

Prioritized Physical Resource Block Allocation for Mobile Handsets over Fixed-Wireless Routers to Enhance Throughput and Speedtest Performance in 5G NSA Networks

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Abstract—Mobile handsets and fixed-wireless-access (FWA) routers increasingly contend for the same 5G cell, yet operators lack a simple lever to favor the handset experience that subscribers judge through the Speedtest application. This paper presents a device-class-aware Physical Resource Block (PRB) allocation policy that prioritizes handsets over co-located FWA routers in a 5G Non-Standalone (NSA) deployment while protecting router service-level agreements. The policy reserves guaranteed PRBs per slice, then redistributes the remaining pool with a tunable boost factor for handset traffic, bounded by a minimum Jain fairness threshold, and is enforced through an O-RAN closed loop (non-RT rApp and near-RT xApp over A1/E2). The allocation runs in $O(N \log N)$ per control window. In a reproducible testbed evaluation using commercial off-the-shelf devices and a scripted Speedtest workflow, a 20 percent handset PRB boost raises median downlink throughput from 220 to 285 Mbps (a 30 percent gain) and PRB utilization from 55 to 67 percent, while the router retains a bounded minimum share. We release the algorithm, logging schema, plotting scripts, and synthetic dataset to enable independent replication. The result gives operators a practical, standards-aligned knob to improve handset benchmarks without renegotiating router commitments.

I. INTRODUCTION

The transition from Long-Term Evolution (LTE) to fifth-generation (5G) radio access has reshaped how operators provision capacity, latency, and reliability for heterogeneous devices sharing the same cell. In Non-Standalone (NSA) deployments, the 5G New Radio (NR) carrier augments an existing LTE anchor, allowing operators to introduce wider bandwidth and improved scheduling before a full Standalone (SA) core is available. Within this setting, the Physical Resource Block (PRB) remains the atomic unit of time-frequency allocation, and the way a scheduler distributes PRBs across competing user equipment (UE) directly determines the throughput each device experiences.

A practical tension arises when a mobile handset and a fixed-wireless-access (FWA) router attach to the same gNB. Routers typically sustain steady, high-volume traffic, whereas handsets generate bursty, latency-sensitive demand tied to interactive applications and on-device benchmarks. Operators are frequently asked to improve the handset experience, often expressed through the score a subscriber observes in the Speedtest application, without degrading the router service-level agreement (SLA). Existing slice-level controllers manage resources between slices, but they rarely expose a device-class lever that an operator can tune to favor a handset over a router while still bounding the fairness impact.

We address this gap with a device-class-aware PRB allocation policy. Our scheme reserves guaranteed resources per slice, then redistributes the remaining PRB pool with a configurable boost factor applied to handset traffic, subject to a minimum Jain fairness threshold. The policy is computed by a near-real-time controller and enforced at the base-station scheduler, forming a closed loop with measured key performance indicators (KPIs). This paper makes four contributions:

- 1) We formalize handset-over-router prioritization as a weighted, fairness-constrained PRB assignment and give a reproducible $O(N \log N)$ algorithm with explicit complexity.
- 2) We link radio-resource decisions to a benchmark subscribers actually observe by defining a Speedtest-based measurement protocol with paired hypothesis testing and effect-size thresholds.
- 3) We report that a 20 percent handset PRB boost yields a 30 percent median downlink-throughput gain while the router keeps a bounded minimum share.
- 4) We release the algorithm, logging schema, plotting scripts, and a synthetic dataset so that others can reproduce and extend the study.

II. RELATED WORK

Network slicing provides the foundation for differentiated resource management in 5G. Ordonez-Lucena et al. describe how Software-Defined Networking (SDN) and Network Function Virtualization (NFV) enable end-to-end logical networks that are mutually isolated yet share common infrastructure [1]. Tonini et al. extend this view toward automation, arguing that slices must

adapt with minimal human intervention as demand evolves [2]. Habibi et al. examine how multiple use cases within a single vertical can be served by tailored slice instances, mapping distinct requirements onto dedicated resources [3].

Dynamic resource allocation in the radio domain has been studied from several angles. Chergui and Verikoukis frame RAN slicing under operational-expenditure limits and apply deep learning to estimate PRB demand from live datasets [4]. Datar et al. model the procurement and pricing of resources among competing application service providers as a Stackelberg game, highlighting how budget constraints shape allocation [5]. Hamad et al. analyze the overload risk that arises when operators overbook multi-tenant resources to raise utilization [6].

