Agenda item: Adhoc 26

Source: Motorola

Title: Text Proposal for the Tx Diversity extensions for ADHOC 26 TR

Document for : Approval

Summary:

The extension of Rel 99 mode 2 closed loop transmit diversity has been assesed for more than 4 elements. A reduced states (4 phase only constellation of the antenna weights (Mode 2-4p0g)) has been considered. Text related the method and results obtained with this extension in the references below to this extension is being proposed.

References

[1] Motorola, Closed loop transmit diversity mode 2 with reduced states for 4 elements (updated), TSGR1#20(00)0561, 22-26th, August, 2000, Berlin, Germany

[2] Motorola, Closed loop transmit diversity mode 2 with reduced states for 4 elements, TSGR1#15(00)1132, 22-26th, August, 2000, Berlin, Germany

5.3.3.2 Dedicated Physical Channel Transmission Scheme for 4-ant UE

If a dedicated physical channel is transmitted to a 4-ant diversity UE, the transmission scheme should be designed with considering the available channel estimations output to the UE. With the proposed CPICH transmission scheme, the available channel estimation output of the 4-ant diversity UE are $\hat{h}_1, \hat{h}_2, \hat{h}_3, \hat{h}_4$ (See Table 3). Currently, there is no accepted 4-antenna open/closed loop transmit diversity scheme but the proposed CPICH transmission scheme can be used with any kind of open/closed loop diversity proposal.

-------------------------------*START of the TEXT proposal in "Section 5: Descriptions of studied concepts" of Adhoc 26 TR*-----------------------

5.2 Closed loop transmit diversity mode 2 with reduced states for 4 elements

Similar to Rel-99 closed loop Tx diversity systems, the weights of transmit antennas are determined at a mobile station and fed back to the base station. The set of weights at the UTRAN-AP $\underline{w}= [w_1\ w_2 \ldots w_i \ldots w_M]^T$, where w_i is a complex weight associated with the *i*th Tx antenna are chosen to maximize *P* below:

$$P = \underline{w}^H H^H H \underline{w}, \qquad (5)$$

where $H=[\underline{h}_1\ \underline{h}_2 \ldots \underline{h}_i \ldots \underline{h}_M]$ and M is the number of Tx antennas. The column vector $\underline{h}_i$ represents an estimated channel impulse response for the *i*th Tx antenna, and its vector length equals to the number of paths.

Recalling the description of the modified mode 2 CL transmit diversity **("Mode2_4p0g")** in R1-00-1132, we consider 4 phase states per element which are defined in Table 1.

Table 5.2: FSM of modified closed loop mode 2 signalling message per element

FSM	Phase difference between antennas (degrees)
00	π
01	$-\pi/2$
11	$\pi/2$
10	0

Therefore we need 6 bits feedback per slot for the update of the antenna coefficients. If we consider **1 bit feedback per slot**, Progressive refinement (as described for Rel 99 Closed loop transmit diversity Mode 2) is used to update the antenna coeficients.

5.2.1 : Format of Feedback Information

The uplink feedback information signalling is the similar to the Rel-99 mode 2, that is using progressive refinement both at the UE and UTRAN-AP. The only change is the number of states, at the UE, to be compared for maximising $P = \underline{w}^H H^H H \underline{w}$, is increased due to 4 elements instead of 2 (Rel 99) and the FSM (table 5.1) corresponding to coeffcient of the antenna 2, 3 and 4 are sent succesively.

-------------------------- *End of the TEXT proposal in "Section 5: Descriptions of studied concepts" of Adhoc 26 TR* --------------------------- --------------------------------

-------------------------------*START of the TEXT proposal in "Section 6 : Link Level Simulations" of Adhoc 26 TR-------*

6.4.1 Closed loop transmit diversity mode 2 with reduced states for 4 elements

TABLE XX : SIMULATION ASSUMPTIONS.

Bit Rate	12.2 kbps
Chip Rate	3.84 Mcps
Convolutional code rate	1/3
Carrier frequency	2 GHz
Power control rate	1500 Hz
PC error rate	4 %
PC Step Size	1 dB total
Channel model(s) and UE velocities	Modified ITU Ped. A : 3 to 40 km/h
Number of Rake Fingers	2 fingers for ITU Ped. A Channel
CL feedback bit error rate	4 %
CL feedback delay	1 slot
TTI	20 ms
Target FER/BlkER	1 %
Geometry (G)	0 dB
Common Pilot	-10 dB total
Correlation between antennas	Pico and Micro models
Channel Estimation	DPCCH pilots ONLY and Ideal Verification
CL feedback rate	1500 bps

The performance of the 4-elements extension of Rel-99 mode 2 is compared here to the Rel-99 CL Tx diversity mode 1, which is used as reference for performance comparison to other schemes proposed.

