



# Enhancing Spectral Efficiency Using 8Rx for 5G FWA

**A Comprehensive Performance Evaluation**

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# 1. Introduction

The demand for 5G data traffic is growing rapidly, driven by an increasing number of 5G users, including those utilizing 5G Fixed Wireless Access (FWA). FWA provides home broadband connectivity, particularly in underserved regions where wireline broadband deployment (such as fiber, copper/DSL, or cable) is not feasible. According to an Ericsson study on FWA market dynamics [1], there are sharply rising deployments costs beyond an inflection point of 50–60 percent of homes covered by a fiber rollout. Covering the last 35 percent requires approximately five times more capital expenditure compared to the first 65 percent. This presents a significant opportunity for 5G FWA to play a role where fiber deployment costs are uneconomical. Therefore, Mobile Network Operators (MNOs) are investing in advanced 5G FWA features to provide a fiber-like experience that offers a fast and cost-effective alternative to a fiber-only model.

Globally, the surge in data traffic is influenced by several factors, such as increased smartphone penetration and high-resolution streaming video services, alongside the rise of 5G FWA. Video streaming remains the dominant service category, accounting for approximately 70% of total data traffic. This trend is fueled by the proliferation of high-definition and immersive content formats, such as 4K and live streaming, as highlighted in multiple industry reports.

The growth of 5G data traffic presents both opportunities and challenges for MNOs. A key challenge is how to accommodate the increased demand from 5G FWA and smartphone subscribers. In the next section, we will delve into these challenges and explore potential solutions.

# 2. Current MNO’s challenges of capacity and Spectrum

The following study conducted by GSMA [2], detailed in their report "Estimating the Mid-Band Spectrum Needs in the 2025-2030 Time Frame," addresses the question: How much mid-band spectrum does a country need to meet ITU’s IMT-2020 (5G) requirements? The study examines 36 cities worldwide with population densities exceeding 8,000 per km<sup>2</sup>.

Table 1: Total Spectrum Needs in 2025-2030 to meet Capacity/Traffic Increase. The following study was conducted by GSMA [2].

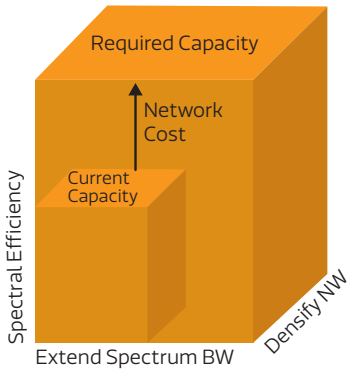
Total Spectrum needs 2025-2030 time frame to meet Capacity/Traffic Increase		
	Estimate Bandwidth	The total* mid-band spectrum (existing + new in 1500-7125 MHz) needs when averaged over all 36 examined cities by GSMA is estimated to be 2,020 MHz in the 2025-2030 time frame
High income cities	1,260 to 3690 MHz	
Upper middle-income cities	1,020 to 2870 MHz	
Lower middle-income cities**	1,320 to 3260 MHz	

\* 5G must deliver a user experienced mobile data rate of 100 Mbit/s in the downlink and 50 Mbit/s in the uplink and accommodate 1 million connections per km<sup>2</sup>.

\*\* Lower middle-income cities may require higher BW because of the absence of Fiber, leading to greater 5G FWA usage, in addition to absence of other high-band spectrum, which can offload pressure from mid-band (e.g., lack of mmW in lower income cities)

The report indicates, as shown in Table 1, a substantial mid-band spectrum requirement by 2030, highlighting the current challenge for Mobile Network Operators (MNOs) to increase spectrum availability, which may only be feasible after 2030. So, how do we address the lack of spectrum availability in the meantime?

There are several strategies to enhance network capacity, including adding new spectrum, deploying new sites, and enhancing spectral efficiency, to meet coverage and capacity expansion needs.



