Project	**IEEE 802.16 Broadband Wireless Access Working Group <**http://ieee802.org/16**>**
Title	**Selective Opportunistic Beamforming for DL MIMO**
Date Submitted	**2008-05-07**
Source(s)	Young Hoon Kwon, Cornelius Van Rensburg, Zhigang Rong, Yunsong Yang, Jack Smith, Anthony Soong, Yang Tang, Jianmin Lu Huawei Technologies E-mail: ytang@huawei.com
Re:	IEEE 802.16m-08/016r1: Call for Contributions on Project 802.16m System Description Document (SDD). Target topic: “Downlink MIMO Schemes” and “Uplink control Structures”.
Abstract	This contribution proposes multi user MIMO scheme for downlink transmission
Purpose	For discussion and approval by TGm
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Objectives

- In this contribution, we propose a downlink multi user MIMO scheme.
- The proposed scheme can reduce channel status information feedback overhead adaptively while maintaining system capacity depending on system load.

Background

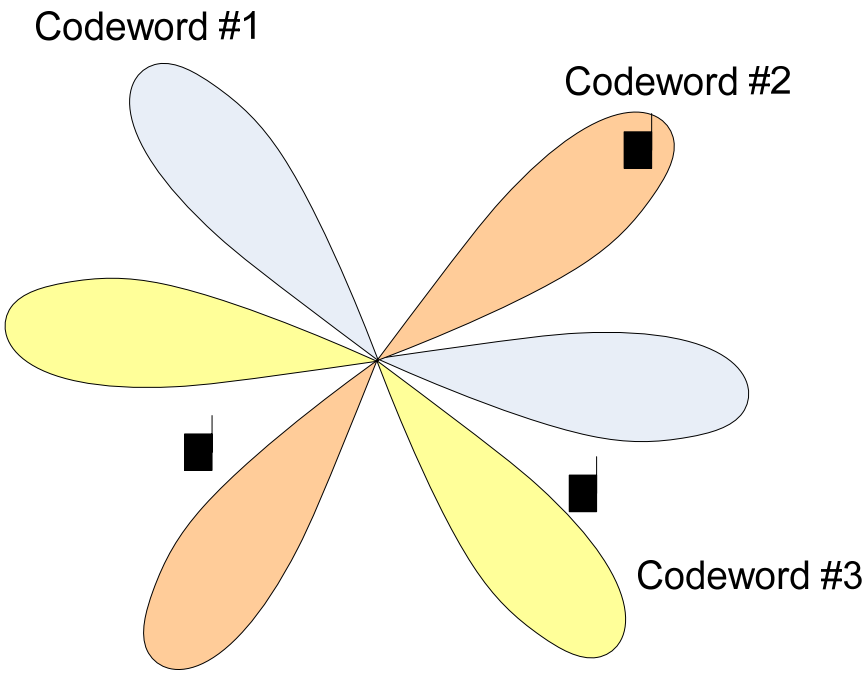
- In case the number of spatial streams increases, the required feedback size for closed loop MIMO increases accordingly.
- Especially for the case there are large number of users in a cell, the feedback overhead will be tremendous and it will occupy considerable amount of reverse link resource.
- To reduce feedback overhead especially for the case of many users, opportunistic beamforming has been proposed.
- However, the performance of opportunistic beamforming decreases significantly in case there are small number of users in a cell.