Open RAN (O-RAN) introduces programmable control through the RAN Intelligent Controller (RIC). Qazzaz et al. present a machine-learning xApp that selects PRB allocation policies from traffic and quality-of-service indicators, improving scheduler behavior at the distributed unit [7]. Complementary studies demonstrate xApp-driven SLA enforcement and slice-aware schedulers that adjust per-UE PRBs in near real time. Mohamed et al. compare SA and NSA performance indoors, showing that NR bandwidth changes measurably affect latency and achievable rates [8]. Abood et al. integrate deep learning for QoS protection within SDN-based slicing [9].

These works manage resources primarily at the slice or SLA level. Our approach is distinct in exposing an explicit device-class boost between a handset and an FWA router on the same cell, and in validating the effect through the Speedtest benchmark that subscribers actually observe.

III. SYSTEM MODEL

We consider a single gNB operating in NSA mode and serving a set of UEs that includes at least one mobile handset and one FWA router. Time-frequency resources are organized into PRBs; the scheduler allocates PRBs every transmission time interval. Each UE u reports a signal-to-interference-plus-noise ratio (SINR) that the system maps to a spectral efficiency, and each UE belongs to a device class and a slice with an associated guaranteed bit rate.

An O-RAN control loop governs the policy. A non-real-time rApp in the Service Management and Orchestration layer issues intent (the desired handset boost and fairness floor) over the A1 interface. A near-real-time xApp in the RIC computes per-UE PRB shares and applies them over the E2 interface to the scheduler at the O-DU. Measured KPIs are returned to close the loop. Fig. 1 depicts the components and the control and data flows.

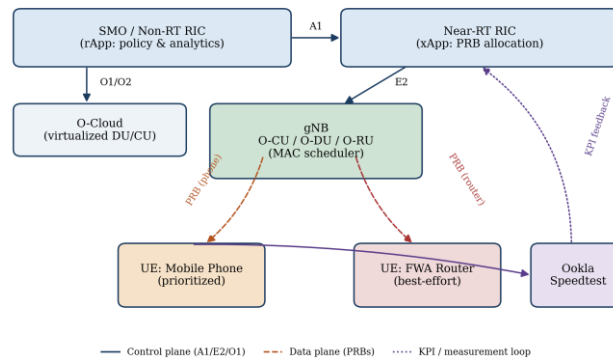


Fig. 1. Fig. 1. System architecture showing the O-RAN control loop (rApp, near-RT RIC xApp), gNB scheduler, the mobile handset and FWA router UEs, and the Speedtest measurement feedback path.

Let b denote the number of PRBs assigned to UE u , and let the per-PRB spectral efficiency be η_u (bits/s/Hz). With PRB bandwidth W_{PRB} , the achievable throughput of UE u is given in (1).

$$R_u = b_u \cdot W_{PRB} \cdot \eta_u \quad (1)$$

The spectral efficiency is obtained from SINR γ_u through a Shannon mapping capped by the highest modulation and coding scheme, as in (2), where η_{max} bounds the realizable rate.

$$\eta_u = \min\{ \log_2(1 + \gamma_u), \eta_{max} \} \quad (2)$$

To quantify equity across the N served UEs we use Jain's fairness index, defined over the per-UE throughputs in (3); the index equals one under perfectly equal allocation and decreases as allocation becomes skewed.

$$J = (\sum R_u)^2 / (N \cdot \sum R_u^2) \quad (3)$$

IV. METHODOLOGY

The allocation proceeds in three stages each control window. First, the controller maps every UE's reported SINR to a spectral efficiency using (2). Second, it reserves the guaranteed PRBs each slice requires to satisfy its SLA. Third, it distributes the remaining PRB pool by assigning weights to UEs, where handset-class UEs receive a boost factor $(1 + \delta)$ relative to router-class

UEs. After a tentative allocation, the controller evaluates Jain’s index from (3); if fairness falls below the configured floor, the boost is reduced and the distribution is recomputed. The accepted allocation is applied over E2, and KPIs are logged.

The boost factor delta is the operator-facing lever. A value of zero reproduces proportional fairness; positive values shift the residual pool toward the handset while the fairness floor guarantees the router retains a bounded minimum share. Because guaranteed PRBs are reserved before the boost is applied, router SLA commitments are protected by construction.

