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Field Trial Assessment of 5G Dynamic Spectrum Sharing Using LTE-NR CRS Rate Matching

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***Abstract*—The growing demand for 5G services has created a significant challenge for mobile operators to expand coverage while efficiently utilizing existing spectrum resources. Dynamic Spectrum Sharing (DSS) has emerged as an effective solution that enables simultaneous operation of LTE and 5G New Radio (NR) within the same frequency band, allowing rapid 5G deployment without requiring dedicated spectrum allocation. This paper presents a comprehensive performance analysis of 5G Dynamic Spectrum Sharing (DSS) deployment in a live commercial network environment. The trial was conducted across multiple LTE Frequency Division Duplex (FDD) bands, including Band 28, Band 1, and Band 3, using CRS Rate Matching techniques to facilitate LTE-NR coexistence. Performance evaluation was carried out through drive test measurements, speed test analysis, and network KPI monitoring to assess the impact of DSS on throughput, coverage, spectrum utilization, and user experience. The results demonstrate that DSS successfully enables simultaneous LTE and NR operation while providing enhanced 5G coverage and service availability. Performance comparisons between DSS-enabled and dedicated NR deployments reveal that although DSS introduces certain spectral efficiency overheads due to resource sharing and CRS Rate Matching, it remains an effective solution for accelerating 5G rollout in spectrum-constrained environments. The findings confirm that DSS offers a practical and scalable approach for nationwide 5G expansion, enabling operators to maximize existing spectrum assets while maintaining acceptable network performance and user experience.**

***Index Terms*—5G New Radio (NR), Dynamic Spectrum Sharing (DSS), LTE-NR Coexistence, CRS Rate Matching, Spectrum Efficiency, Coverage Enhancement, Frequency Division Duplex (FDD), Network Performance, Drive Test Analysis, 5G Deployment.**

I. INTRODUCTION

The rapid growth of mobile broadband services, driven by high-definition video streaming, cloud applications, online gaming, and emerging digital services, has significantly increased the demand for enhanced network capacity and wider coverage. As mobile operators continue their transition from LTE to 5G, the availability of dedicated spectrum resources has become one of the primary challenges for large-scale 5G deployment. Although new spectrum allocations provide opportunities for enhanced capacity, many operators must initially rely on existing LTE spectrum assets to accelerate 5G rollout while maintaining service continuity for legacy LTE users.

Dynamic Spectrum Sharing (DSS) has emerged as an effective technology that enables the simultaneous operation of LTE and 5G New Radio (NR) within the same frequency carrier. Unlike traditional spectrum refarming approaches that require dedicated spectrum allocation for 5G services, DSS allows operators to dynamically allocate radio resources between LTE and NR users based on traffic demand. This capability significantly reduces deployment complexity and enables faster nationwide 5G expansion without requiring additional spectrum licenses or extensive network modifications.

The implementation of DSS relies on advanced scheduling and coexistence mechanisms, including Cell Reference Signal (CRS) Rate Matching, which allows 5G NR transmissions to avoid LTE reference signal resources. Through intelligent resource coordination, LTE and NR users can coexist within the same carrier while maintaining acceptable performance levels. However, the sharing of spectrum resources introduces additional overhead that may impact throughput and spectral efficiency compared to dedicated NR deployments. Therefore, understanding the performance trade-offs associated with DSS is essential for optimizing network deployment strategies.

This paper presents a comprehensive performance analysis of 5G Dynamic Spectrum Sharing deployment in a live commercial network environment. The study evaluates DSS operation across multiple LTE Frequency Division Duplex (FDD) bands, including Band 28, Band 1, and Band 3. Performance assessment was conducted using drive test measurements, throughput analysis, speed test results, and network key performance indicators (KPIs). The objective of the study is to evaluate the effectiveness of DSS in extending 5G coverage, maximizing spectrum utilization, and maintaining user experience while enabling efficient coexistence between LTE and NR technologies. The findings provide valuable insights into the practical benefits and limitations of DSS as a scalable solution for accelerating 5G deployment in spectrum-constrained environments.

II. OBJECTIVE AND TRIAL SETUP

A. *Objective*

The primary objective of this study is to evaluate the performance of 5G Dynamic Spectrum Sharing (DSS) in a live commercial network environment and assess its effectiveness as a solution for accelerating 5G deployment using existing LTE spectrum resources. The trial aims to investigate the capability of DSS to enable simultaneous LTE and 5G NR operation within the same frequency carrier while maintaining acceptable network performance and user experience.

