

QoS-Aware Sum-Rate Maximization and Parametric Analysis in FAS-RSMA

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Abstract—This paper investigates a Fluid Antenna System (FAS)-Rate-Splitting Multiple Access (RSMA) downlink sum-rate maximization under Quality of Service constraints. A traditional single-antenna base station serves FAS-equipped receivers that select the port with the largest instantaneous channel power gain under Jakes spatial correlation. The number of ports N and normalized aperture W jointly shape the effective gains, RSMA feasibility, and system outage. To handle the resulting non-convex problem, a boundary-based reduction is adopted. A parametric analysis over the (N, W) configuration space is then performed, revealing near-optimal FAS designs that preserve most of the maximum average sum-rate while avoiding unnecessary receiver complexity and aperture growth under practical implementation constraints for compact receiver architectures.

Keywords—FAS-RSMA, parametric analysis, QoS, sum-rate maximization.

I. INTRODUCTION

Rate-Splitting Multiple Access (RSMA) has emerged as a flexible and dynamic transmission strategy for interference management in wireless systems. By splitting user messages into common and private parts, RSMA can partially decode interference through the common stream while treating the remaining interference as noise through private streams [1]–[3]. In parallel, Fluid Antenna Systems (FASs) have attracted increasing attention due to their ability to exploit spatial diversity by selecting among multiple candidate ports distributed over a compact physical aperture [4]–[5]. In FAS-equipped receivers, different ports may experience different small-scale fading conditions, and selecting a favorable port can highly improve the effective channel gain [6].

Recent works have highlighted the potential of FAS-RSMA from a performance perspective, especially in terms of outage and throughput gains over conventional fixed-antenna benchmarks, including Traditional Antenna System (TAS) [7]–[8]. Moreover, the RSMA literature has optimization frameworks for sum-rate maximization under Quality of Service (QoS) constraints in non-FAS setups [9]–[10]. Therefore, the aim of this paper is to address QoS-constrained sum-rate maximization as an operational tool to study the behavior of an FAS-RSMA system and to investigate how FAS configuration parameters affect the resulting performance.

In particular, this paper focuses on the combined role of the number of FAS ports N and the normalized aperture W . These parameters determine the spatial correlation among

ports and, consequently, the effective channel gains entering the RSMA allocation problem. Further discussions on ports correlation in FAS are presented in [11]–[12]. In a simple way, in the absence of implementation constraints, increasing N and enlarging W tends to improve the available selection diversity [8]. However, from an engineering perspective, it is important to determine whether smaller FAS configurations can retain nearly the same QoS-constrained performance. This motivates a joint (N, W) configuration analysis based on near-optimal performance regions and practical selection rules.

The main contributions of this paper are as follows. First, we formulate a QoS-constrained sum-rate maximization problem for a two-user FAS-RSMA downlink setup, where the RSMA allocation is adapted to the instantaneous FAS-selected channel gains. To address the resulting non-convex problem, a boundary-based reduction is adopted, providing an interpretable characterization of the feasible allocation structure induced by the QoS constraints. Finally, a QoS-aware configuration criterion is proposed, in which infeasible channel realizations contribute zero rate to the average sum-rate. This criterion identifies near-optimal and Pareto-efficient [13] FAS configurations, supporting practical tradeoffs among sum-rate preservation, system outage, number of ports, and aperture size under Jakes spatial correlation.

The remainder of this paper is organized as follows. Section II presents the system model. Section III formulates the QoS-constrained sum-rate maximization problem and describes the adopted boundary-based reduction. Section IV presents the numerical results and the joint FAS configuration analysis. Finally, Section V concludes the paper.

II. SYSTEM MODEL

We consider a downlink FAS-RSMA system composed of one Base Station (BS) and two users, indexed by $u \in \{1, 2\}$. The BS is equipped with a single conventional transmit antenna, whereas each user is equipped with a one-dimensional FAS with N candidate ports arranged along a linear aperture, in a Uniform Linear Array (ULA) configuration. Let D denote the physical length of the FAS aperture and λ the carrier wavelength. The normalized aperture is $W = D/\lambda$, and the spacing between two adjacent candidate ports is $\Delta = D/(N - 1)$, i.e., $\Delta/\lambda = W/(N - 1)$.