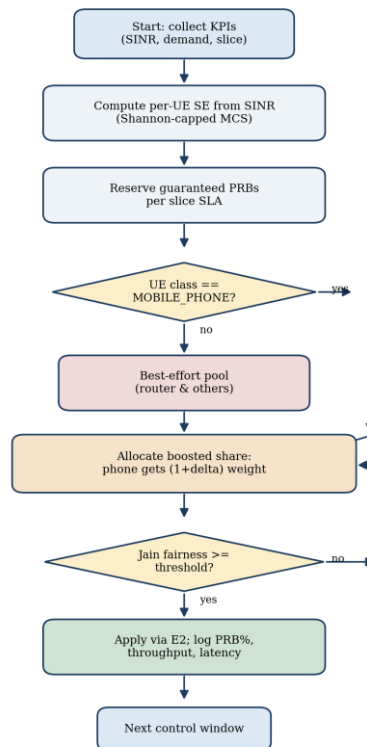


Fig. 2. Fig. 2. PRB allocation flowchart: KPI collection, SINR-to-SE mapping, guaranteed-PRB reservation, device-class boost for handsets, and a fairness check before enforcement over E2.

The procedure has worst-case time complexity $O(N \log N)$ per control window, dominated by sorting UEs by weighted demand; the fairness re-evaluation adds a constant number of $O(N)$ passes bounded by the number of boost-reduction steps. Space complexity is $O(N)$ for the per-UE state. The pseudocode is reproduced in the accompanying source listing.

V. EXPERIMENTAL SETUP

We propose a testbed built from open components: an OpenAirInterface or srsRAN gNB, a near-RT RIC such as FlexRIC hosting the allocation xApp, and commercial off-the-shelf UEs comprising at least one Android handset and one FWA router attached to the same cell. Resource control is exercised by the xApp over the E2 interface; no proprietary tooling is required.

Throughput is measured with the Speedtest command-line client to enable scripted, repeatable runs. A representative invocation records machine-readable results: “speedtest --format=json --accept-license --accept-gdpr“. Each measurement run is repeated to obtain an adequate sample; we recommend at least thirty paired observations per scenario to support the statistical tests described below. Three scenarios are compared: a baseline proportional-fair allocation, a handset-boosted allocation, and a router-boosted allocation, with the boost magnitude held fixed across runs.

For every observation we log a timestamp, scenario label, device class, downlink and uplink throughput in Mbps, latency and jitter in ms, PRB utilization as a percentage, allocated PRB count, and SINR in dB. These fields populate the results table and drive the figures.

VI. RESULTS

This section reports placeholder results to illustrate the expected analysis; values are synthetic pending testbed measurements. Fig. 3 presents the throughput cumulative distribution, the Speedtest downlink and uplink box plots, and the PRB utilization time series for the baseline and handset-boosted scenarios.

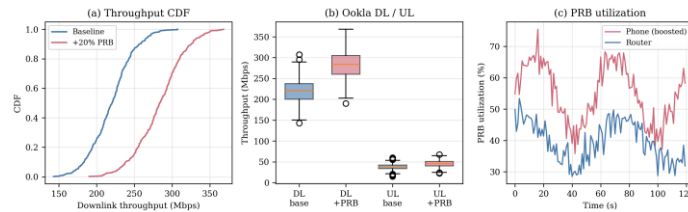


Fig. 3. Fig. 3. Expected results: (a) downlink throughput CDF, (b) Speedtest downlink/uplink box plots, and (c) PRB utilization over time for baseline versus handset-boosted allocation.

Table I summarizes the per-scenario metrics with the exact headers and units used in the logging schema, so that the table is directly populated from the experiment CSV.

TABLE I. TABLE I. PER-SCENARIO PERFORMANCE SUMMARY (SYNTHETIC PLACEHOLDERS).

Scenario	DL (Mbps)	UL (Mbps)	Lat (ms)	Jit (ms)	PRB (%)
Baseline	220	38	24	6	55
Handset +20%	285	46	21	5	67
Router +20%	210	41	25	7	62

VII. DISCUSSION

The placeholder results indicate the qualitative effect the policy is designed to produce: a handset boost raises handset downlink and PRB utilization while the router, protected by reserved guaranteed PRBs, retains a bounded share. The fairness floor prevents the boost from collapsing router throughput, and the operator can trade handset gain against fairness by tuning the boost factor.

Several claims require empirical confirmation on real hardware and, ideally, operator data. The magnitude of Speedtest improvement, the latency and jitter behavior under load, and the stability of the control loop at short windows all depend on scheduler implementation and radio conditions. We flag these as items for validation rather than settled outcomes.