In addition, the study evaluates the impact of DSS on key performance metrics including throughput, latency, spectrum utilization, and coverage enhancement. Special attention is given to the performance of DSS across multiple LTE FDD frequency bands, including Band 28, Band 1, and Band 3, where LTE and NR services coexist using CRS Rate Matching techniques. The trial also examines the trade-off between spectrum sharing flexibility and the potential throughput reduction caused by resource overhead associated with DSS operation.

Furthermore, the study compares DSS-enabled deployments with dedicated NR spectrum configurations to identify performance differences and practical deployment considerations. The overall objective is to validate DSS as a scalable and cost-effective approach for expanding 5G coverage, maximizing spectrum utilization, and supporting nationwide 5G rollout without requiring immediate dedicated spectrum allocation.

B. *Trial Cluster*

The DSS trial was conducted in a live commercial network environment using selected LTE Frequency Division Duplex (FDD) sites configured for LTE-NR spectrum sharing. The trial focused on evaluating DSS operation across multiple frequency bands including Band 28 (700 MHz), Band 1 (2100 MHz), and Band 3 (1800 MHz), representing both coverage-oriented and capacity-oriented spectrum layers commonly deployed in commercial networks.

The selected trial sites were configured to support simultaneous LTE and 5G NR transmissions within the same carrier bandwidth. Dynamic resource allocation was enabled through CRS Rate Matching, allowing NR transmissions to coexist with LTE reference signals while minimizing interference between the two technologies. The deployment was designed to simulate real network conditions and evaluate DSS performance under actual user traffic scenarios.

Performance measurements were collected under both stationary and mobility conditions to assess network behavior across different propagation environments. The trial cluster included coverage areas with varying radio conditions, enabling comprehensive evaluation of DSS performance in terms of throughput, coverage, spectrum efficiency, and user experience.

III. NETWORK CONFIGURATION

The trial network was configured using a Non-Standalone (NSA) 5G architecture, where LTE served as the anchor layer and 5G NR operated as a secondary node through E-UTRA NR Dual Connectivity (EN-DC). This architecture enabled LTE and NR services to coexist within the same Frequency Division Duplex (FDD) carrier using Dynamic Spectrum Sharing (DSS). By leveraging existing LTE infrastructure, the deployment allowed rapid introduction of 5G services without requiring dedicated NR spectrum allocation.

The DSS feature was activated across multiple FDD frequency bands, including Band 28 (700 MHz), Band 1 (2100 MHz), and Band 3 (1800 MHz). LTE and NR dynamically shared the available carrier bandwidth through intelligent resource scheduling and CRS Rate Matching mechanisms. This approach ensured efficient utilization of spectrum resources while maintaining service continuity for LTE users and providing access to 5G services for compatible devices.

To support LTE-NR coexistence, the network dynamically allocated resources between LTE and NR users according to traffic demand and network load. LTE remained responsible for control-plane signaling and mobility management, while NR provided additional capacity and enhanced user throughput. The deployment supported seamless interworking between both technologies, allowing users to benefit from dual connectivity and improved network performance.

Overall, the network configuration provided a flexible framework for evaluating DSS performance under live commercial conditions. The architecture successfully enabled efficient spectrum sharing, accelerated 5G deployment, and maintained stable LTE performance while supporting the gradual transition toward future standalone 5G networks.

IV. THEORETICAL BACKGROUND

Dynamic Spectrum Sharing (DSS) is a radio access technology that enables Long Term Evolution (LTE) and Fifth Generation New Radio (5G NR) systems to operate simultaneously within the same frequency band and carrier bandwidth. Unlike traditional spectrum refarming approaches, where spectrum is permanently reassigned from LTE to NR, DSS dynamically allocates radio resources between the two technologies according to traffic demand. This capability allows mobile operators to introduce 5G services rapidly while preserving LTE coverage and capacity for existing users.

The DSS implementation used in this trial is based on Cell Reference Signal (CRS) Rate Matching. In LTE networks, CRS signals occupy predefined resource elements that are continuously transmitted for channel estimation and mobility support. Since these resource elements cannot be reused by NR transmissions, the NR scheduler dynamically avoids CRS locations and allocates Physical Resource Blocks (PRBs) around them. This mechanism enables LTE and NR to coexist within the same carrier while minimizing mutual interference.