Proposed Idea

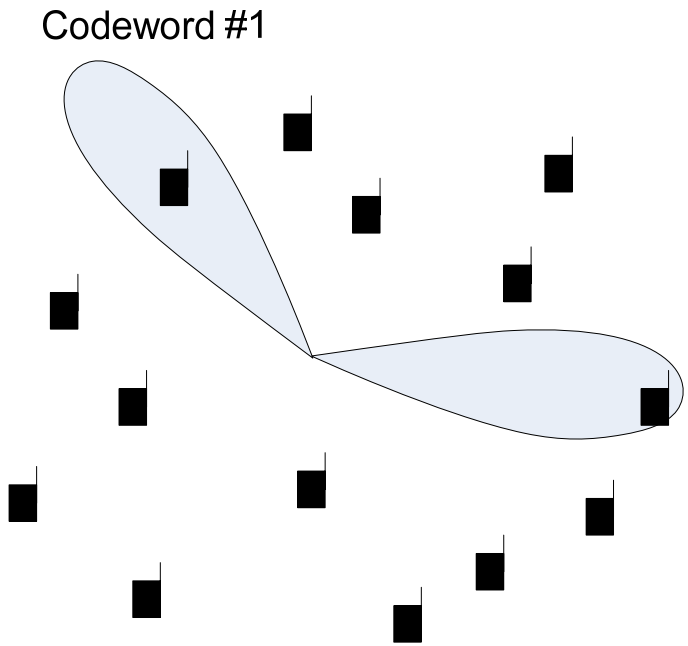
- Selective Opportunistic Beamforming (SOBF)
  - Adaptively change effective codebook size according to cell loading condition.
  - In low user density, use larger effective codebook so that each user can have less channel quantization error.
  - In high user density, use smaller effective codebook so that feedback overhead is minimized while performance is maintained due to multi user diversity gain.

Proposed Idea

- Example scenario
  - Each codeword has two vectors.



Multiple candidate codewords for low user density



Single candidate codeword for high user density

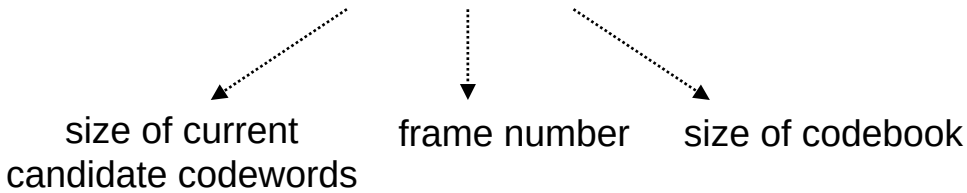
Proposed Idea

- System configuration
  - Big codebook is predefined.
  - Only part of this codebook is used for candidate codewords at every scheduling period.
  - BS decides the size of candidate codewords depending on cell loading information (implementation issue). And, the size and which part of the codebook is used are broadcasted by BS.
  - The amount of CSI feedback information is adaptively varied depending on the size of candidate codewords.

Proposed Idea

- Indexing of used candidate codewords
  - Size of candidate codewords: Broadcasted by control channel
  - Starting point of used codewords: Two ways
    - Explicit indexing: Broadcasted by control channel
    - Implicit indexing
      - Both BS & MS has agreement which codewords are used at specific frame.
      - Starting point information is not broadcasted.
      - E.g.) starting point of i-th frame, SP[i]