In the RSMA framework, the message intended for user u is split into a common part and a private part. The common parts of both users are jointly encoded into a common stream, while the private parts are independently encoded into private streams. Let s_c denote the common stream and s_u the private

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stream intended for user u . The transmitted signal is

$$x = \sqrt{Pt_c} s_c + \sum_{u=1}^2 \sqrt{Pt_u} s_u, \quad (1)$$

where P is the total transmit power at the BS, $t_c \in [0, 1]$ is the power fraction allocated to the common stream, and $t_u \in [0, 1]$ is the power fraction allocated to the private stream of user u , with $t_c + t_1 + t_2 = 1$. For user u , the channel observed across the N candidate ports is modeled by $\mathbf{h}_u = [h_{u,1} \ h_{u,2} \ \dots \ h_{u,N}]^T \in \mathbb{C}^{N \times 1}$. The small-scale fading in $\mathbf{h}_u$ follows a $CN(\mathbf{0}, \mathbf{\Sigma})$ distribution, where $\mathbf{\Sigma} \in \mathbb{C}^{N \times N}$ is the spatial correlation matrix associated with the FAS ports. Following the Jakes-based spatial correlation model, as well as in [7], the (i, j) -th entry of $\mathbf{\Sigma}$ is

$$[\mathbf{\Sigma}]_{i,j} = J_0\left(\frac{2\pi|i-j|D}{(N-1)\lambda}\right) = J_0\left(\frac{2\pi|i-j|W}{N-1}\right), \quad (2)$$

where $J_0(\cdot)$ is the zeroth-order Bessel function of the first kind. Therefore, N and W jointly determine the spatial correlation among candidate ports.

For each user, the FAS selects the port with the largest instantaneous channel power gain, following the port-selection rule adopted in [7]. Therefore, the effective channel gain of user u is

$$g_u = \max_{1 \leq n \leq N} |h_{u,n}|^2. \quad (3)$$

For fixed W , increasing N reduces the normalized inter-port spacing, potentially increasing port correlation, whereas for fixed N , increasing W enlarges the normalized aperture and tends to reduce spatial correlation. These effects motivate the joint analysis of N and W in Section IV.

III. PROBLEM FORMULATION AND REDUCTION

As an initial step, we formulate an optimization problem aimed at maximizing the total data rate while meeting QoS criteria. The FAS parameters N and W do not appear explicitly as optimization variables; however, they affect the problem through the correlated channel realizations and the resulting gains g_u , as evaluated in the following section. Let σ^2 denote the noise power, $\bar{\gamma} = P/\sigma^2$ the average transmit SNR, and $a_u = \bar{\gamma}g_u$. Under the power allocation coefficients (t_c, t_1, t_2) , the maximum decodable common-stream rate at user u is

$$\begin{aligned} r_{c,u}^{\max} &= \log_2 \left(1 + \frac{a_u t_c}{1 + a_u(t_1 + t_2)} \right) \\ &= \log_2(1 + a_u) - \log_2(A_u), \end{aligned} \quad (4)$$

where $A_u = 1 + a_u - a_u t_c$. After decoding and removing the common stream, user u decodes its private stream while treating the other private stream as noise. The achievable private rate is

$$\begin{aligned} r_{p,u} &= \log_2 \left(1 + \frac{a_u t_u}{1 + a_u t_j} \right) \\ &= \log_2(A_u) - \log_2(B_u), \quad j \neq u, \end{aligned} \quad (5)$$

where $B_u = 1 + a_u - a_u t_c - a_u t_u$. Furthermore, let $r_{c,u}$ denote the portion of the common rate assigned to user u , with $R_c = r_{c,1} + r_{c,2}$. Since the common stream must be decoded by both

users, $R_c \leq \min\{r_{c,1}^{\max}, r_{c,2}^{\max}\}$. Without loss of generality, the users are indexed such that $g_1 \leq g_2$, so the weakest user limits the common stream, i.e., $R_c \leq r_{c,1}^{\max}$. The total rate of user u is $r_u = r_{c,u} + r_{p,u}$, and the system sum-rate is $R_{\text{sum}} = r_1 + r_2$.

