

Operational downlink performance limits of next-generation networks

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Purpose:

This presentation is intended to give a realistic view on achievable performance under operational conditions.

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Operational downlink performance limits of next-generation networks

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Alcatel-Lucent, March 2007

Overview

- Objective: Estimate *operational* downlink performance limits of next-generation networks (like 802.16m).
 - To provide guidance on whether performance targets being considered are reasonable.
- Methodology: Map SINR to data rate based on Shannon limit with 3 dB implementation penalty per spatial stream.
 - Reasonable approximation of state-of-the-art modems.
- Metrics: peak rate (10% coverage), median rate (50% coverage), and cell edge rate (90% coverage).

System architectures being compared

- **SIMO: 3 sectors per cell, 1 Tx antenna per sector.**
 - Serves as baseline for comparison.
- **SU-MIMO: 3 sectors per cell, 4 Tx antennas per sector.**
 - Closed-loop spatial multiplexing, with perfect CSI at Tx (feasible even with fewer than 4 Rx antennas per user).
- **MU-MIMO: 12 sectors per cell, 1 Tx antenna per sector.**
 - Intended as rough approximation of advanced beamforming techniques through precoding.

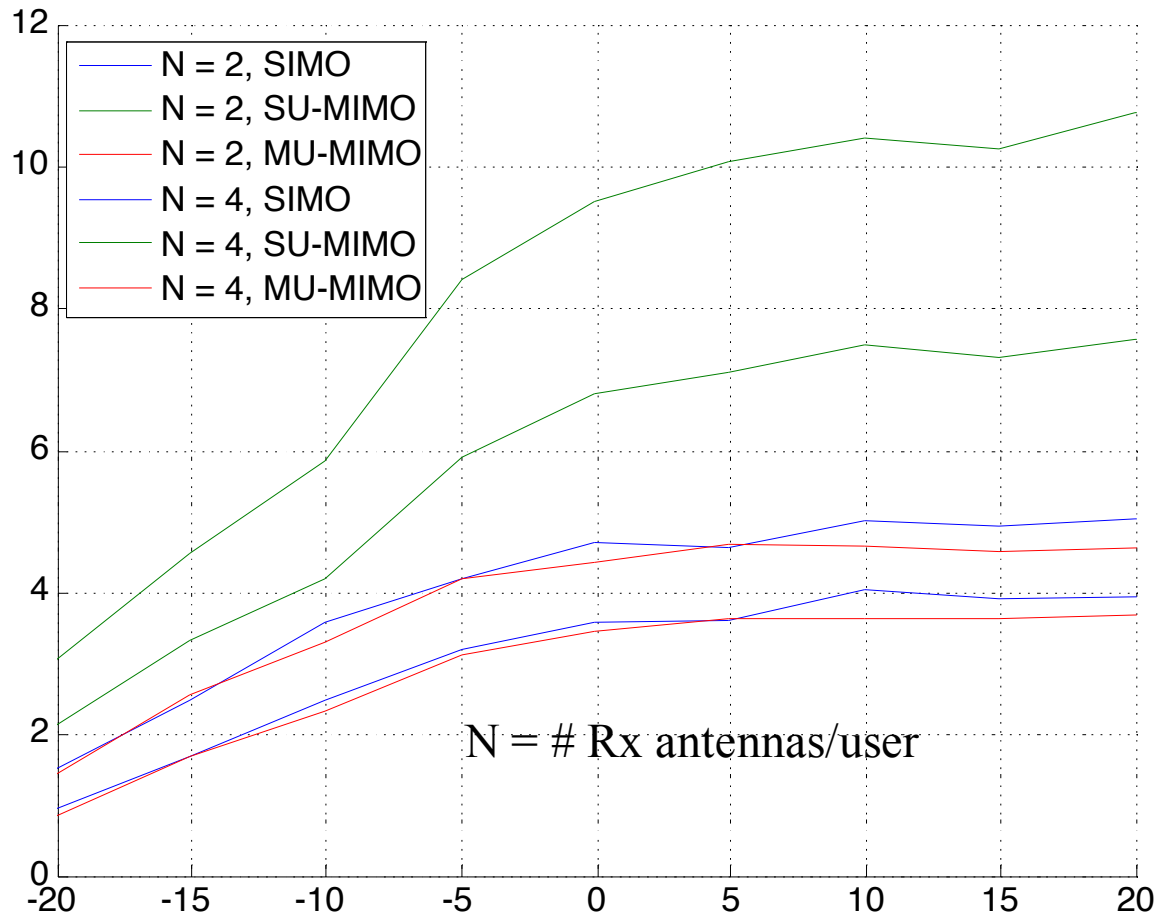
Methodology

- Generate CDF of SINR by dropping users randomly in center cell of 19-cell network (all sectors transmit at full power).
 - Universal frequency reuse assumed (no FFR, etc.).
- Map CDF of SINR to CDF of achievable data rate, based on Shannon capacity with 3 dB SINR loss per spatial stream.
 - Entire available bandwidth used to serve users (overheads for pilots, signaling, etc., not accounted for).
- Extract 10%, 50%, and 90% points of data rate CDF.