$$SP[i] = \mathrm{mod}(K \times FRN, X)$$

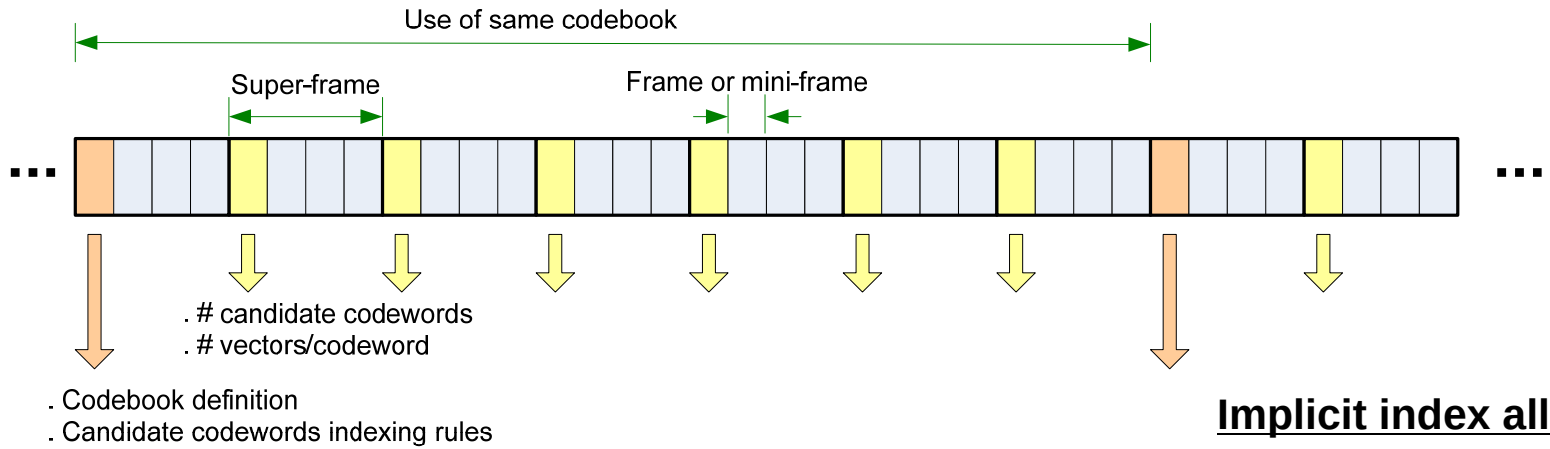


Proposed Idea

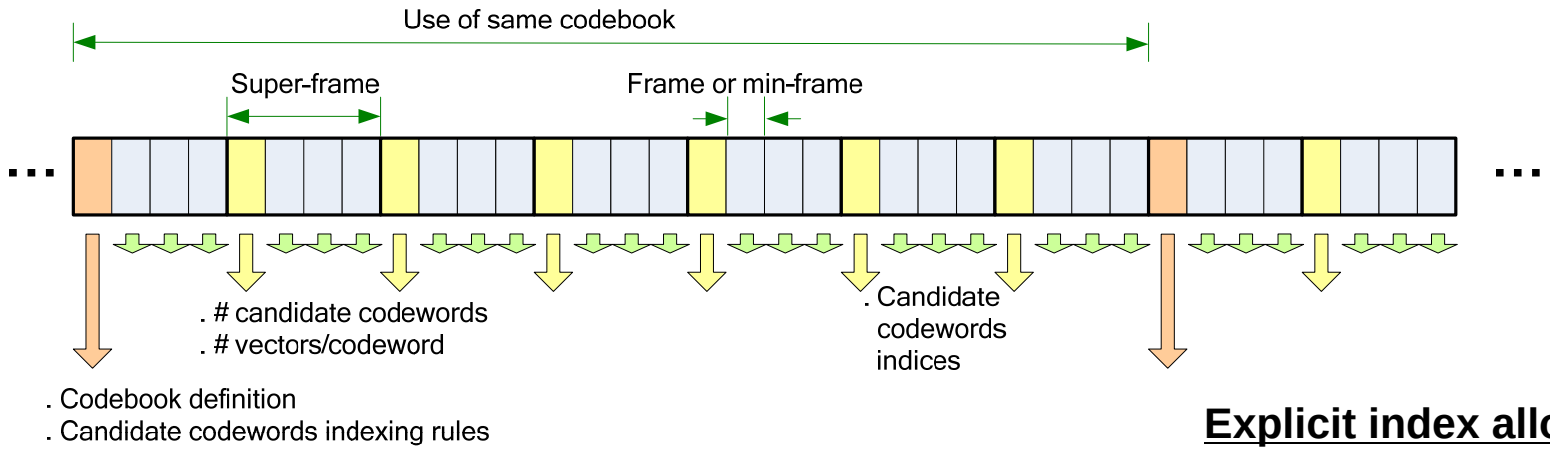
- CSI feedback channel
  - The effective size of CSI feedback channel needs to be varied dynamically according to the size of candidate codewords.
  - For a specific frame, the size of CSI feedback for every user is the same. It does not require different sizes for different users.
  - Possible way of designing CSI feedback channel
    - Way 1: Redesign CSI feedback channel such that occupied resource size can be a variable
    - Way 2: Assign fixed feedback channel resource size but allocated different power according to candidate codewords size to reduce other cell interference adaptively