Let $r_u^{\min}$ denote the minimum QoS requirement of user u . The QoS-constrained sum-rate maximization problem is formulated as

$$\max_{t_c, t_1, t_2, r_{c,1}, r_{c,2}} R_{\text{sum}} \quad (6a)$$

$$\text{s.t. } r_{c,1} + r_{c,2} \leq \log_2(1 + a_1) - \log_2(A_1), \quad (6b)$$

$$r_{c,1} + \log_2(A_1) - \log_2(B_1) \geq r_1^{\min}, \quad (6c)$$

$$r_{c,2} + \log_2(A_2) - \log_2(B_2) \geq r_2^{\min}, \quad (6d)$$

$$t_c + t_1 + t_2 = 1, \quad (6e)$$

$$t_c \geq 0, t_1 \geq 0, t_2 \geq 0, \quad (6f)$$

$$r_{c,1} \geq 0, r_{c,2} \geq 0. \quad (6g)$$

Problem (6) is non-convex. Nevertheless, in the two-user case, its structure can be exploited to obtain a compact boundary-based reduction. For fixed t_c , one has $t_2 = 1 - t_c - t_1$, and the private rates become $r_{p,1}(t_1; t_c) = \log_2(A_1) - \log_2(A_1 - a_1 t_1)$ and $r_{p,2}(t_1; t_c) = \log_2(A_2) - \log_2(1 + a_2 t_1)$. Moreover, the maximum common rate is $R_c^{\max}(t_c) = \log_2(1 + a_1) - \log_2(A_1)$.

Let us define the common-rate deficit required to satisfy the QoS constraints as

$$\Delta(t_1; t_c) = [r_1^{\min} - r_{p,1}(t_1; t_c)]^+ + [r_2^{\min} - r_{p,2}(t_1; t_c)]^+, \quad (7)$$

where $[x]^+ = \max\{x, 0\}$. Thus, for a fixed t_c , feasibility is equivalent to $\Delta(t_1; t_c) \leq R_c^{\max}(t_c)$, and the reduced scalar problem is

$$\begin{aligned} \max_{0 \leq t_1 \leq 1-t_c} R_c^{\max}(t_c) + r_{p,1}(t_1; t_c) + r_{p,2}(t_1; t_c) \\ \text{s.t. } \Delta(t_1; t_c) \leq R_c^{\max}(t_c). \end{aligned} \quad (8)$$

The feasible frontier is characterized by

$$\Delta(t_1; t_c) = R_c^{\max}(t_c), \quad (9)$$

whose expression depends on which users still require common-rate support. This can be organized in the following regimes:

$$\mathcal{R}_{12}: r_{p,1} < r_1^{\min}, r_{p,2} < r_2^{\min}, \quad (10)$$

$$\mathcal{R}_1: r_{p,1} < r_1^{\min}, r_{p,2} \geq r_2^{\min}, \quad (11)$$

$$\mathcal{R}_2: r_{p,1} \geq r_1^{\min}, r_{p,2} < r_2^{\min}, \quad (12)$$

where $\mathcal{R}_{12}$ denotes the regime in which both users still require common-rate support to satisfy their QoS constraints, $\mathcal{R}_1$ denotes the regime in which only user 1 requires common-rate support, and $\mathcal{R}_2$ denotes the regime in which only user 2 requires common-rate support. Accordingly, (9) becomes

$$\mathcal{R}_{12}: r_{p,1}(t_1; t_c) + r_{p,2}(t_1; t_c) = r_1^{\min} + r_2^{\min} - R_c^{\max}(t_c), \quad (13)$$

$$\mathcal{R}_1: r_{p,1}(t_1; t_c) = r_1^{\min} - R_c^{\max}(t_c), \quad (14)$$

$$\mathcal{R}_2: r_{p,2}(t_1; t_c) = r_2^{\min} - R_c^{\max}(t_c). \quad (15)$$

For fixed t_c , $\Delta(t_1; t_c)$ represents the common-rate demand required to compensate the private-rate deficits, whereas