**Option #1: Increase # of sites**

That will increase OPEX/CAPEX beyond what may be planned already.

**Option #2: Add new Spectrum**

That will require planning for new spectrum use from both UE and Network.

**Option #3: Enhance Spectral Efficiency**

There are techniques technologies applicable to enhance Spectral Efficiency (S.E) without a substantial network cost.

Figure 1: General Factors Impacting Capacity

As illustrated in Figure 1, spectral efficiency plays a crucial role in enhancing network capacity and supporting more users with higher traffic demand per user, thereby minimizing the need for additional spectrum or site deployments.

Enhancing spectral efficiency is considered a financially viable option for network operators. In the next section, we will demonstrate how a 5G CPE with 8Rx (4 Layers) helps Mobile Network Operators (MNOs) overcome network capacity challenges that arise due to a lack of available spectrum.

### 3. 8Rx Performance Analysis

MediaTek performed an 8Rx evaluation in one of the 5G TDD n78 clusters within a live network. The evaluation involved multiple operators with varying traffic profiles, ranging from high traffic to moderate traffic. The n78 band had a bandwidth of 100 MHz with 4 layers.

Additionally, mobility testing was carried out to evaluate and establish user experience improvements with an increased number of receivers (#Rx). This testing also included the evaluation of the FDD band (n28), which had a bandwidth of 10 MHz with 2 layers.

To begin, it is essential to understand how 8Rx enhances user experience by delivering higher downlink throughput through improved spectral efficiency, all while being transparent to any network feature. This understanding provides insights into how increasing the number of receivers (#Rx) can elevate the overall user experience.

In the following section, we will delve into multiple key performance metrics observed during live network testing to explore the practical benefits of 8Rx. Figures 2 and 3 demonstrate a significant improvement in higher DL MIMO utilization of 3 and 4 layers, as well as the increased use of higher order modulation (64QAM and 256QAM). Additionally, there is a higher utilization of CQI values greater than or equal to 10. The observed improvement is attributed to enhanced channel estimation and the diversity gain provided by 8Rx.

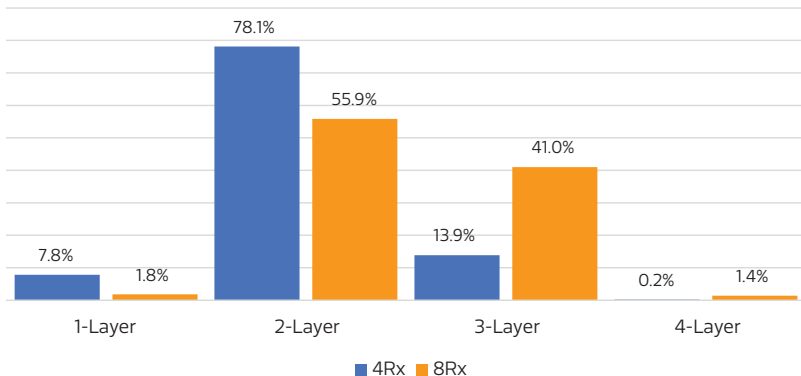


Figure 2: DL MIMO Utilization [For RSRP between -70 dBm and -105 dBm]

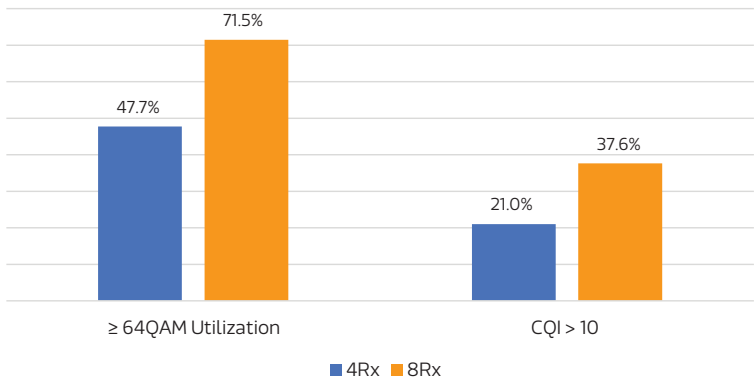


Figure 3: CQI & QAM Utilization [For RSRP ≥ -95dBm]

These enhancements result in a DL throughput gain of 47%, 46% and 54% for Near Cell (RSRP > -70 dBm), Mid Cell (RSRP > -95 dBm) and Far Cell (RSRP > -105 dBm) scenarios, respectively as seen in figure 4.

