Journal of Theoretical and Applied Information Technology
30th April 2013. Vol. 50 No.3

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

DOWNLINK ADAPTIVE CLOSED LOOP MIMO RESEARCH FOR 2 ANTENNAS IN TD-LTE SYSTEM

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ABSTRACT

For downlink adaptive controlling, feedback from the UE used can highly improve user data rate. The adaptive algorithm provides the gain of high peak rates (dual stream) when close to the cell and good cell edge performance (single stream). In this paper, firstly, it described CL loop MIMO adaptive switch for TD-LTE system, moreover, explained three UE feedback categories, CQI, PMI, RI mode, especially expatiated on 2 different CQI mode theoretical calculation and application. Finally, the paper gives and analyses the detailed simulation for different transmission mode and also gets some technical conclusion.

Keywords: *Dynamic Switching, Reporting Mode, Aperiodic Feedback, Channel Model, CDF Performance, MIMO Mode*

1. INTRODUCTION

TD-LTE allows dynamic switching between transmission with one and two code words on UE basis. It assumes usage of 2 TX antenna at eNB (port #0, #1) and transmission mode is 4. Its precoding is based on UE feedback. Codebooks can be known between eNB and UE each other (3GPP specification). Toward as downlink adaptive CL MIMO for 2 antennas, it's valid only for PDSCH, and other channels stilly use TX diversity.

About adaptive CL MIMO for 2 antennas, dynamic switch only happened between rank 1 and rank 2 transmission, whoseselection is based on filtered CQI and RI information and O&M configurable thresholds. CL MIMO has spatial multiplexing and multiple antennas being able to transmit different signals, too. For example, when it upgrade to spatial multiplexing, there are 2 parameters MimoCqiThU, MimoRiThU need be changed. On the other hand, when downgrading from spatial multiplexing, another 2 parameters MimoCqiThD, MimoRiThD will be updated. The adaptive algorithm provides high peak rates when using two code words and good cell edge performance when using single code word, too. Section 2 presents CL loop MIMO adaptive switch. In section 3, we describe the purpose of UE feedback for the different reporting mode in detail. Section 4 and 5 give some technical conclusion toward as performance simulation analysis of different index/parameter.

2. CL LOOP MIMO ADAPTIVE SWITCH

For the use of Adaptive Closed Loop (CL) MIMO, it defines adaptive switching. The eNB scheduler selects Spatial Multiplexing dynamically while applying closed loop MIMO for two antennas. Spatial multiplexing is applied only for the PDSCH, too.

Various parameters are added to TD-LTE system to support adaptive switching between CL MIMO 1 CW Mode and CL MIMO 2 CW Mode, Detail info is as below:

1) mimoClCqiThD - This defines the CQI Threshold for fallback to closed loop MIMO single codeword transmission (in CQI).

2) mimoClCqiThU - This defines the CQI Threshold for activation of closed loop MIMO dual codeword transmission (in CQI).

3) mimoClRiThD - This defines the Rank Threshold for fallback to closed loop MIMO single codeword transmission.

4) mimoClRiThU - This defines the Rank Threshold for activation of closed loop MIMO dual codeword transmission.

CQI and RI are filtered for CL operation using mimoClCqiAvg and mimoClRiAvg respectively. MimoCICqiAvg parameter is averaging filter constant for CL CQI Measurements. MimoCIRiAvg parameter is averaging filer constant for CL RI Measurements. Figure 1 show

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

mimoClCqiAvg and mimoClRiAvg parameter function for CL operation.

