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Reducing Transmit Power by Optimizing the Location of Distributed Antenna Arrays

Background

Distributed antenna system (DAS): interconnected antenna arrays distributed over different locations. Centralized antenna system (CAS): all the antennas in one location. We aim to optimize the array placement of the DAS for minimizing the total transmit power while guaranteeing a minimum received power at each user location (Figure 1).

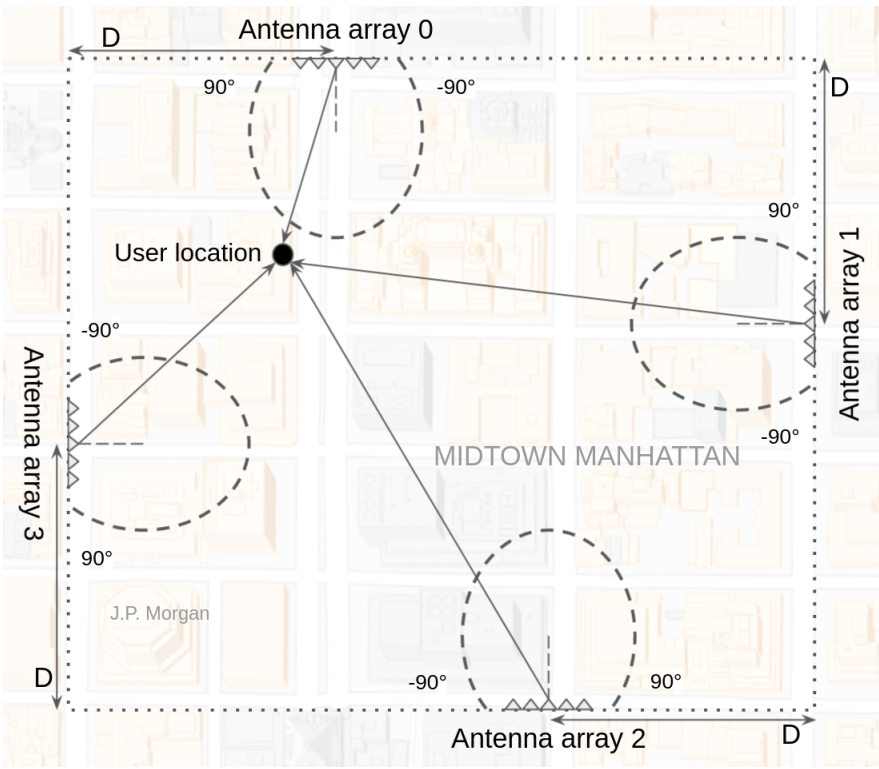

Figure 1: The DAS: four 32-element (half-wavelength spaced) uniform rectangular arrays (URAs) symmetrically placed; dashed curves: array gain patterns; black point: one of the possible user locations that uniformly cover the dotted square region.

Contributions

- Study the optimization of the array placement for the DAS in an urban area scenario with a square topology for the first time.
- Investigate the optimal array placement and transmit power of the DAS considering antenna gain and mutual coupling.

Results

(1) Array placement and radiation pattern have a huge impact on the performance of the DAS. The DAS with unoptimized array placement may perform worse than the CAS (Figure 2).

(2) Using patch antennas with mutual coupling, the DAS saves 7-11 dB power compared to the CAS (Figure 2).