Methodology

- Results parameterized by “reference SNR” at midpoint of two adjacent bases (no interference).
 - Accounts for net effect of Tx power, noise bandwidth, cell size, propagation characteristics, antenna gains, cable losses, noise figures, etc.
- For typical parameter values and bandwidth approaching 100 MHz, reference SNR should be in the 0-10 dB range.
- Standard parabolic sector antenna pattern assumed.

Peak spectral efficiency (per user)

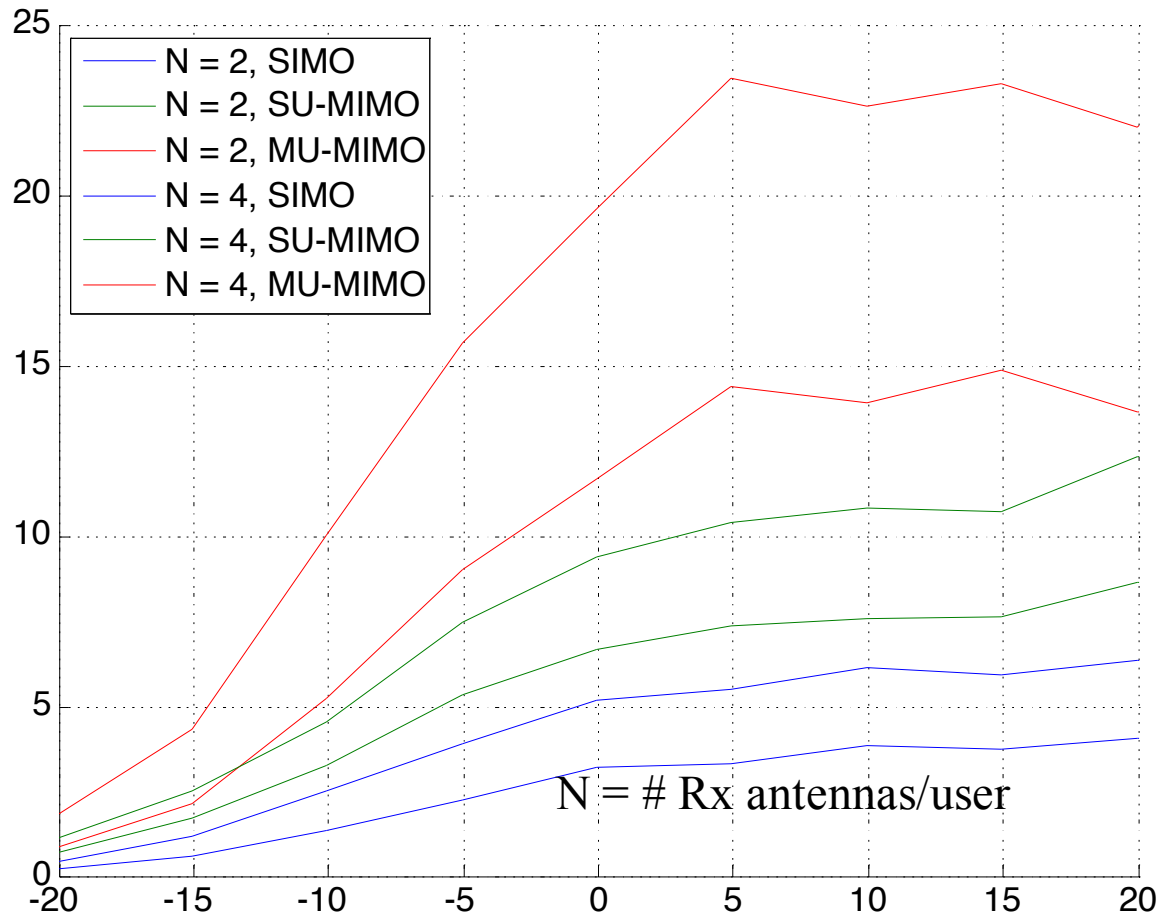


SU-MIMO is best, due to sp. mux. gain.

Saturation in peak rate due to back-lobes of other sectors of same cell (limits peak SINR).

