



## Multi-User Multi-Stream Hybrid Precoding for Broadband Millimeter-wave Massive MIMO Systems (Extended Abstract)

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### 1 Extended Abstract

To compromise the hardware complexity and system performance, the hybrid analog/digital precoding architecture is widely considered in millimeter-wave (mmWave) massive multiple-input multiple-output (MIMO), which brings great challenge to the precoding design [1]. In this letter, we propose an efficient multi-user multi-stream hybrid precoding scheme for broadband mmWave massive MIMO systems, and further extend it so that it can be applied in a more practical dynamic partially-connected structure. The general criterion for designing precoding is to minimize the sum-mean-square-error (SMSE) between the received symbols  $\hat{\mathbf{x}}_u$  and transmit symbols  $\mathbf{x}_u$ . The SMSE of the  $k$ -th subcarrier can be expressed as

$$\xi_u[k] = \mathbb{E} \left[ \left\| \beta^{-1}[k] \hat{\mathbf{x}}_u[k] - \mathbf{x}_u[k] \right\|_2^2 \right], \quad (1)$$

where the normalization factor  $\beta[k]$  is introduced to remove the influence of beamforming gain. Based on the min-SMSE criterion, we propose to separately design the digital and analog precoder/combiner. More details about the proposed scheme are provided as follow.

1) *Digital Precoder/Combiner Design.* We design the digital precoder/combiner by using the state-of-the-art optimization method. The partial derivative of the desired variable with respect to  $\xi_u[k]$  and the well-known Lagrange multiplier method are applied to find the optimal digital combiner and precoder, respectively.

2) *Analog Precoder/Combiner Design.* Based on the designed digital precoder/combiner, we re-formulate  $\xi_u[k]$  via mathematical derivation and obtain a new and more tractable criterion to design the analog precoder/combiner. We also consider that the analog precoder/combiner are drawn only from the finite codebooks, which benefits the computational complexity and feedback overhead.

3) *Extension to Dynamic Partially-connected Structure.* We further extend the aforementioned scheme to a more energy-efficient dynamic partially-connected structure. To cope with the more hardware constraint brought by such a structure, we proposed a low-complexity energy-based greedy antenna grouping design to group the antennas at the base station and achieve better performance.

Simulations have been conducted to fairly compare the performance of the proposed scheme with that of the existing hybrid precoding schemes [2, 3]. The simulation results demonstrate that the proposed scheme with the fully-connected structure provides an upper-bound for all other schemes, and the proposed scheme with the dynamic partially-connected structure outperforms its counterparts [2, 3].

### References

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