$R_c^{\max}(t_c)$ represents the maximum common-rate supply available through the weakest user. Hence, the frontier separates feasible allocations from outage events. The regimes $\mathcal{R}_{12}$, $\mathcal{R}_1$, and $\mathcal{R}_2$ indicate which users still require common-rate support after the private-rate allocation is fixed. Thus, the solution is governed by QoS-active boundaries, regime transitions, and power-allocation extremes.

The transition points between regimes are obtained from $r_{p,1}(t_1; t_c) = r_1^{\min}$ and $r_{p,2}(t_1; t_c) = r_2^{\min}$, yielding $\hat{t}_1(t_c) = \frac{A_1}{a_1}(1 - 2^{-r_1^{\min}})$ and $\hat{t}_2(t_c) = \frac{A_2}{a_2}2^{-r_2^{\min}} - 1$. Likewise, the single-user frontier equations (14) and (15) admit the candidates $\tilde{t}_1(t_c) = \frac{A_1}{a_1}(1 - 2^{-(r_1^{\min} - R_c^{\max}(t_c))})$ and $\tilde{t}_2(t_c) = \frac{A_2}{a_2}2^{-(r_2^{\min} - R_c^{\max}(t_c))} - 1$. For the regime $\mathcal{R}_{12}$, let us define $\eta(t_c) = A_1 A_2 2^{-(r_1^{\min} + r_2^{\min} - R_c^{\max}(t_c))}$. The corresponding frontier points are the real roots of

$$a_1 a_2 t_1^2 + (a_1 - A_1 a_2) t_1 + \eta(t_c) - A_1 = 0. \quad (16)$$

For each fixed t_c , define $J(t_1; t_c) = R_c^{\max}(t_c) + r_{p,1}(t_1; t_c) + r_{p,2}(t_1; t_c)$. Since $J(t_1; t_c)$ is strictly convex with respect to t_1 over each regime interval, the maximum of the inner scalar problem is attained at a boundary point of the feasible set. Therefore, the search over t_1 can be restricted to the finite set $C(t_c)$ containing the interval endpoints, the transition points, the single-user frontier points, and the real roots of (16), after discarding candidates outside $[0, 1 - t_c]$ or violating the corresponding regime and QoS feasibility conditions. Consequently, the original problem is reduced to

$$\max_{0 \leq t_c \leq 1} \max_{t_1 \in C(t_c)} J(t_1; t_c). \quad (17)$$

In the numerical implementation, t_c is evaluated over a predefined grid $\mathcal{T}_c \subset [0, 1]$. For each t_c , the feasible subset of candidates is denoted by $C_f(t_c)$, and the best inner solution is

$$t_1^*(t_c) = \arg \max_{t_1 \in C_f(t_c)} J(t_1; t_c). \quad (18)$$

The selected common-stream power fraction is $t_c^* = \arg \max_{t_c \in \mathcal{T}_c} J(t_1^*(t_c); t_c)$, ignoring infeasible values of t_c , and $t_2^* = 1 - t_c^* - t_1^*(t_c^*)$. Once t_c^* , t_1^* , and t_2^* are obtained, the common-rate allocation is chosen to satisfy the QoS constraints through $d_u = [r_u^{\min} - r_{p,u}(t_1^*; t_c^*)]^+$, $u = 1, 2$. If $d_1 + d_2 \leq R_c^{\max}(t_c^*)$, the QoS constraints are feasible; any remaining common rate can be assigned to either user without changing the sum-rate. In the simulations, this procedure was numerically verified against the Couenne solver and yielded coincident or nearly identical results. Furthermore, related RSMA optimization works, such as [9], also arrive at structurally similar allocation principles in more general user settings. In contrast, the present two-user treatment follows a boundary-based methodological path, emphasizing the feasible frontier induced by the QoS constraints.