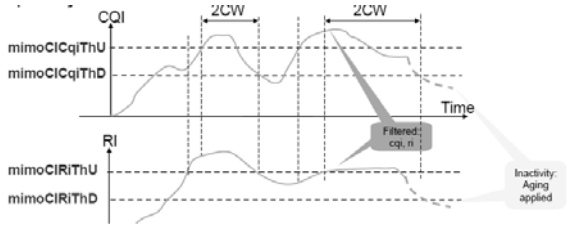

Fig1. mimoClCqiAvg and mimoClRiAvg parameter function

3. UE FEEDBACK

The purpose of UE feedback is to provide the eNodeB information about DL channel state, Measured values by the UE and signaled to the eNodeB using PUCCH or PUSCH. UE feedback can be divided into three categories:

1) CQI - Channel Quality Indicator

2) RI - Rank Indicator

3) PMI - Precoding Matrix Indicator

general feedback reported by the UE is just a recommendation. The eNodeB does not need to follow it totally.

The most important part of channel feedback is the CQI. The CQI is defined as a table containing 16 entries with modulation and coding schemes (MCSs). The UE shall report back the highest CQI index corresponding to the MCS for which the transport block BLER shall not exceed 10%.

Rank Indicator is the only relevant when the UE is operating in MIMO modes with spatial multiplexing (For single antenna operation or TX diversity it is not used). RI is the UEs recommendation for the number of layers to be used in spatial multiplexing. The RI can have values {1 or 2} with 2-by-2 antenna configuration and {1, 2, 3, or 4} with 4-by-4 antenna configuration (not RL20). The RI is always associated to one or more CQI reports

PMI provides information about the preferred Precoding Matrix. Just like RI, also PMI is relevant to MIMO operation only.

CQI reporting mode includes periodic reporting and aperiodic reporting. For periodic reporting, the baseline mode for CQI/PMI/RI transmission is periodic reporting on PUCCH. If the UE is scheduled to send UL data in the subframe where it should transmit periodic CQI/PMI/RI, the periodic report is moved to PUSCH and multiplexed with data. The reporting instances for wideband CQI/PMI are subframes satisfying as below equation 1.

$$\left(10\times n_f + \lfloor n_s/2 \rfloor - N_{OFFSET,CQI}\right) \bmod N_P = 0 \quad (1)$$

The reporting instances for RI are subframes satisfying as below equation 2.

$$\left(10\times n_f + \lfloor n_s/2 \rfloor - N_{OFFSET,CQI} - N_{OFFSET,RI}\right) \bmod \left(N_P \cdot M_{RI}\right) = 0 \quad (2)$$

In case of collision of RI and wideband CQI/PMI the wideband CQI/PMI is dropped. Details see 3GPP specification 36.213.7.2.2.

A UE shall perform aperiodic CQI, PMI and RI reporting using the PUSCH in subframe n+k, upon receiving in subframe n either a DCI format 0, or a Random Access Response Grant. The eNodeB can configure the periodicity parameters, too. The size of a single report is limited up to about 11 bits depending on the reporting mode. It's limited amount of frequency information.

For aperiodic reporting, they are explicitly triggered by the eNodeB using a specific bit in the PDCCH UL grant. Aperiodic report can be either piggybacked with data or sent alone on PUSCH. It is possibile for large and detailed reports (up to more than 60 bits), too.

The two modes can also be used to complement each other. The UE can be e.g. configured to send aperiodic reports only when it is scheduled, while periodic reports can provide coarse channel information on a regular basis.

For periodic feedback on PUCCH, If UE scheduled the report mapped in PUSCH and multiplexed with data. Moreover, wideband CQI report always need be sent if closed loop MIMO configured PMI added or spatial MUX supported RI added or subband CQI, per bandwidth part subband , CQI reports added.

For aperiodic feedback on PUSCH, it can only be requested via UL Grant in PDCCH. For example, when subband size is 6PRB at 10MHz, subband PMI + wideband CQI is selected. On the other hand, when subband size is3 PRB at 10MHz, Average Best-M+ wideband PMI is selected.

4. PERFORMANCE SIMULATION ANALYSIS

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4.1 simulation assumption

There are several types of algorithms for the downlink adaptive CL MIMO. Before link level performance evaluation, we should make clear which channel model should be used, how to define the simulation parameters and the basic assumption for this feasibility study.

