Operational downlink performance limits of next-generation networks

IEEE 802.16 Presentation Submission Template (Rev. 8.3)

Document Number:

C802.16m-07/077

Date Submitted:

2007-03-12

Source:

Howard Huang, Sivarama Venkatesan, Reinaldo Valenzuela
Alcatel-Lucent
Voice: [Telephone Number]
Fax: [Fax Number]
E-mail: Joerg.Schaepperle@alcatel-lucent.de

Venue:

[Cite the specific meeting and any known agenda details.]

Base Document:

[If this presentation accompanies an 802.16 document, cite the document number (e.g., IEEE C802.16x-02/NNr0) and URL <http://ieee802.org/16/… C80216x-02_NNr0.pdf>.]

Purpose:

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

Operational downlink performance limits of next-generation networks

Howard Huang, Sivarama Venkatesan, Reinaldo Valenzuela

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.

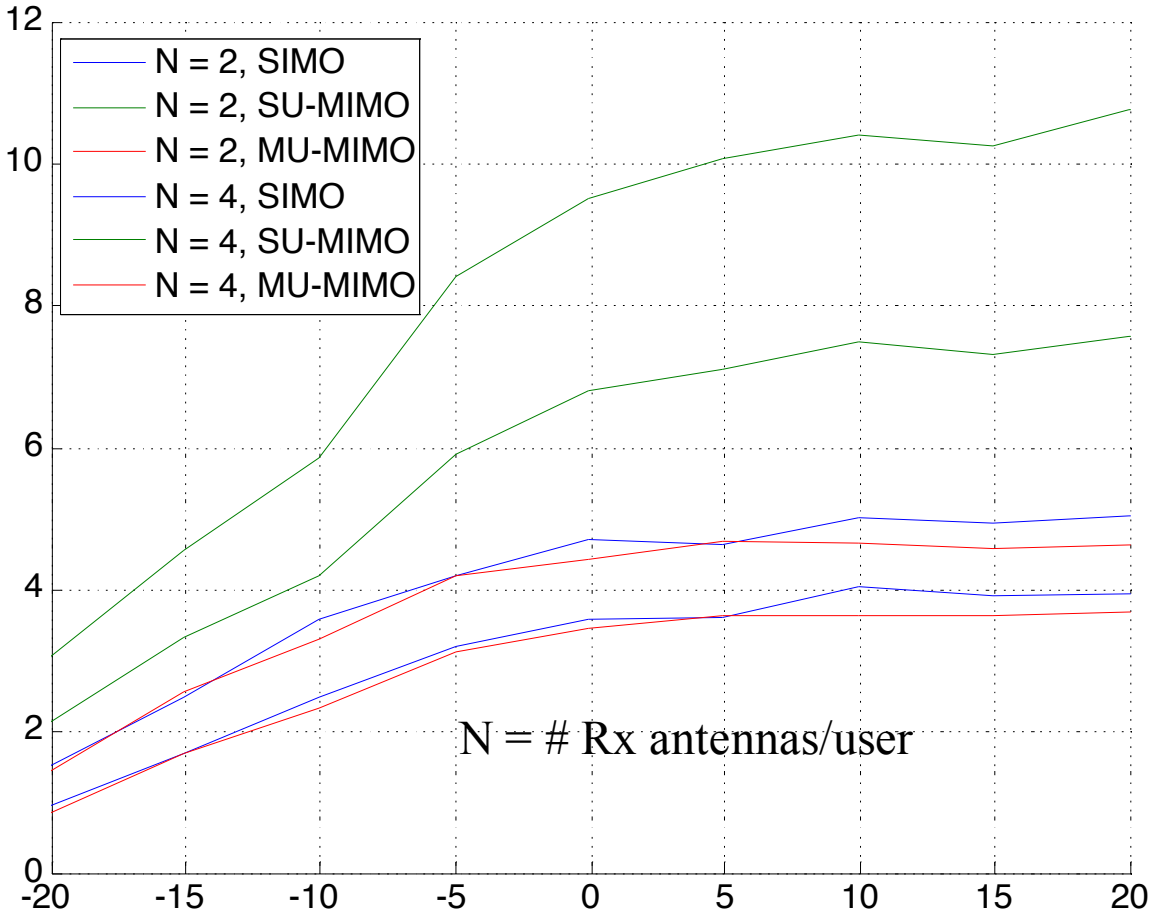
Methodology

- 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)