IV. JOINT FAS CONFIGURATION ANALYSIS AND RESULTS

This section evaluates the proposed QoS-aware FAS-RSMA framework from the perspective of FAS configuration design.

TABLE I:
SIMULATION PARAMETERS.

Parameter	Value
Users, Fig. 1 to 3	$U = 2$
Channel model, all figures	Correlated Rayleigh fading
Correlation model, all figures	Jakes-based, 1D ULA FAS
SNR, Fig. 1 to 3	10 dB
QoS requirement, Fig. 1	$r_1^{\min} = r_2^{\min} = 2.0$ bit/s/Hz
Monte Carlo realizations, Fig. 1 and 2	$M = 1400$
Tolerance levels, Fig. 1	$\epsilon \in \{1\%, 3\%, 5\%, 10\%\}$
QoS requirement, Fig. 3	$r_1^{\min} = r_2^{\min} = 2.5$ bit/s/Hz
Monte Carlo realizations, Fig. 3	$M = 2800$

Since N and the normalized aperture W are not isolated parameters, we analyze their joint impact on the average sum-rate and on the system outage probability. The objective is to determine whether near-maximum performance can be retained with smaller receiver configurations, thereby reducing either the number of ports, the aperture size, or both. To this end, the simulated (N, W) grid is first used to identify near-optimal and Pareto-efficient FAS configurations. Then, representative configurations are further assessed under increasing QoS requirements and through a dedicated aperture-sweep analysis that illustrates how spatial correlation affects the achievable gains.

Let $\mathcal{G}$ denote the simulated grid of FAS configurations, where each point is a pair (N, W) . For each configuration, the average sum-rate is computed over M Monte Carlo realizations by assigning zero rate to infeasible channel realizations. Thus,

$$\bar{R}_{\text{sum}}(N, W) = \frac{1}{M} \sum_{m=1}^M \tilde{R}_{\text{sum}}^*(m; N, W), \quad (19)$$

where $\tilde{R}_{\text{sum}}^*(m; N, W) = R_{\text{sum}}^*(m; N, W)$ if the QoS constraints are feasible, and $\tilde{R}_{\text{sum}}^*(m; N, W) = 0$ otherwise. Let

$$\bar{R}_{\text{sum}}^{\max} = \max_{(N, W) \in \mathcal{G}} \bar{R}_{\text{sum}}(N, W) \quad (20)$$

denote the best average sum-rate observed over the grid. For a prescribed tolerance ϵ , the near-optimal configuration set is defined as

$$\mathcal{G}_\epsilon = \left\{ (N, W) \in \mathcal{G} : \bar{R}_{\text{sum}}(N, W) \geq (1 - \epsilon) \bar{R}_{\text{sum}}^{\max} \right\}. \quad (21)$$

Thus, ϵ represents the maximum relative sum-rate loss tolerated with respect to the best grid configuration. For example, $\epsilon = 0.05$ means that all configurations retaining at least 95% of $\bar{R}_{\text{sum}}^{\max}$ are accepted. Within $\mathcal{G}_\epsilon$, representative configurations are selected according to different implementation priorities. If reducing the number of ports is the main priority, the selected number of ports is

$$N_\epsilon^{(N)} = \min \{N : \exists W \text{ such that } (N, W) \in \mathcal{G}_\epsilon\}. \quad (22)$$

Among the accepted configurations with $N = N_\epsilon^{(N)}$, the smallest aperture is selected as

$$W_\epsilon^{(N)} = \min \left\{ W : (N_\epsilon^{(N)}, W) \in \mathcal{G}_\epsilon \right\}. \quad (23)$$