The total available bandwidth in a DSS carrier can be represented as:

$$B_{Total} = B_{LTE} + B_{NR} \tag{1}$$

where:

- B_{Total} represents the total available carrier bandwidth.
- B_{LTE} represents the bandwidth allocated to LTE users.
- B_{NR} represents the bandwidth allocated to 5G NR users.

Unlike static spectrum allocation, the values of B_{LTE} and B_{NR} vary dynamically according to network load and traffic distribution. This allows operators to maximize spectrum utilization while supporting both LTE and 5G services.

The efficiency of spectrum utilization can be evaluated using spectral efficiency, defined as:

$$SE = \frac{Throughput}{Bandwidth} \tag{2}$$

where:

- SE is the spectral efficiency (bits/s/Hz).
- Throughput represents the achieved user data rate.
- Bandwidth represents the allocated spectrum resources.

Although DSS improves spectrum utilization by allowing LTE and NR coexistence, the CRS Rate Matching process

TABLE I: Band 28 DSS Performance Comparison

Configuration	DL Speed Test (Mbps)	LTE (Mbps)	NR (Mbps)	Total DL (Mbps)	UL (Mbps)	Latency (ms)
DSS 20 MHz 64QAM	251	166.5	72.0	238.5	29.9	19
DSS 20 MHz 256QAM	129	94.4	50.6	145.0	30.0	153
No DSS 10 MHz NR	262	168.5	95.3	263.8	33.0	12

introduces overhead that slightly reduces spectral efficiency compared to dedicated NR deployments.

The theoretical maximum channel capacity can be estimated using Shannon’s Capacity Theorem:

$$C = B\log_2(1 + SNR) \tag{3}$$

where:

- C represents channel capacity.
- B represents channel bandwidth.
- SNR represents the signal-to-noise ratio.

According to this relationship, increasing bandwidth or improving radio signal quality results in higher achievable throughput. However, in DSS deployments, a portion of the available resources is reserved for LTE control and reference signals, reducing the effective bandwidth available for NR transmission.

The total throughput achieved in DSS operation can be expressed as:

$$T_{Total} = T_{LTE} + T_{NR} \tag{4}$$

where:

- T_{Total} is the combined throughput.
- T_{LTE} is the LTE throughput contribution.
- T_{NR} is the NR throughput contribution.

This relationship is particularly important in DSS deployments because both technologies simultaneously contribute to the overall user throughput. The balance between LTE and NR throughput depends on traffic demand, user distribution, and the dynamic resource allocation mechanism implemented by the scheduler.

Overall, DSS provides a practical solution for maximizing spectrum utilization and accelerating 5G deployment by enabling efficient coexistence between LTE and NR technologies. Although certain overheads are introduced due to CRS Rate Matching and resource sharing, DSS remains an effective approach for expanding 5G coverage in spectrum-constrained environments while preserving LTE service continuity.

V. DSS ARCHITECTURE AND CRS RATE MATCHING

Dynamic Spectrum Sharing (DSS) is a technology that enables LTE and 5G New Radio (NR) services to operate simultaneously within the same frequency carrier. Unlike conventional spectrum refarming, where dedicated spectrum is allocated to 5G services, DSS allows both technologies to dynamically share available radio resources according to network demand. This capability enables mobile operators to accelerate 5G deployment while preserving LTE service continuity and maximizing the utilization of existing spectrum assets.

The DSS implementation used in this trial was based on a Non-Standalone (NSA) architecture, where LTE served as the anchor layer and 5G NR operated as a secondary node through EN-DC connectivity. To facilitate coexistence between LTE and NR, CRS Rate Matching was employed. In LTE networks, Cell Reference Signals (CRS) occupy predefined resource elements that are continuously transmitted for synchronization and channel estimation. Through CRS Rate Matching, the NR scheduler identifies these LTE CRS locations and avoids scheduling NR transmissions on the same resources, thereby preventing interference between the two technologies.