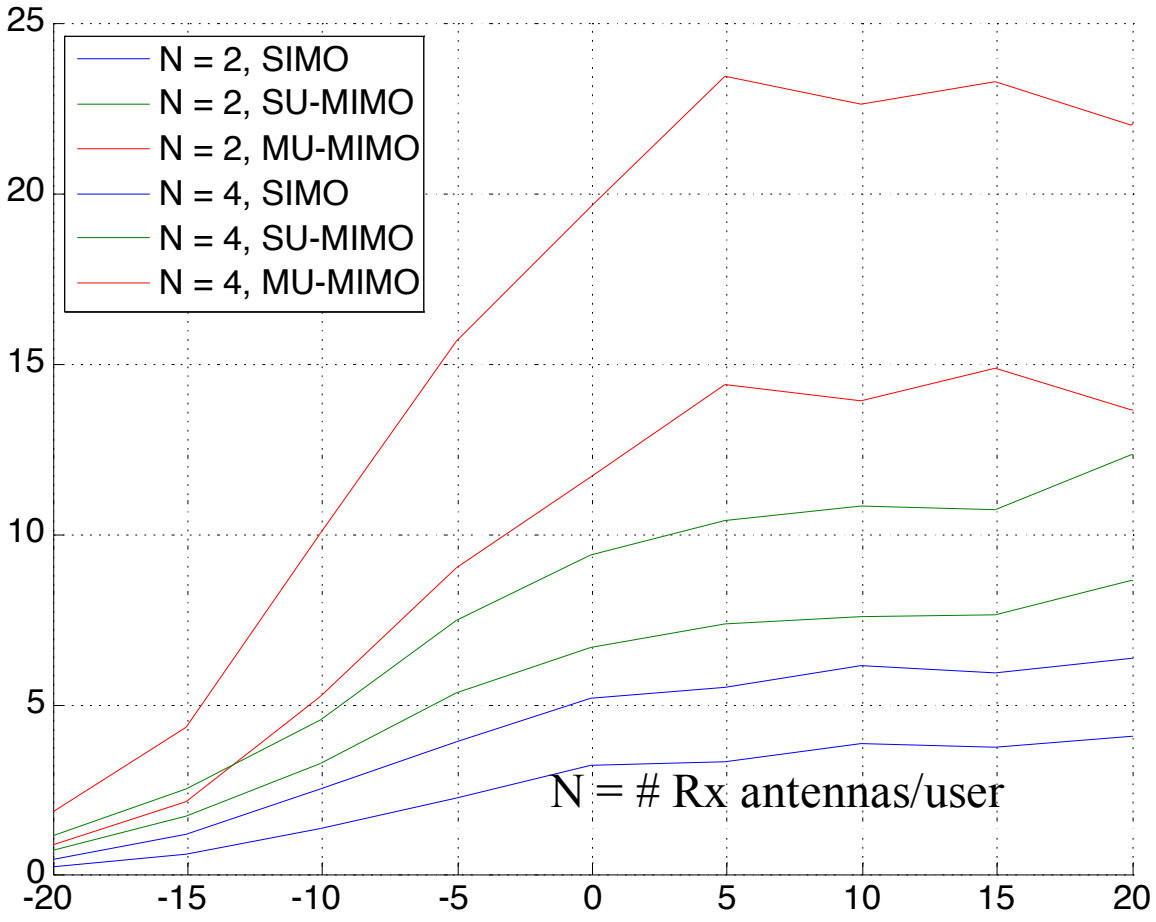


SU-MIMO is best, due to sp. mux. gain.

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)

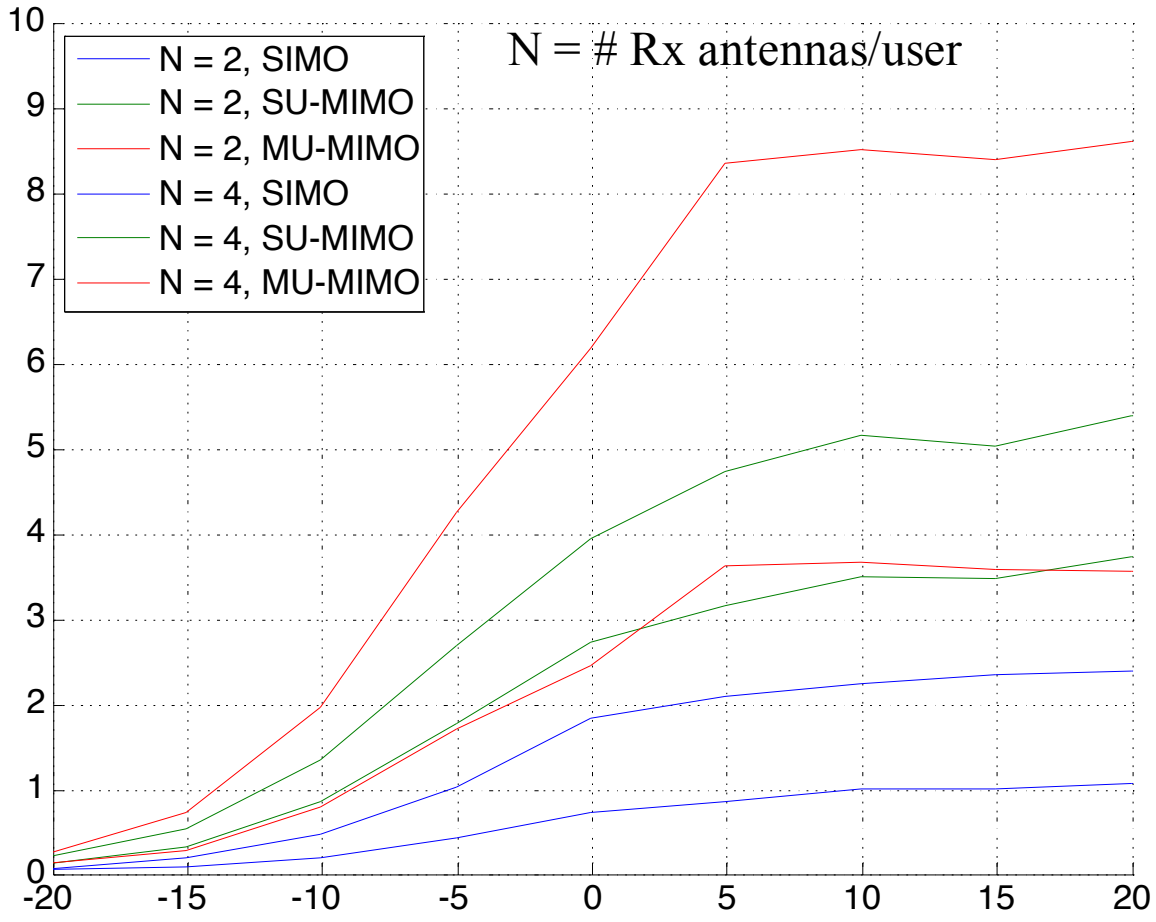


MU-MIMO is the clear winner, due to greater resource reuse in each cell (more users served simultaneously).

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.