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Massive MIMO System

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Abstract: The Massive MIMO system use of large-scale antenna array brings improvement in spectral efficiency to wireless system. The number of antenna at BS increase thus a string signals are achievable. We prove that large degree of freedom offered by Massive MIMO can be used to reduce transmit power. The matched filter processing at the BS uncorrelated noise & interference disappears completely.

I. INTRODUCTION

Massive MIMO departs from the Shannon practice on three ways. The Base Station (BS) learns down link channel. In TDD the required to acquire CSI independent of number of base station antennas. The number of BS antenna increased to several times the number of Users. Number of Pilot Symbols required. The Linear Precoding multiplexing on Down Link (DL).

The rate scaling for Multi filter interference as the numbers of antennas are going to increase the power levels spitted to equal to the all antennas. Power number of pilot equal to the power per symbol/ no.of users. Where p_u is power of user. The desired power is very significant able to suppress the channel for each user divided by M.

II. RATE SCALING IN MASSIVE MIMO SYSTEM:

The very large multi user MIMO system comprise of a hundred / few hundred of antennas simultaneously serving few tens of users [1]. BS antennas grows large the random channel vectors between the users & BS become pairwise orthogonal. The matched filter processing at the BS uncorrelated noise & interference disappears completely [2]. Now consider the uplink MU-MIMO one BS with an array of M antennas receives data from Rth single antenna user. The channel vector between BS & user R

$$V_R = \begin{bmatrix} v_{1R} \\ v_{2R} \\ v_{3R} \\ . \\ .\, v_{NR} \end{bmatrix}$$

Where V is the channel Vector. Then $M \times 1$ received vector Y at the BS is

$$Y = \sqrt{p_u}\ [\, v_1\, v_2\, v_3 \dots \dots \dots v_R] \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ . \\ . \\ x_R \end{bmatrix} + \begin{bmatrix} n_1 \\ n_2 \\ n_3 \\ . \\ n_M \end{bmatrix}$$

$$Y = \sqrt{p_u}\, VX + n$$

Where n is a vector AWGN. p_u has interpretation normalized transmitted SNR & it is dimensionless. The channel coefficient $v_{mR} = h_{mR}\sqrt{\beta_R}$

h_{mR} is the fast fading coefficient from the Rth user to Mth antenna of a BS.

β_R Models the attenuation and shadow fading.

$$E\{|h_{mR}|\} = 1$$
$$E\{|v_{mR}|^2\} = \beta_R$$
$$V = HD^{1/2}$$

$$V = [h_1\, h_2\, h_3\, h_4 \dots \dots\ h_R] \left[\begin{pmatrix} \beta_1 & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & \beta_R \end{pmatrix}\right]$$

D is $R \times R$ diagonal matrix where $[D_R] = \beta_R$

$$Y = \sqrt{p_u} \sum_{i=1}^{R} \tilde{h}_i x_i + n$$

Consider user 1 as the desired user without loss

$$Y = \sqrt{p_u} R \tilde{h}_1 x_1 + \sqrt{p_u} \sum_{i=2}^{R} \tilde{h}_i x_i + n$$

Consider user 1 & user 2 as the desired user without loss

$$Y = \sqrt{p_u}\tilde{h}_1 x_1 + \sqrt{p_u}\tilde{h}_2 x_2 + \sqrt{p_u} \sum_{i=3}^{R} \tilde{h}_i x_i + n$$

The Matched filter for user 1 is

$$reciver_1 = \frac{\tilde{h}}{\|\tilde{h}_1\|}\ Y$$

$$reciver_1 = \sqrt{p_u}\|\tilde{h}_1\|x_1 + \sqrt{p_u}\sum_{i=2}^{R}\frac{\tilde{h}_1^H}{\|\tilde{h}_1\|}\tilde{h}_i x_i + \frac{\tilde{h}_1^H}{\|\tilde{h}_1\|}n$$

$$reciver_2 = \frac{\tilde{h}_2}{\|\tilde{h}_2\|}Y$$

$$SINR = \frac{p_{u\,\|\tilde{h}_1\|^2}}{p_u\sum_{i=2}^{R}\left[\frac{\tilde{h}_1^H}{\|\tilde{h}\|}\tilde{h}_i x_i\right]^2 + 1}$$

$$\frac{\tilde{h}_1^H}{\|\tilde{h}_1\|}n \sim N(0,1)$$

$$\frac{\tilde{h}_1^H}{\|\tilde{h}_1\|}R_i \sim N(0,\beta_i)$$

$$SINR \rightarrow \frac{p_{u\,\|R_1\|^2}}{p_u\sum_{i=2}^{R}\beta_i + 1}$$

$$p_u = \frac{E_u}{M}$$

E_u is power of each user.

$$SINR \rightarrow \frac{\frac{E_u}{M}_{\|R_1\|^2}}{\frac{E_u}{M}\sum_{i=2}^{R}\beta_i + 1}$$