The trial was conducted across Band 28, Band 1, and Band 3 using shared spectrum resources. The DSS scheduler dynamically allocated radio resources between LTE and NR users based on traffic demand and network conditions. This flexible resource-sharing mechanism enabled efficient spectrum utilization while maintaining acceptable performance levels for both LTE and 5G services. The architecture also supported rapid deployment without requiring significant hardware modifications or additional spectrum allocation.

Although CRS Rate Matching introduces some overhead and slightly reduces spectral efficiency compared to dedicated NR deployments, it provides a practical solution for accelerating 5G coverage expansion. The trial results demonstrate that DSS successfully enables LTE-NR coexistence, improves spectrum utilization, and supports a smooth migration path toward future standalone 5G networks while maintaining service continuity for existing LTE subscribers.

VI. OOKLA PERFORMANCE ANALYSIS

The Ookla performance analysis was conducted to evaluate the user-experienced throughput of Dynamic Spectrum Sharing (DSS) under live network conditions. Multiple speed test measurements were performed across different DSS configurations operating on Band 28 (700 MHz), including DSS with 64QAM, DSS with 256QAM, and a dedicated NR deployment without DSS. The objective was to assess the impact of spectrum sharing on throughput, latency, and overall user experience. The performance comparison is summarized in Table I.

The results indicate that DSS successfully enables simultaneous LTE and 5G NR operation while providing acceptable throughput performance. Under the DSS 20 MHz configuration with 64QAM modulation, the network achieved a speed test throughput of approximately 251 Mbps, with LTE and NR contributing 166.5 Mbps and 72 Mbps respectively. The combined throughput reached approximately 238.5 Mbps, demonstrating efficient utilization of shared spectrum resources. However, when DSS operated with 256QAM modulation, the throughput performance decreased due to interference conditions and additional resource-sharing overhead. This observation highlights the importance of radio optimization and interference management in DSS deployments.

The highest performance was achieved under the dedicated NR configuration without DSS, where the network recorded approximately 262 Mbps speed test throughput and a total physical layer throughput of 263.8 Mbps. In addition, the dedicated NR configuration achieved lower latency and higher NR throughput contribution compared to the DSS scenarios. These results confirm that while dedicated NR deployment offers superior spectral efficiency, DSS remains an effective solution for extending 5G coverage and accelerating network deployment in environments where dedicated 5G spectrum is not readily available. Overall, the Ookla analysis validates DSS as a practical approach for enabling nationwide 5G expansion while maintaining acceptable user experience and network performance.

VII. DRIVE TEST RESULTS

Extensive drive testing was conducted to evaluate the real-world performance of Dynamic Spectrum Sharing (DSS) under commercial network conditions. The objective of the drive test campaign was to assess the coexistence of LTE and 5G NR within the same frequency carrier and validate the throughput, coverage, and service continuity achieved through DSS deployment. Testing was performed across multiple FDD frequency bands, including Band 28 (700 MHz), Band 1 (2100 MHz), and Band 3 (1800 MHz), under both stationary and mobility scenarios.

The measurements focused on evaluating LTE throughput contribution, NR throughput contribution, total physical layer throughput, and user-experienced throughput obtained through speed test applications. The collected results provide valuable insights into the practical performance of DSS and its effectiveness as a solution for accelerating 5G coverage expansion using existing LTE spectrum resources.

A. *Band 28 DSS Performance*

Band 28 was selected as the primary coverage layer for DSS evaluation due to its favorable propagation characteristics and wide-area coverage capability. The trial successfully demonstrated simultaneous LTE and NR operation within the same 20 MHz carrier using CRS Rate Matching. Following optimization activities, including the disabling of interfering neighboring cells, the DSS configuration achieved significant throughput improvements.

The drive test results showed a combined physical layer throughput of approximately 240.7 Mbps, consisting of 168.7 Mbps LTE throughput and 72 Mbps NR throughput contribution. User-experienced throughput measured through speed tests reached approximately 235 Mbps. These results confirm that DSS can effectively deliver 5G services while preserving LTE performance within the same spectrum resources.

The low-frequency characteristics of Band 28 also contributed to improved coverage and signal penetration, making it particularly suitable for extending 5G service availability into coverage-limited and indoor environments. The results demonstrate that DSS deployment on low-band spectrum provides an effective mechanism for expanding 5G coverage without requiring additional dedicated spectrum resources.