Therefore, $(N_\epsilon^{(N)}, W_\epsilon^{(N)})$ first minimizes the number of ports and then uses the aperture as a tie-breaker. Conversely, if

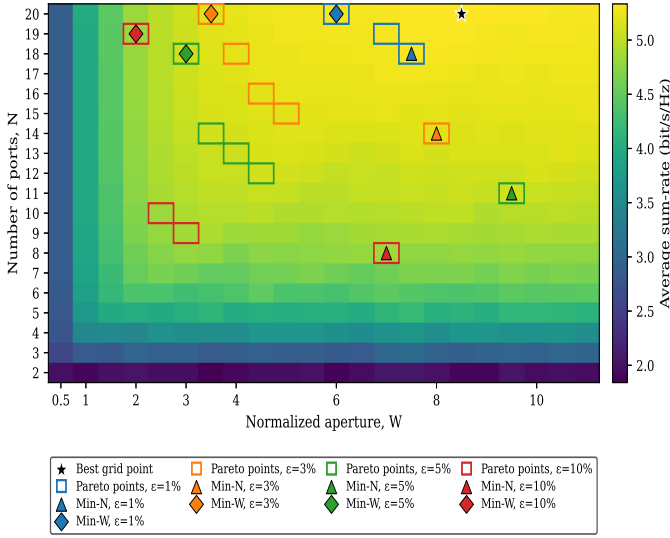


Fig. 1. Average sum-rate of the QoS-aware solution over the simulated (N, W) grid. The best grid point denotes the configuration with the highest average sum-rate.

reducing the physical aperture is the main priority, the selected aperture is

$$W_{\epsilon}^{(W)} = \min \{W : \exists N \text{ such that } (N, W) \in \mathcal{G}_{\epsilon}\}. \quad (24)$$

Among the accepted configurations with $W = W_{\epsilon}^{(W)}$, the smallest number of ports is selected as

$$N_{\epsilon}^{(W)} = \min \{N : (N, W_{\epsilon}^{(W)}) \in \mathcal{G}_{\epsilon}\}. \quad (25)$$

Hence, $(N_{\epsilon}^{(W)}, W_{\epsilon}^{(W)})$ first minimizes the aperture and then uses the number of ports as a tie-breaker. In addition to these representative choices, the Pareto-efficient configurations within $\mathcal{G}_{\epsilon}$ are identified. A configuration (N_1, W_1) dominates another configuration (N_2, W_2) if $N_1 \leq N_2$ and $W_1 \leq W_2$, with at least one strict inequality. Hence, a dominated configuration uses no fewer ports and no smaller aperture than another accepted configuration. The Pareto-efficient set contains all accepted configurations that are not dominated by any other accepted pair. These points form a discrete efficient frontier in which reducing N generally requires increasing W , or reducing W generally requires increasing N , while preserving the prescribed sum-rate tolerance. This analysis provides an engineering-oriented way to identify FAS configurations that retain near-maximum average sum-rate while avoiding unnecessary increases in the number of ports or in the aperture size. The simulation parameters are listed in Table I.

The configuration parameters N and W jointly affect the average sum-rate, as shown in Fig. 1. The Pareto-efficient points depend on the resolution of the simulated grid. A denser grid, comprising more admissible values of N and a finer range of W , could reveal additional configurations and yield a more detailed efficient frontier, at the cost of increased computational complexity. From a practical perspective, the near-optimal region supports different implementation priorities: smaller N favors lower receiver complexity, whereas smaller W favors more compact physical implementations, with limited sum-rate loss relative to the best grid point.