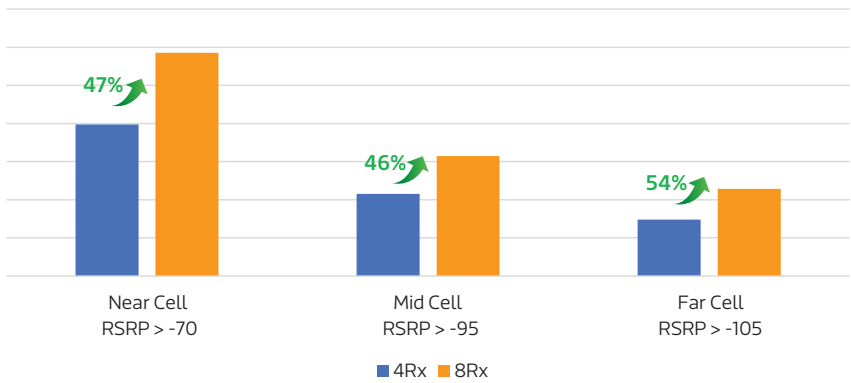


Figure 4: Normalized DL Throughput Gain [For RSRP between -70 dBm and -105 dBm]

We also performed 8Rx evaluation in a mobility scenario to assess the user experience across varying RSRP levels. Figure 5 illustrates that the DL throughput performance across different RSRP levels, showing that 8Rx DL throughput is significantly better than 4Rx throughput.

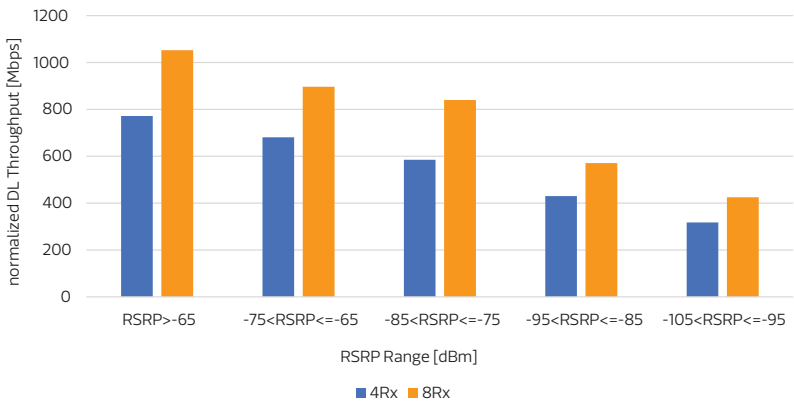


Figure 5: DL Throughput [Mbps] distribution at varying RSRP levels

The CDF analysis in figure 6 compares normalized DL throughput performance between 8Rx and 4Rx for the same test. At the 50th percentile (median), 8Rx achieves approximately 680 Mbps, representing a 36% improvement over 4Rx's 500 Mbps. This indicates that, for half of the measured samples, 8Rx consistently delivers higher throughput, reflecting a consistent enhancement in spectral efficiency, which is a key performance indicator of 8Rx.

