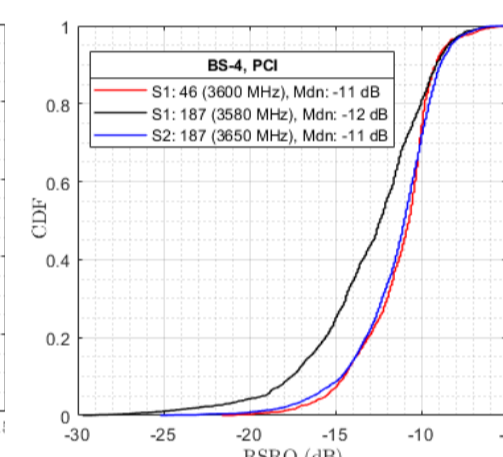


Figure 12: CDF of RSRQ for BS-3.

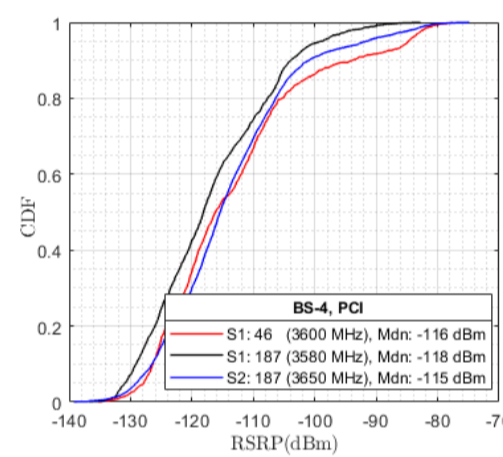


Figure 13: CDF of RSRP for BS-3.

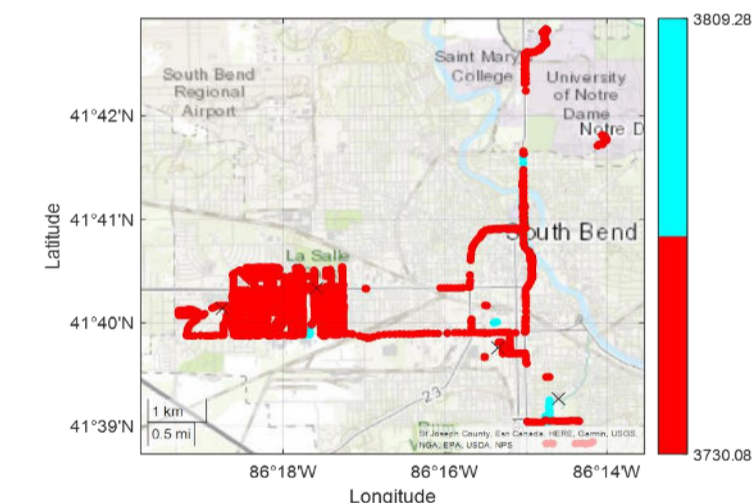


Figure 14: Frequency regions for Verizon C-Band.

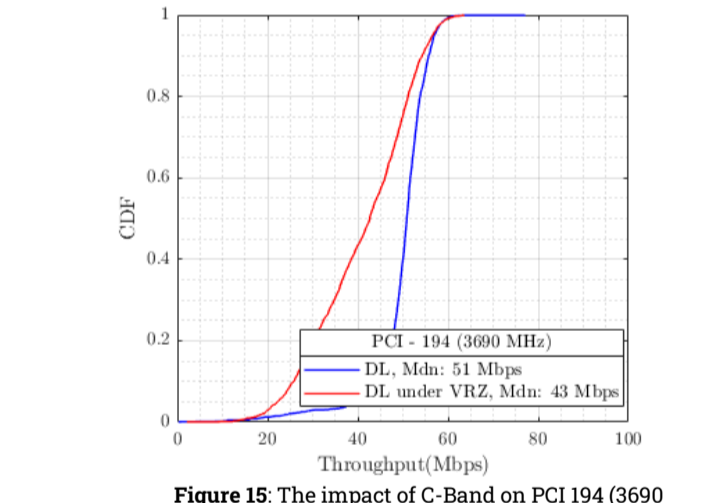


Figure 15: The impact of C-Band on PCI 194 (3690 MHz) at BS-1.

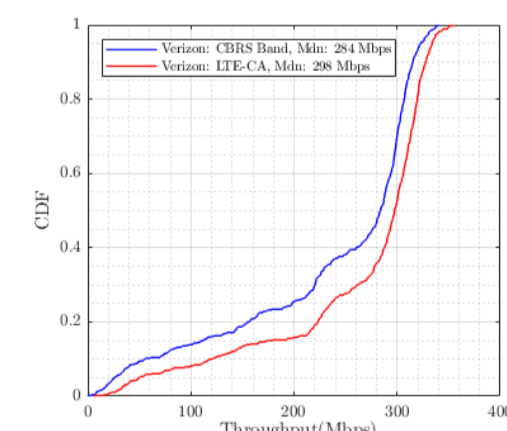


Figure 16: CBRS and LTE-CA throughput.

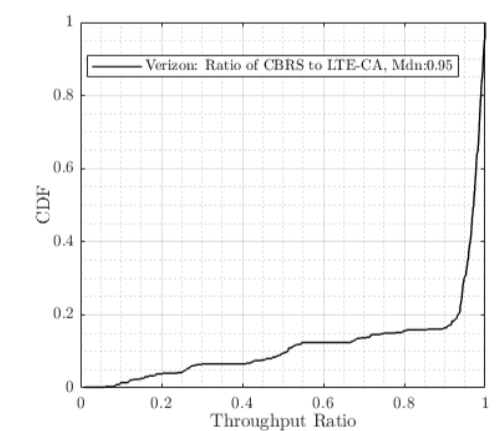


Figure 17: Verizon throughput with LTE-CA using CBRS.

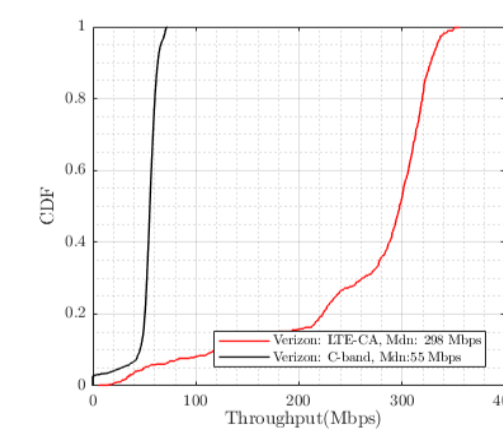


Figure 18: Verizon LTE-CA and C-band throughput.

## Conclusion and Discussion

- Google SAS shows that all 15 channels with 10 MHz bandwidth is available in the region of South Bend. However, the current deployment in South Bend focuses on only three GAA channels, i.e., 3580 MHz, 3670 MHz and 3690 MHz.
- It has been observed that less congestion in a channel result in higher throughput as can be seen via PCI 195 with the frequency of 3600 MHz.
- Frequency 3580 MHz is used by 2 PCIs (26,96) on West Tower, which overlap with Navarre (187), leading to lower throughput compared to PCI 46 at Navarre.
- Proposing alternate frequency assignments for South Bend CBRS in light of Verizon's deployments in C-band and CBRS. Therefore, it is necessary to evaluate the system performance considering different channel utilization and allocation schemes.
- Quantifying South Bend CBRS and Verizon deployments.