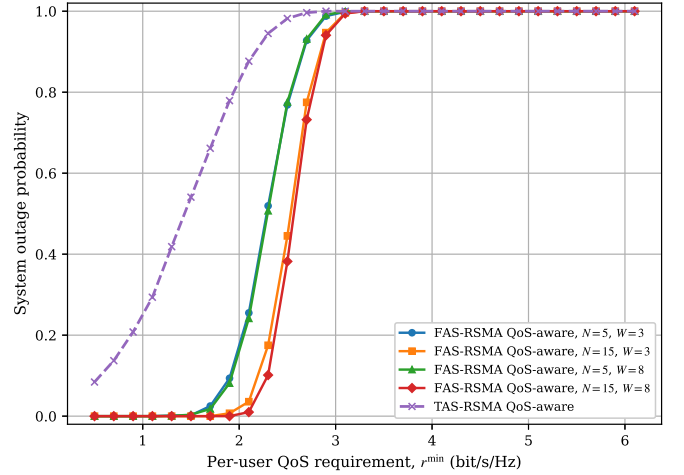


Fig. 2. System outage probability versus the per-user QoS requirement for selected FAS-RSMA configurations and the TAS-RSMA benchmark, considering $r^{\min} = r_1^{\min} = r_2^{\min}$.

Fig. 2 shows that FAS-RSMA, compared with TAS-RSMA, supports more stringent QoS requirements before entering system outage. Overall, the results reveal a general performance-improvement trend as N and W increase. However, the gains obtained by enlarging W are not strictly monotonic, since the oscillatory Jakes correlation structure may induce local fluctuations, and the improvement eventually saturates as the available spatial diversity is increasingly exploited.

For a fixed aperture W , increasing N does not enlarge the available physical region for port selection; it only refines the spatial sampling of the same interval. Thus, more candidate ports become available, which tends to improve the selected FAS gain, but the additional ports also become more correlated as the inter-port spacing decreases. Therefore, increasing N over a fixed aperture is expected to improve the average performance with diminishing returns. Conversely, for a fixed N , increasing W enlarges the aperture and changes the spatial correlation among ports. Under the Jakes-based model, the correlation between ports separated by m index positions is

$$\rho_m(W) = J_0\left(2\pi \frac{mW}{N-1}\right), \quad m = 1, \dots, N-1. \quad (26)$$

Since $J_0(\cdot)$ is oscillatory, strict monotonic improvement with W is not guaranteed. Nevertheless, increasing W generally reduces spatial dependence among ports and improves selection diversity until saturation occurs.

Fig. 3 shows that the sum-rate gain with increasing W saturates earlier for smaller values of N . To support this interpretation, we consider two deterministic correlation-based indicators. First, we define the average squared correlation as

$$C_N(W) = \frac{2}{N(N-1)} \sum_{m=1}^{N-1} (N-m) \left| J_0\left(2\pi \frac{mW}{N-1}\right) \right|^2, \quad (27)$$

which corresponds to the average squared off-diagonal correlation of the Jakes covariance matrix. The factor $(N-m)$ accounts for the number of port pairs separated by m index positions. Second, we consider a correlation-based effective number of ports as $N_{\text{eff}}(N, W) = N^2 / \|\Sigma\|_F^2$, where $\|\Sigma\|_F^2$ is

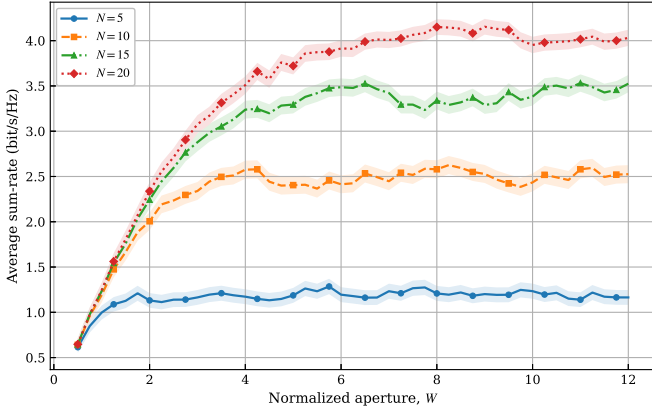


Fig. 3. Average sum-rate of the QoS-aware solution versus the normalized aperture W for different values of N . The shaded regions represent approximate 95% confidence intervals.