Proposed Idea

- Preferred operation scenario: Feed forward information



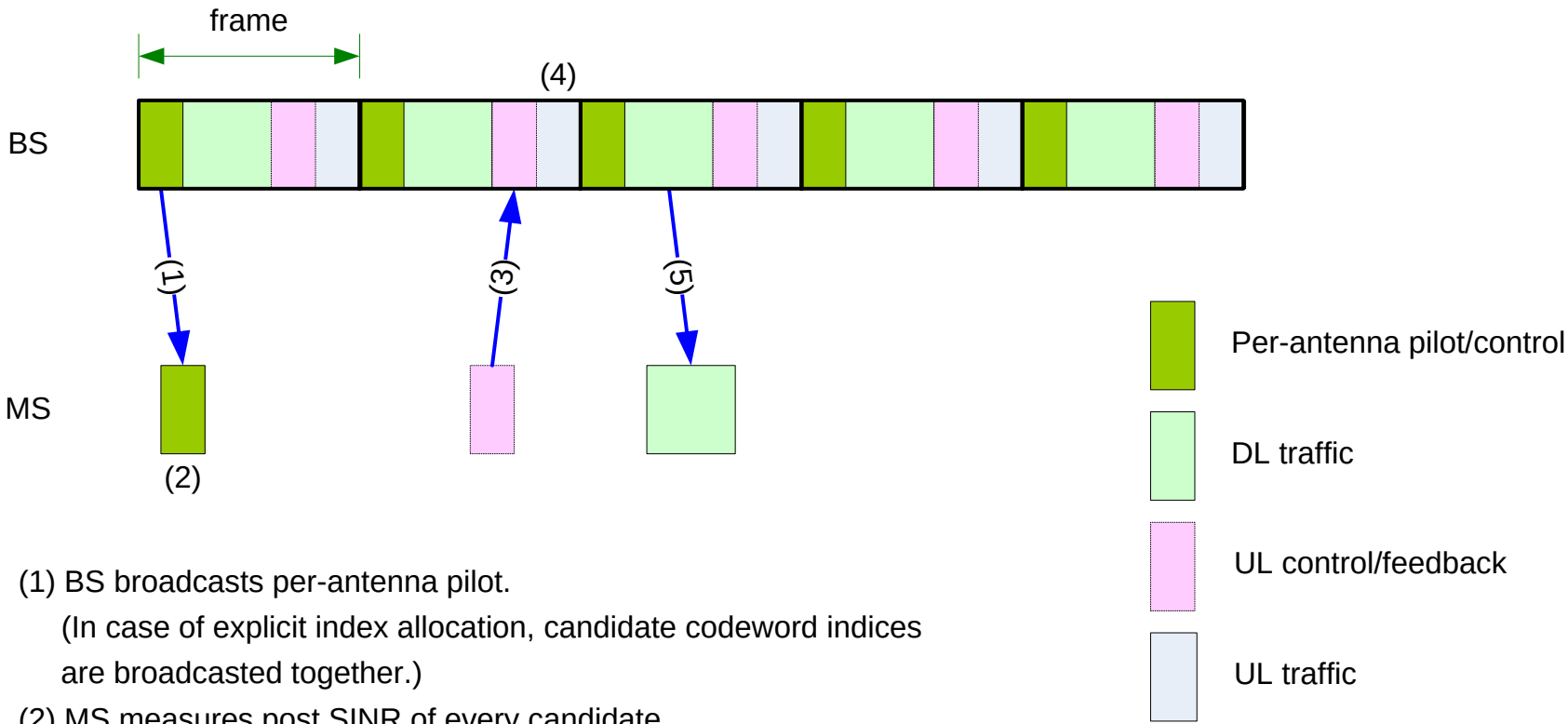
Implicit index allocation



Explicit index allocation

Proposed Idea

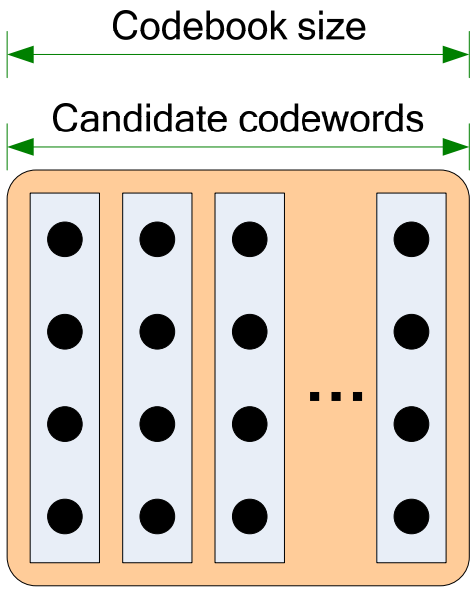
- Preferred operation scenario: Procedures



(1) BS broadcasts per-antenna pilot.
(In case of explicit index allocation, candidate codeword indices are broadcasted together.)
(2) MS measures post SINR of every candidate
(3) MS feedbacks the strongest SINR together with corresponding cordword and/or vector indices.
(4) BS schedules based on feedback information from every user.
(5) BS transmits traffic data to scheduled users using fedback beam weights.

Proposed Idea

- Harmonization with conventional CL-MIMO
  - By proper setting parameters of proposed idea, conventional CL-MIMO can be included.
    - In case the number of candidate cordwords is set equal to codebook size, it is equivalent to conventional CL-MIMO.