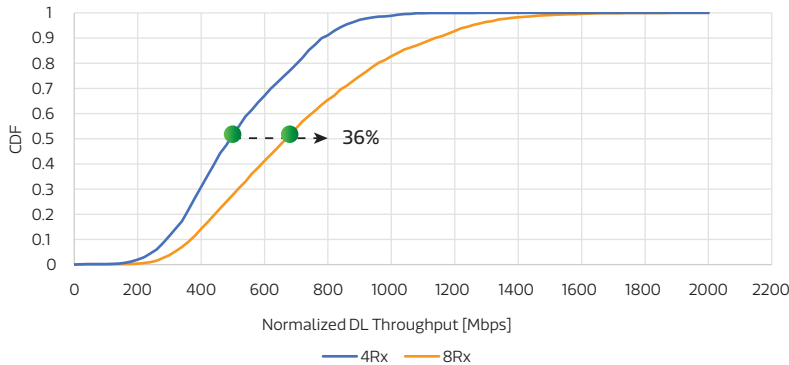


Figure 6: Cumulative Distribution of Downlink Throughput [Mbps]: 8Rx vs. 4Rx

An additional test was conducted to evaluate the correlation between the #Rx and spectral efficiency, by increasing #Rx from 2 to 8 along multiple mobility test routes in a city. The routes were selected to represent contrasting network conditions: one set passed through a densely populated market during peak hours, where the Physical Resource Block (PRB) allocation to the device under test was low due to high network load, and the other set was in a lightly populated area during off-peak hours, where network load was minimal. As shown in Figure 7, increasing #Rx resulted in a consistent average improvement of 43% in spectral efficiency across both FDD and TDD networks. In addition, the 8Rx device showed resilience to the network load and provided high gains over 4Rx. These results provide strong evidence that upgrading #Rx enhances spectral efficiency under a wide range of network conditions.

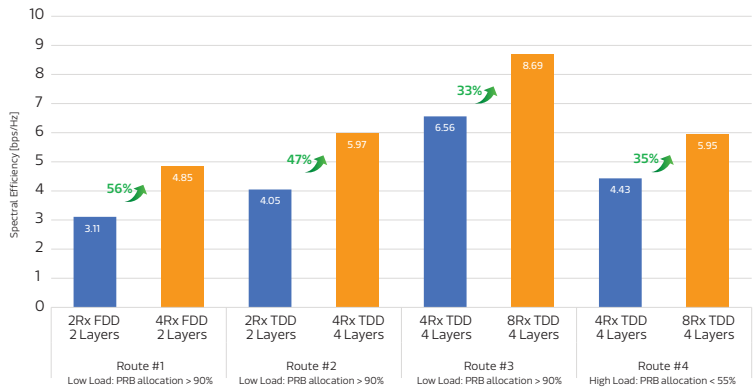


Figure 7: Spectral Efficiency (bps/Hz) on mobility routes in different cities

To assess the capacity enhancements provided by the 8Rx FWA solution, we estimate the capacity density in terms of Mbps per square kilometer. For consistency, we use the same configuration as presented in the previous section: the n78 band with 100 MHz bandwidth and a baseline spectral efficiency of 6.56 bps/Hz. Our calculations are based on an urban environment with a cell radius of 300 meters, utilizing three-sector base stations. The network infrastructure is shared by both smartphone and 5G FWA users at each site. On average, each user at a site consumes 30 GB of data per month. Typically, there are more smartphone users with lower data consumption compared to 5G FWA users, who tend to have higher usage. For the purpose of simulating busy hour traffic, we assume each user is active for 150 hours per month.

Since 8Rx will not be immediately available to all FWA users due to the gradual adoption of new devices, we assume that 25% of 5G FWA users are 8Rx capable, while the remaining 75% (including smartphone and other FWA users) continue to use the 4Rx solution. As illustrated in Figure 7, the spectral efficiency gain of 8Rx is 33% under low load conditions in city #3, which is the value applied in this simulation.

Figure 8 compares the capacity and user densities between two scenarios: one where all devices (100% of smartphones and FWA users) utilize the 4Rx solution, and another where 25% of FWA users have been upgraded to 8Rx. The results demonstrate that not only does the capacity density improve with the introduction of 8Rx FWA users, but the spectral efficiency gain also enables an additional 540 subscribers per square kilometer. This represents a significant increase in capacity, and user density will continue to rise as more 8Rx devices are deployed throughout the network.