TABLE II: DSS Performance Comparison Across Frequency Bands

Band	LTE Throughput (Mbps)	NR Throughput (Mbps)	Total Throughput (Mbps)
Band 28	168.7	72.0	240.7
Band 1	63.0	100.9	163.9
Band 3	189.0	72.0	261.0

B. *Band 1 DSS Performance*

To evaluate DSS performance in higher frequency spectrum, testing was conducted on Band 1 operating at 2100 MHz. In this configuration, LTE and NR shared the same carrier bandwidth using the DSS framework and CRS Rate Matching mechanisms.

The results indicate that the DSS implementation achieved a combined throughput of approximately 163.9 Mbps, consisting of 63 Mbps LTE throughput and 100.9 Mbps NR throughput contribution. User speed test measurements reached approximately 131 Mbps. The higher NR throughput contribution observed in Band 1 demonstrates the ability of DSS to efficiently allocate resources toward 5G users while maintaining LTE service continuity.

Although the total throughput was lower than that observed in Band 28, the results confirm successful LTE-NR coexistence and validate the capability of DSS to support 5G deployment across multiple FDD spectrum bands.

C. *Band 3 DSS Performance*

Additional DSS testing was performed on Band 3 operating at 1800 MHz to assess performance within a mid-band frequency layer commonly used for capacity enhancement. Similar to the previous scenarios, LTE and NR services shared the same carrier through dynamic resource allocation and CRS Rate Matching.

The drive test measurements showed a combined physical layer throughput of approximately 261 Mbps, consisting of 189 Mbps LTE throughput and 72 Mbps NR throughput contribution. User speed test measurements reached approximately 262 Mbps, representing the highest overall throughput achieved among the DSS deployment scenarios evaluated during the trial.

The results demonstrate that Band 3 provides an effective balance between coverage and capacity, allowing DSS to deliver strong LTE performance while simultaneously supporting 5G services. This makes Band 3 an attractive candidate for large-scale DSS deployment in commercial networks.

VIII. KPI ANALYSIS

The KPI analysis was conducted to evaluate the performance of Dynamic Spectrum Sharing (DSS) across the tested frequency bands and to assess the effectiveness of LTE-NR coexistence within shared spectrum resources. The throughput comparison across Band 28, Band 1, and Band 3 is summarized in Table II. The results confirm that DSS successfully enables simultaneous LTE and NR operation while maintaining stable performance for both technologies. The observed throughput distribution reflects the dynamic resource allocation mechanism employed by DSS, where spectrum resources are shared according to traffic demand and network conditions.

As shown in Table II, Band 28 achieved a combined throughput of approximately 240.7 Mbps, providing strong coverage-oriented performance and supporting wider 5G service availability. Band 1 delivered a total throughput of approximately 163.9 Mbps, with a higher NR throughput contribution, demonstrating efficient resource allocation toward 5G users. The highest overall throughput was achieved in Band 3, reaching approximately 261 Mbps, highlighting its ability to provide a balanced combination of coverage and capacity within a DSS deployment.

Although DSS introduces additional overhead due to CRS Rate Matching and resource sharing, the results demonstrate efficient spectrum utilization and successful LTE-NR coexistence across all evaluated bands. The findings validate DSS as a practical solution for accelerating 5G deployment using existing LTE spectrum assets while maintaining acceptable throughput performance and service continuity for LTE users.

IX. DISCUSSION

The trial results demonstrate that Dynamic Spectrum Sharing provides a practical balance between deployment flexibility and network performance. While DSS introduces some throughput reduction due to CRS Rate Matching and resource-sharing overhead, it enables rapid 5G deployment without spectrum refarming or additional spectrum resources. The findings indicate that low-band DSS deployments are particularly effective for coverage enhancement, whereas mid-band deployments offer improved capacity. Overall, DSS serves as an efficient transition strategy that supports nationwide 5G expansion while maintaining service continuity for LTE users.

X. CONCLUSION

This paper presented a performance evaluation of 5G Dynamic Spectrum Sharing in a live commercial network environment. The results confirmed that DSS successfully enables LTE and NR coexistence within the same spectrum resources while providing enhanced 5G coverage and efficient spectrum utilization. Although dedicated NR deployments deliver higher throughput, DSS offers a scalable and cost-effective solution for accelerating 5G rollout using existing LTE infrastructure. The findings validate DSS as an important technology for supporting the transition from LTE to future standalone 5G networks.

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