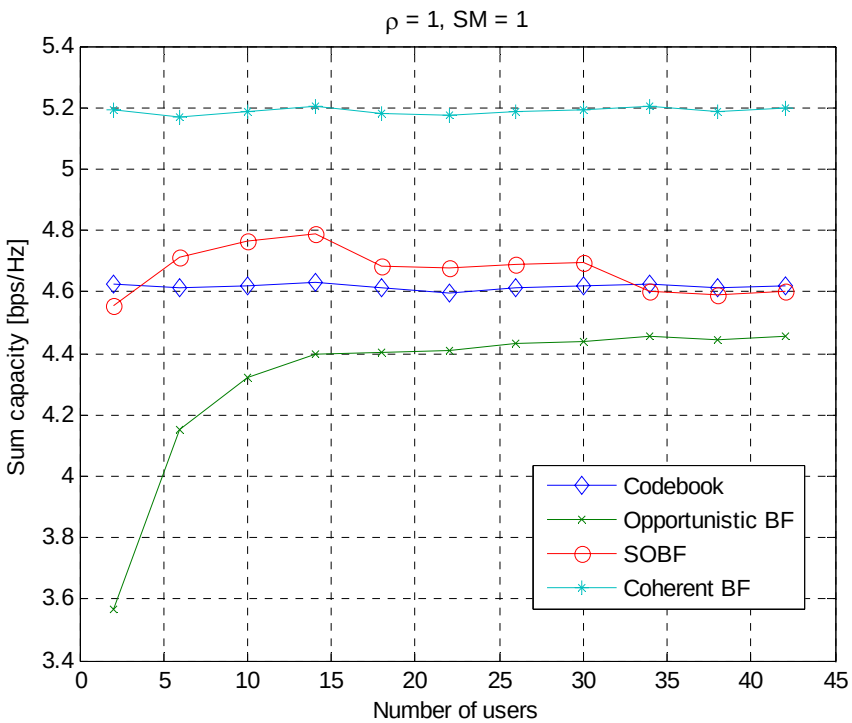
Simulation Results

- Simulation condition

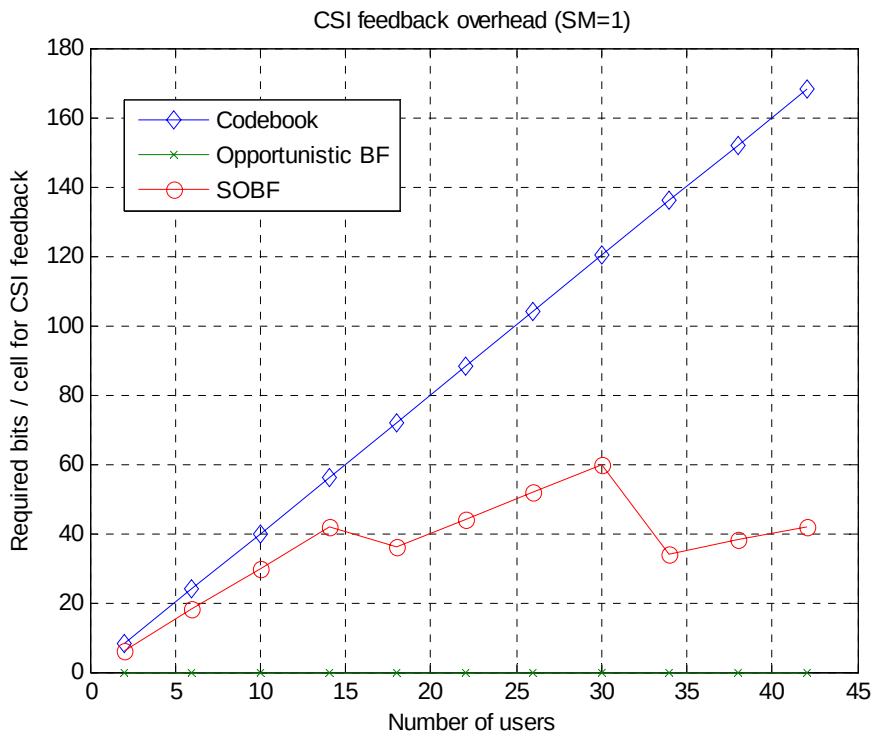
Items	Used Parameters
Antenna config.	4Tx / 1Rx
Spatial Multiplexing	1 (SM=1), 2 (SM=2)
MIMO scheme	. Codebook based (LTE 4bit codebook) . Opportunistic BF . SOBF
Scheduler	Proportional Fair
Channel	i.i.d Complex Gaussian
Mobility	Static (Perfect frame-by-frame correlation (ρ=1)) Very fast (No frame-by-frame correlation (ρ=0))
SNR	10dB average (Same for all users)
Sum rate	Shannon capacity

Simulation Results

- SM = 1, static case (ρ=1)