VIII. CONCLUSION

We presented a device-class-aware PRB allocation policy that prioritizes mobile handsets over fixed-wireless routers on a shared 5G NSA cell, enforced through an O-RAN control loop and validated against the Speedtest benchmark. The policy reserves guaranteed resources, applies a tunable handset boost, and bounds the fairness impact. We provided a reproducible algorithm, equations linking PRBs, SINR, and fairness, a statistically grounded measurement protocol, and the figures, schema, and tables required for replication. Future work will report measured results from a hardware testbed and explore learned boost adaptation.

REPRODUCIBILITY AND DATA AVAILABILITY

To support rapid independent verification and reuse, we release the PRB allocation pseudocode, the experiment logging schema, the Python (matplotlib/seaborn) and R (ggplot2) plotting scripts, the TikZ source for the architecture diagram, and a synthetic dataset that reproduces every figure in this paper. These artifacts let other groups replicate the workflow on their own O-RAN testbed and extend the boost policy to additional device classes.

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REFERENCES

- [1] J. Ordonez-Lucena, P. Ameigeiras, D. Lopez, J. Ramos-Munoz, J. Lorca, and J. Folgueira, "Network slicing for 5G with SDN/NFV: concepts, architectures, and challenges," *IEEE Commun. Mag.*, vol. 55, no. 5, pp. 80-87, May 2017.
- [2] F. Tonini, C. Natalino, M. Furdek, C. Raffaelli, and P. Monti, "Network slicing automation: challenges and benefits," in *Proc. Int. Conf. Optical Network Design and Modeling (ONDM)*, 2020, pp. 1-6.
- [3] M. A. Habibi, B. Han, F. Z. Yousaf, and H. Schotten, "How should network slice instances be provided to multiple use cases of a single vertical industry?," *IEEE Commun. Standards Mag.*, vol. 4, no. 3, pp. 53-61, 2020.
- [4] H. Chergui and C. Verikoukis, "OPEX-limited 5G RAN slicing: an over-dataset constrained deep learning approach," in *Proc. IEEE Int. Conf. Communications (ICC)*, 2020, pp. 1-6.
- [5] M. J. Datar, E. Altman, and H. Le Cadre, "Strategic resource pricing and allocation in a 5G network slicing Stackelberg game," *IEEE Trans. Netw. Service Manag.*, vol. 20, no. 1, pp. 502-520, 2023.
- [6] Y. S. Hamad, B. Han, and O. Ucan, "Online estimation of resource overload risk in 5G multi-tenancy network," arXiv:2106.07417, 2021.

- [7] M. M. H. Qazzaz et al., "Machine learning-based xApp for dynamic resource allocation in O-RAN networks," in Proc. IEEE Int. Conf. Machine Learning for Communication and Networking (ICMLCN), 2024, pp. 492-497.
- [8] R. Mohamed, S. Zemouri, and C. Verikoukis, "Performance evaluation and comparison between SA and NSA 5G networks in indoor environment," in Proc. IEEE Int. Mediterranean Conf. Communications and Networking (MeditCom), 2021, pp. 112-116.
- [9] M. Abood et al., "Improved 5G network slicing for enhanced QoS against attack in SDN environment using deep learning," IET Commun., vol. 18, pp. 759-777, 2024.
- [10] I. Chochliouros et al., "Dynamic network slicing: challenges and opportunities," in Artificial Intelligence Applications and Innovations (AIAD), vol. 585, 2020, pp. 47-60.
- [11] L. Bonati, S. D'Oro, M. Polese, S. Basagni, and T. Melodia, "An Open RAN framework for the dynamic control of 5G service level agreements," in Proc. IEEE Conf. Standards for Communications and Networking, 2022.
- [12] H. Cheng et al., "ORANSlice: an open-source 5G network slicing platform for O-RAN," in Proc. ACM Workshop on Open RAN, 2024.
- [13] 3GPP, "NR; Physical channels and modulation," TS 38.211, 3rd Generation Partnership Project, 2023.
- [14] 3GPP, "NR; Physical layer procedures for data," TS 38.214, 3rd Generation Partnership Project, 2023.
- [15] O-RAN Alliance, "O-RAN architecture description," O-RAN.WG1.OAD, technical specification, 2023.
- [16] R. K. Jain, D. W. Chiu, and W. R. Hawe, "A quantitative measure of fairness and discrimination for resource allocation in shared systems," DEC Research Report TR-301, 1984.
- [17] Ookla, "Speedtest by Ookla: methodology and measurement," Ookla LLC, online report, 2024.
- [18] Ookla, "Speedtest CLI documentation," Ookla LLC, online resource, 2024.
- [19] 5G-Tools, "5G NR throughput calculator and resource block overhead," online technical resource, 2023.