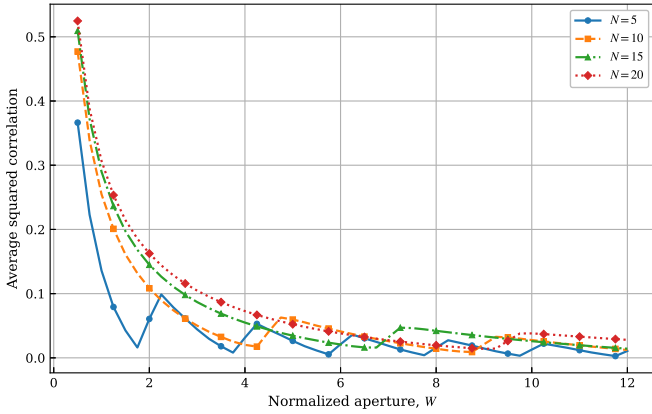


Fig. 4. Average squared spatial correlation versus the normalized aperture W for different values of N .

the squared Frobenius norm of the FAS correlation matrix. Using the Toeplitz/Jakes structure of Σ , this indicator can be written as

$$N_{\text{eff}}(N, W) = \frac{N}{1 + 2 \sum_{m=1}^{N-1} \left(1 - \frac{m}{N}\right) |J_0(2\pi \frac{mW}{N-1})|^2} \quad (28)$$

$$= \frac{N}{1 + (N-1)C_N(W)}.$$

Therefore, N_{eff} acts as an effective-dimensionality indicator, with $N_{\text{eff}} \approx N$ for weakly correlated ports and $N_{\text{eff}} \approx 1$ for almost fully correlated ports.

Fig. 4 and 5 show the W -sweep with these metrics. These quantities are not optimization objectives and are used only as interpretative indicators. Since they are deterministic functions of the Jakes correlation matrix, such figures do not use Monte Carlo realizations. Overall, the results reveal the coupled nature of the FAS design: increasing W is more beneficial when there are enough ports to exploit the aperture, while increasing N is more useful when the aperture is sufficiently large to provide distinct spatial samples.

V. CONCLUSIONS AND FUTURE WORK

The results presented in this work show that the FAS configuration should account for the joint effect of N and W on

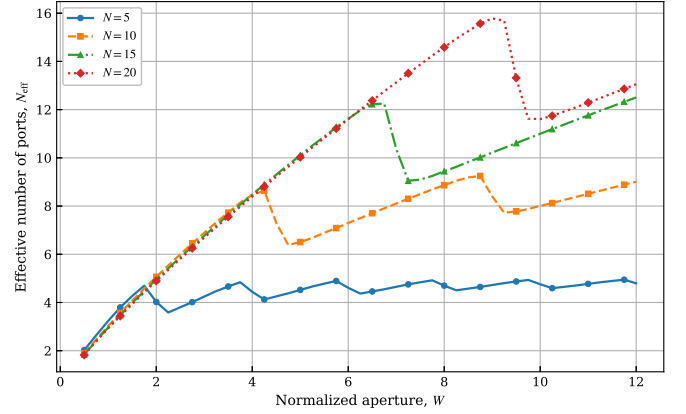


Fig. 5. Effective number of ports versus the normalized aperture W for different values of N .

spatial correlation, port-selection diversity, QoS feasibility, and implementation complexity. The proposed criterion identifies near-optimal FAS designs that preserve most of the maximum average achievable sum-rate while avoiding unnecessary increases in the number of ports or aperture size. The W -sweep analysis further shows that aperture enlargement is more beneficial when enough ports are considered, with gains eventually saturating due to the finite effective spatial diversity of the receiver. Future work may address larger user sets, uplink multi-antenna BS deployments, imperfect channel estimation, adaptive port-search strategies, and hardware-aware FAS-RSMA design.

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