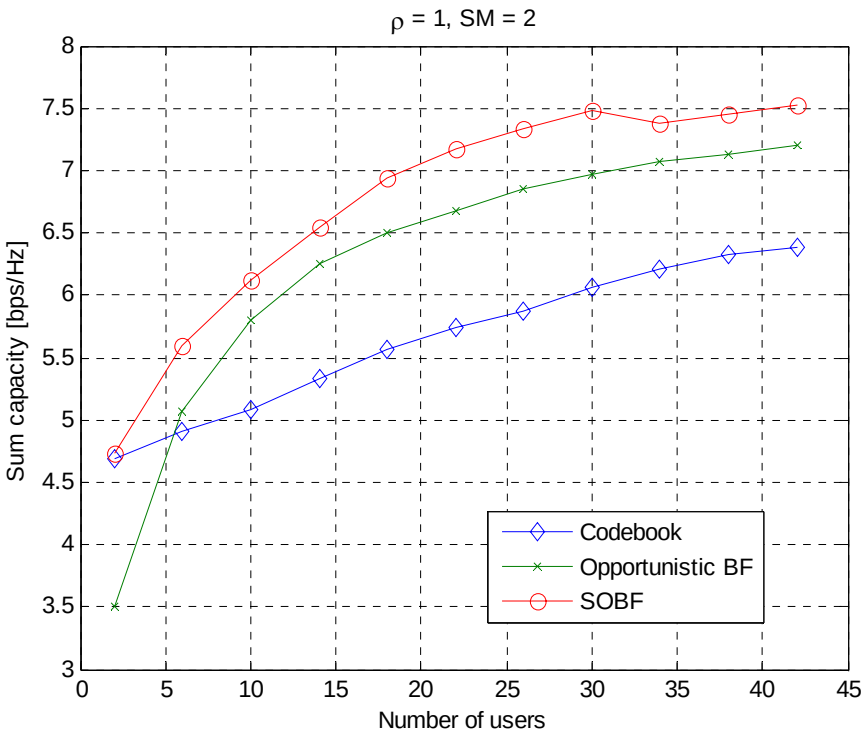
Capacity



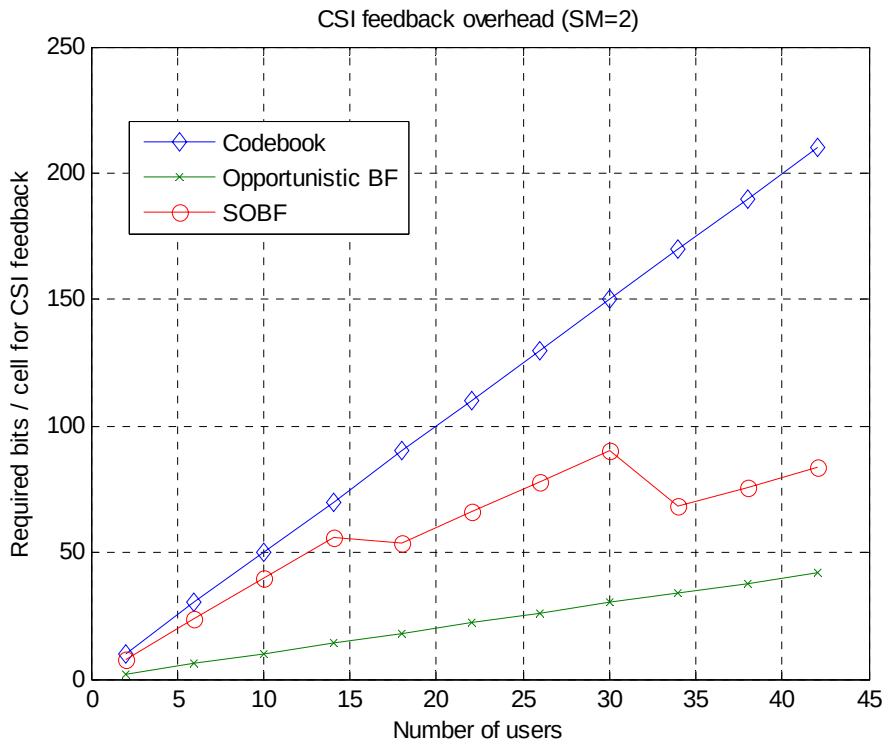
CSI Feedback Overhead

Simulation Results

- SM = 2, static case (ρ=1)