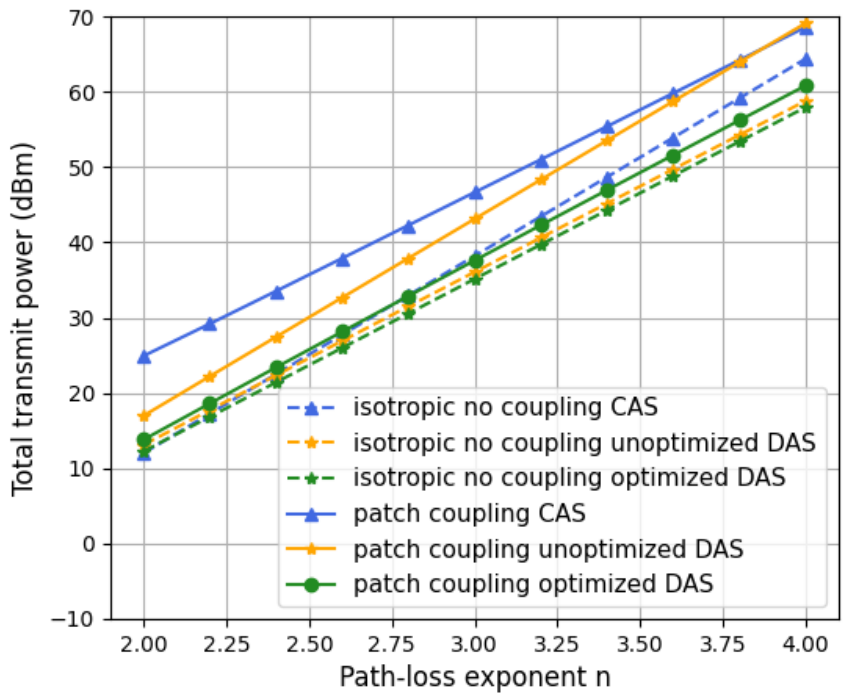

Figure 2: Power required by the DAS with signals from different arrays non-coherently combined and CAS of one 128-element URA, two gain patterns: isotropic antennas without mutual coupling and patch antennas with mutual coupling, region: 400 m×400 m.

(3) For the DAS using patch antennas, mutual coupling effect has a larger impact on the optimal placement compared to region size and coherence of the signals from different arrays (Figure 3).

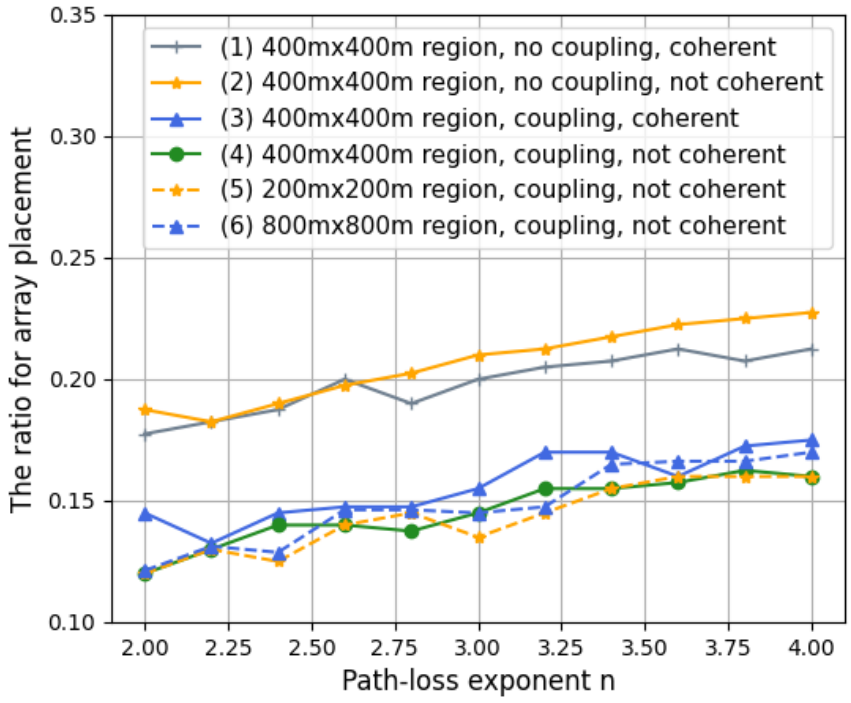

Figure 3: Optimal array placement in different scenarios. Each placement is symmetrical regarding the region center and represented by the ratio between the x-coordinate of the top array and edge length of the square region.