For the downlink adaptive CL MIMO feasibility study iteration, the assumption is as below info:

1) Simulation case: Macro, case 1, 10MHz in 2GHz band, 500m ISD, 3 sectors per site

2) Path loss: 128.1+37.6 log10(R), +20dB indoor penetration loss

3) Channel model: Typical Urban at 3km/h

4) Shadow fading: Lognormal at 8dB STD

5) DL Tx power: 40W (46dBm)

6) Intercell interference: fully loaded sectors in two surrounding rings of BS,

7) Feedback measurement and reporting: CQI, PMI and RI ideal: error-free and at full resolution (360 kHz, 2ms) feedback delay: 4TTIs (@2ms)

4.2 performance simulation and analysis

We set different transmission mode to check the CDF value for performance throughput. Figure 2 show CDF performance throughput value for different transmission modes (Rx diversity, OL single, OL switched, CL single, CL switched). From the results, we can see that open loop MIMO (green line) loses against 1*2 in most conditions, and then, closed loop MIMO (red line) gains a little due to ideal feedback, moreover, significant gains only in high SINR, closed loop MIMO's is not better than open loop MIMO's in this point.

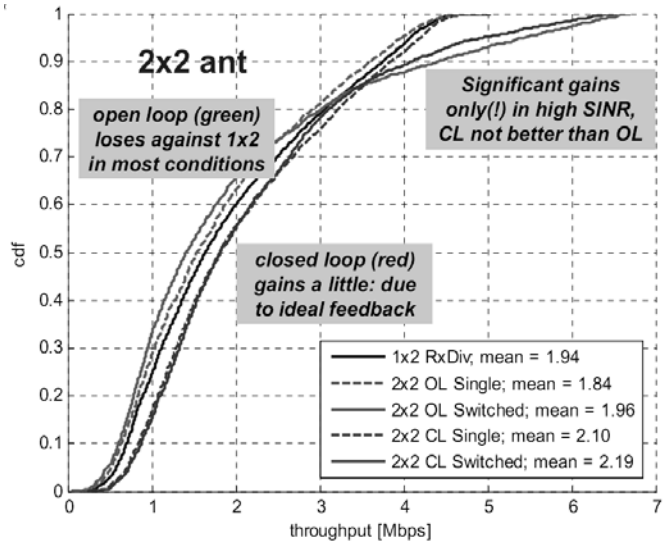

Fig.2 CDF Performance Throughput Value For Different Transmission Modes

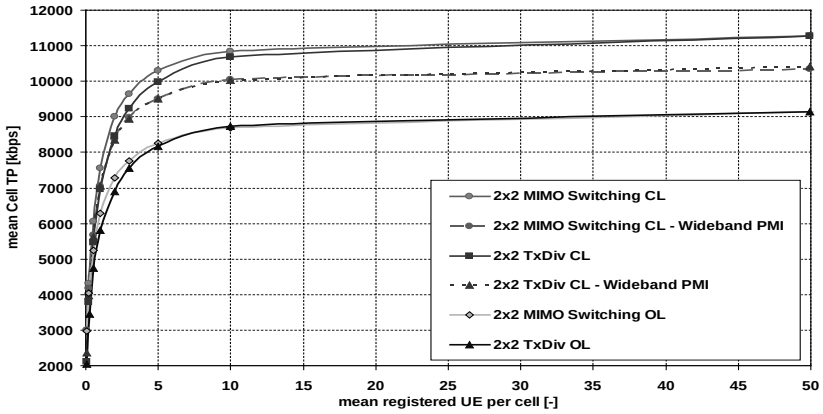

Fig.3 Mean Cell TP For Different Transmission Mode

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

In Figure 3, it gives the result for mean cell TP values for different transmission modes UE per cell, obviously, closed loop MIMO switching gain clearly visible at low to medium load as expected, and then CL MIMO is 2dB gain higher than other transmission mode. At the same reason for Fig.2, CL MIMO is a loss due to more realistic wideband PMI.