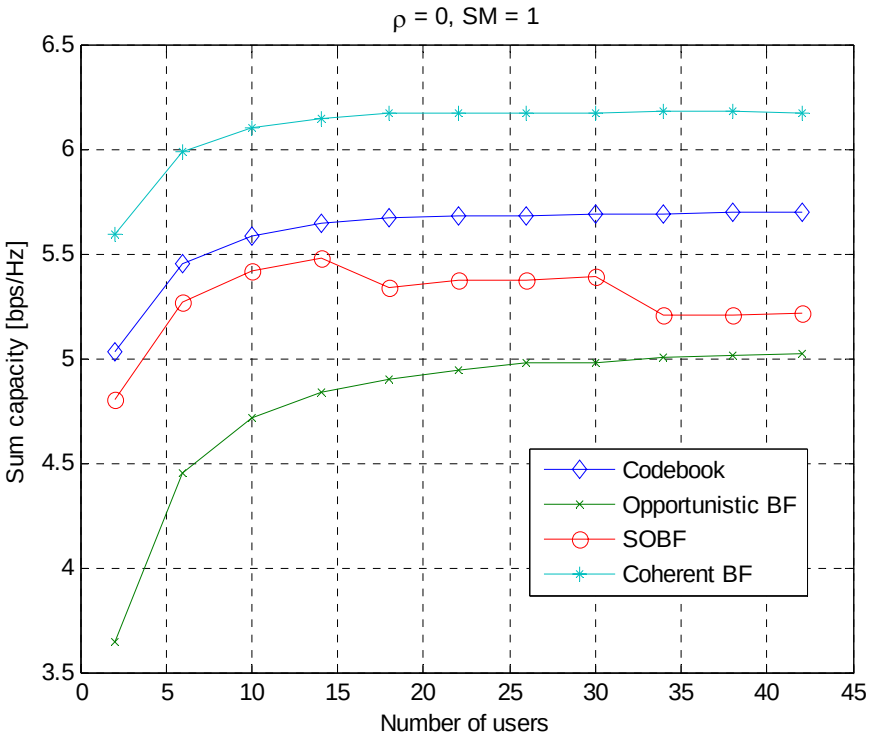
Capacity



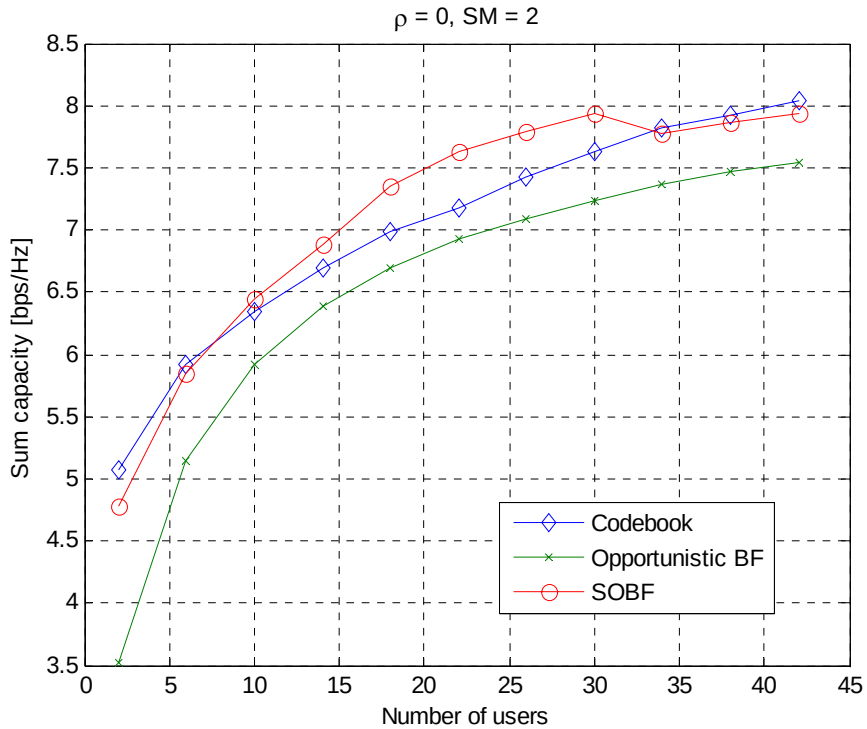
CSI Feedback Overhead

Simulation Results

- High mobility case (ρ=0)



SM = 1



SM = 2

Advantages

- Trade off between feedback overhead & performance can be controlled by BS.
- Total amount of feedback is reduced while maintaining system performance.
- Can be generalized to include CL-MIMO.

Text Proposal

Insert the following text in Chapter 11 (Physical Layer):

11.Z1 Codebook design for DL MIMO

…

11.Z1.X Candidate codewords

At every CSI feedback period, only part of codewords out of entire codebook is used in obtaining best codeword, and the used codewords for the period are broadcasted by BS.

…

11.Z2 Uplink control structure

…

11.Z2.Y CSI feedback bits

The size of CSI feedback bits is determined by the size of used codewords for the period, which is broadcasted by BS.