III. LOWER & UPPER BOUNDS

DPC would be implemented when channel gains are completely known on the transmitter side [3]. Dirty paper coding (DPC) is a method of pre-coding the data such that the effect of the interference can be canceled subject to some interference that is known to the Transmitter [4]. More specifically, the interferences due to the first up to (k-1) user signals [8] are canceled in the course of pre-coding the kth user signal. If the u^{th} user signal is given by

Then the received signal is given as $\begin{bmatrix} y_1 \\ y_2 \\ y_3 \\ y_4 \\ y_5 \end{bmatrix} =$

$$\begin{bmatrix} H_1^{DL} \\ H_2^{DL} \\ H_3^{DL} \\ H_4^{DL} \\ H_5^{DL} \end{bmatrix}[x_1] + \begin{bmatrix} z_1 \\ z_2 \\ z_3 \\ z_4 \\ z_5 \end{bmatrix}$$

Massive MIMO is highly competitive with the DPC.

Uplink Pilots Control Signals	Uplink Data Transmission		Down link Pilots Control Signals	Down link Data Transmission	

<…Coherent time Period……>

Lower bounds Limit

Now consider capacity lower bounds by making assumptions of AWGN linear beam forming in DL[5]. The Gaussian distribution [7-10] on the uncertainty receiver of UL & DL the resulting lower bound is given by

$$C^{DL} \geq C^{DL}{}_{lower} = \frac{T_{data}^{DL}}{T_{coher}}E\{\log_2(1 + SNR_{lower}^{DL}(v^{DL}))\}$$

$$C^{UL} \geq C^{UL}{}_{lower} = \frac{T_{data}^{UL}}{T_{coher}}E\{\log_2(1 + SNR_{lower}^{UL}(v^{UL}))\}$$

v^{DL} Denote beam-forming vector for DL & v^{UL} denotes that beam-forming vector for UL. $v^{DL} = [v^{DL}{}_1, v^{DL}{}_2, \dots\dots v^{DL}{}_K]$

$$v^{UL} = [v^{UL}{}_1, v^{UL}{}_2, \dots\dots v^{UL}{}_K]$$

Upper bound limit

The upper bounds provide important on the DL & UL performance. Capacity limit provides in the asymptotic of many BS antennas. DL upper capacity bound is

$$\lim_{BS\rightarrow\infty} c_{upper}^{DL} = \frac{T_{data}^{DL}}{T_{coher}}\log_2(1 + \frac{N}{BS + UE.N}))$$

the UL capacities are fundamentally limited by transceiver.

IV. SIMULATION RESULTS

The Fig represents that lower and upper bounds on capacity. As the N increases the Spectral Efficicency increased[6]. The upper bound and lower bound provide a joint characterization of the UL when N large.

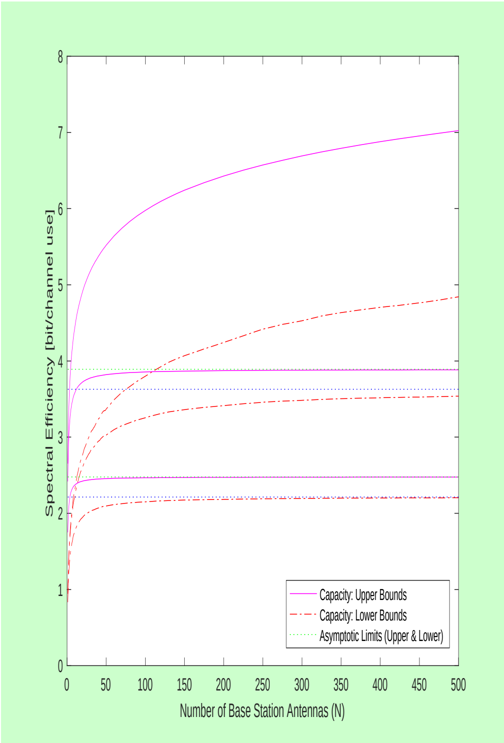

Fig: 1 SNR at 20dB N=500

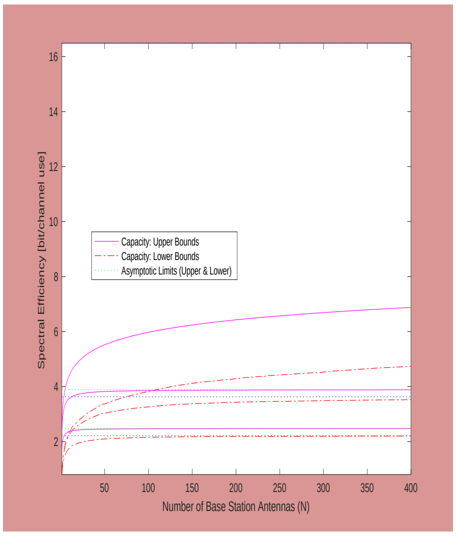

Fig: 2 SNR at 20dB N=400

The maximum numbers of antenna are used for the simulation [11]. The simulation takes place randomly N = [1:50 60:10:150 175:400];

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