So we can get some important result/information from the view of Closed loop MIMO as below:

1) Gain – CL MIMO is 10% over OL scheme in real scenarios

2) Precoding matrixes known on both sides (UE – eNB)

3) UE feedback – CQI/PMI/RI -> Enb decides

4) Peak throughput improvement -2 codewords

5) Cell edge behavior improvement – codeword

5. CONCLUSION

Compensation values need to be applied to the CQI values prior to determination of the immediate rates as detailed in LTE RRM relate specification whenever the MIMO_MODE_SETTING_UE (see LTE RRM relate specification) for a UE do not match with the latest available RI (rank information) being available for this UE. Signaling of resource allocations for dual stream transmission (open and closed loop MIMO) has been agreed to use DCI format 2A/2 (no modified or compact format has been agreed).

Signaling of resource allocations for dual stream transmission (open and closed loop MIMO) has been agreed to use DCI format 2A/2 (no modified or compact format has been agreed). For dual stream transmission allocations can be signaled per code word. Specific value for MCS/RV are used to determine if a transport block (and with that a code word) is being in use (i.e., blanking of HARQ processes), see [3GPP-36.213], section 7.1.7.2. Usage of any transport block can be indicated and HARQ feedback corresponds to this allocation, i.e., the swap flag need not be used to map allocations to a specific codeword if only a single codeword is enabled when using format 2.

REFRENCES:

[1] Cesar C. Gaudes, Ignacio Santamaria, Javier Via, Enrique Masgrau, Talesa Sese. Roubust array beamforming with sidelobe control, using support vector machines. IEEE Trans. Sig. Proc., vol.55, no.2, pp.654-672, February 2007.

[2] Chuang, J. Sollenberger, N. "Beyond 3G：wideband wireless data access based on OFDM and dynamic packet assignment". IEEE Commun. Mag, July 2000,pp.80-85.

[3] A.Lozano, A. M. Tulino, and S. Verdu, "Multiple-antenna capacity in the low-power regime", IEEE Trans. Inform. Theory, PP. 2530-41, October 2003

[4] Fault Detection Using Deconvolutive STFT Spectrogram", Journal of Convergence Information Technology (JCIT), vol. 7, no. 8, 287-294, 2012.

[5] Lufei Ding, Fulu Geng, Principle of radar, pp.51-53, Publishing Houses of Xidian University, China, 2005.

[6] "Evolved Universal Terrestrial Radio Access (E-UTRA); Physical layer; Measurements," 3GPP TS 36.214, version 8.0.0, September 2007.Article in a conference proceedings.

[7] "Evolved Universal Terrestrial Radio Access (E-UTRA); Physical channels and modulation," 3GPP TS 36.211, version 8.0.0, September 2007.

[8] H. Singh, S Singh. Smart-802.11b MAC protocol for use with smart antennas. IEEE International Conference on Communications (ICC'04), Paris, France, June 20−24, 2004, vol.6, 2684−2688.

[9] Guo Li, Guo Yan, Li Ning. A fast convergence DOA estimation algorithm. International Conference in Communications and Networking in China 2006 (CHINACOM'2006), Beijing, China, Oct. 25−27, 2006.

[10]Zukang Shen, Runhua Chen, Andrews, J.G., et.a1. "Low complexity user selection algorithms for multiuser MIMO systems with block diagonalization," IEEE Transactions on Signal Processing, v01. 54, 110. 9, PP.3658—3663, Sept.2006.

[11]3GPP TS 36.212 v8.2.0. Evolved Universal Terrestrial Radio Access(E-UTRA) ; Multiplexing and Channel Coding(Release 8)

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

[12]3GPP TS 36.201 v8.2.0 . Evolved Universal Terrestrial Radio Acess(E-UTRA) ; LTE Physical Layer-General Description(Release 8)

[13]3GPP TS 36.212 V8.70. Evolved Universal Terestrial Radio Access(E — UTRA); Muhiplexing and Channel Coding (Release 8) [S].2009.