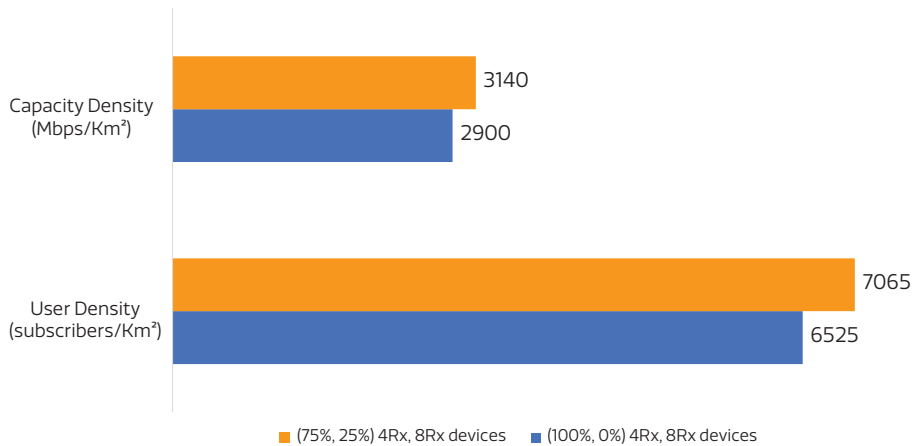


Figure 8: Capacity and user densities

## 4. Conclusion

Spectral efficiency alleviates the need for additional spectrum bandwidth or installing more sites than planned. It plays a crucial role in enhancing network capacity and accommodating more users, with higher traffic demand per user. Enhancements in spectral efficiency can lead to an increase in Average Revenue Per User (ARPU) in a shorter period for Mobile Network Operators (MNOs) with less capital expenditure (CAPEX).

In a network lacking new spectrum opportunity, particularly the C-band as a capacity layer, and with a high number of enhanced Mobile Broadband (eMBB) users, along with strict Total Cost of Ownership (TCO) requirements to drive ARPU up, the optimal solution is to implement features and techniques that enhance spectral efficiency. Supporting more Rx and more layers have clear technical benefits, even without introducing new network features.

The findings presented in this whitepaper highlight the significant advantages of 8Rx technology in elevating 5G network performance, resulting in improved throughput, coverage, and reliability. MediaTek’s T930 platform stands as a leading solution in this space, offering advanced 8Rx support for superior downlink performance. Its pioneering 8Rx enablement, with 3CC and 200 MHz bandwidth, enables a remarkable increase in spectrum efficiency at the cell edge, effectively extending coverage and improving the user experience in challenging environments.

The MediaTek T930 with 8Rx helps MNOs enhance their FR1 segment, position themselves competitively. MediaTek continues to lead the industry with advanced Rx & Tx capabilities, and more layers in eMBB use cases.

In addition to 8Rx, the T930 modem delivers exceptional sub-6GHz 5G speeds with up to 6CC carrier aggregation, and first-to-market innovations such as 5-layer 3Tx with 3CC, achieving uplink speeds of up to 2.8Gbps, setting the benchmark for FWA solutions. With its cutting-edge capabilities, the MediaTek T930 platform empowers operators and device manufacturers to unlock the full potential of 5G networks and deliver exceptional user experiences.

## 5. Acknowledgements

We would like to express our sincere gratitude to the MediaTek Communication System Design (CSD) team for their invaluable guidance and support throughout the development of this whitepaper. Their expertise and insights were instrumental in shaping the direction of this study. We also extend our heartfelt thanks to the System Validation (SV) Team for their dedication in executing the tests and field evaluations. Their rigorous efforts ensured the reliability and accuracy of the results presented in this work.

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