With 2 Rx antennas, peak rate is capped at approx. 7 bps/Hz.

Median spectral efficiency (per cell)

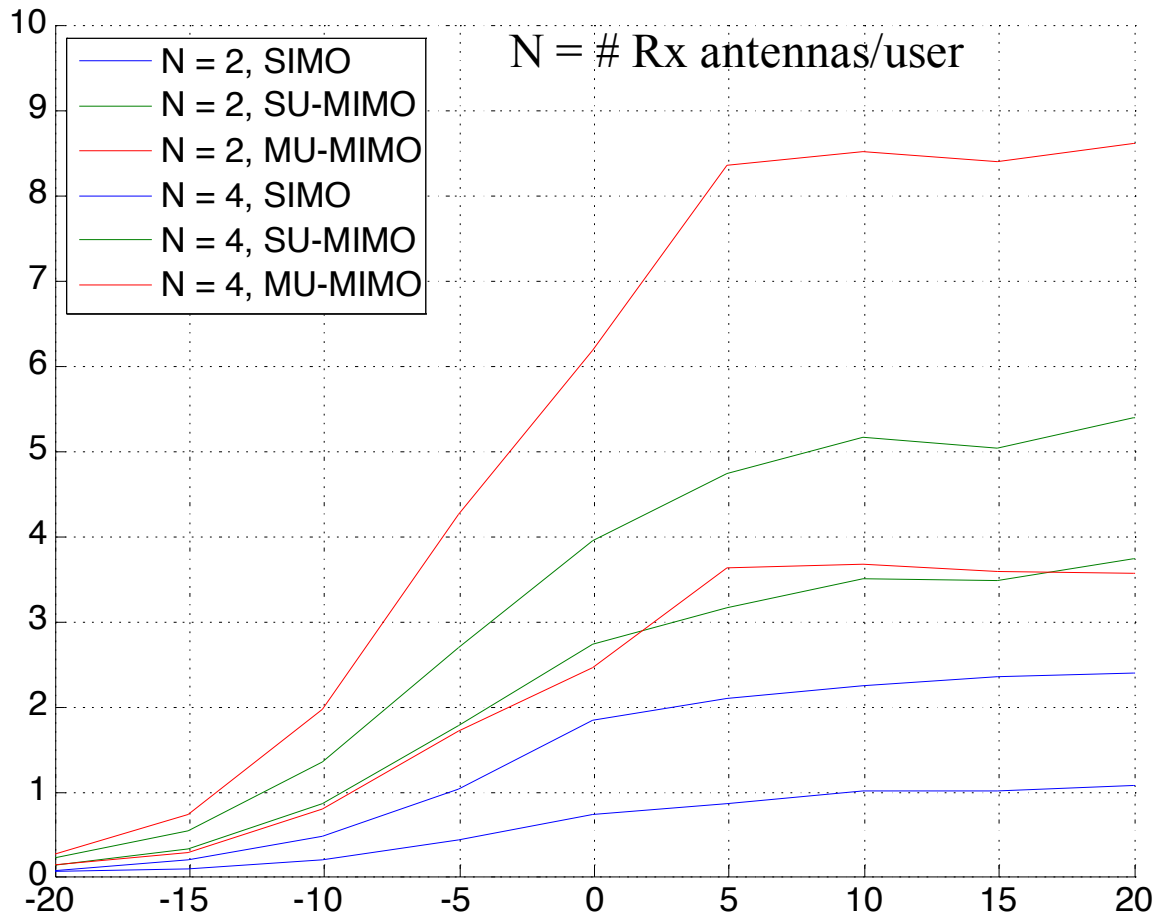


MU-MIMO is the clear winner, due to greater resource reuse in each cell (more users served simultaneously).

Saturation in median rate caused primarily by other-cell interf.

With 2 Rx antennas, median throughput is capped at 12-15 bps/Hz/cell.

Cell edge spectral efficiency



MU-MIMO is again the winner, due to greater resource reuse in each cell (more users served simultaneously).

Saturation in cell-edge rate caused primarily by other-cell interf.

With 2 Rx antennas, edge throughput is capped at 3-4 bps/Hz/cell.

Conclusions

- Estimated operational downlink performance limits of next-generation networks like 802.16m:
 - Methodology based on mapping SINR CDF to data rates using Shannon limit (with implementation loss).

Compared SIMO, SU-MIMO and MU-MIMO architectures.

 - MU-MIMO approximated by high-order sectorization.
- Metrics used are based on data rate CDF (10%, 50%, and 90% availability), and are arguably more meaningful than theoretical limit imposed by modulation and coding.