6.4.1.1 Modified ITU Ped. A (ETRP) : Dedicated pilot channel estimation

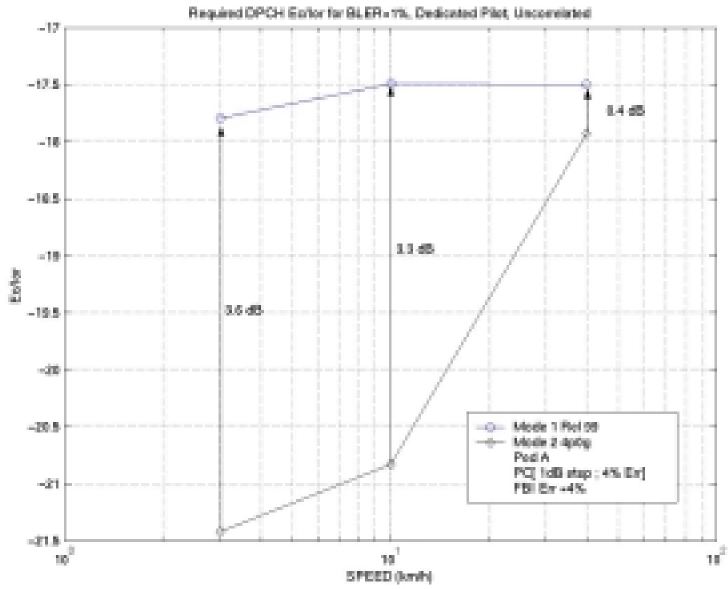

Figure x : 4-elements reduced state mode 2 for uncorrelated channel model

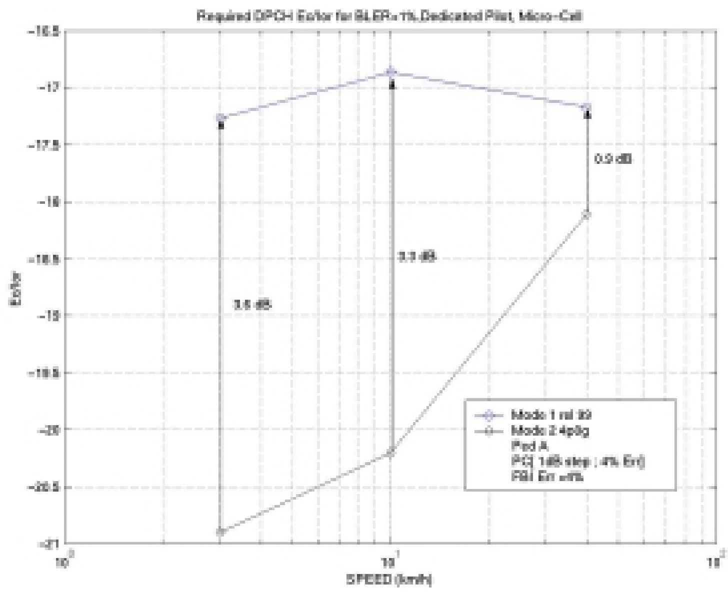

Figure x+1 : 4-elements reduced state mode 2 for micro-cell channel

6.4.1.2 Modified ITU Ped. A (ETRP) : channel estimation assuming Ideal verification

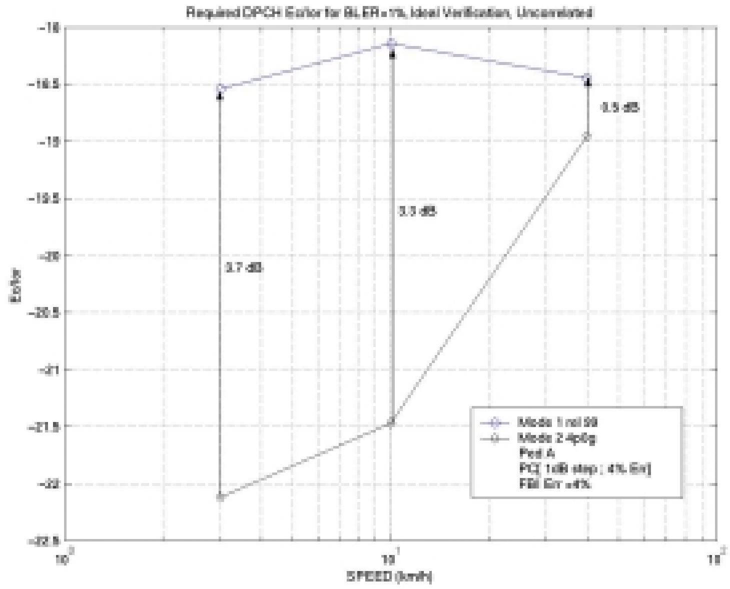

Figure x+2 : 4-elements reduced state mode 2 for uncorrelated channel

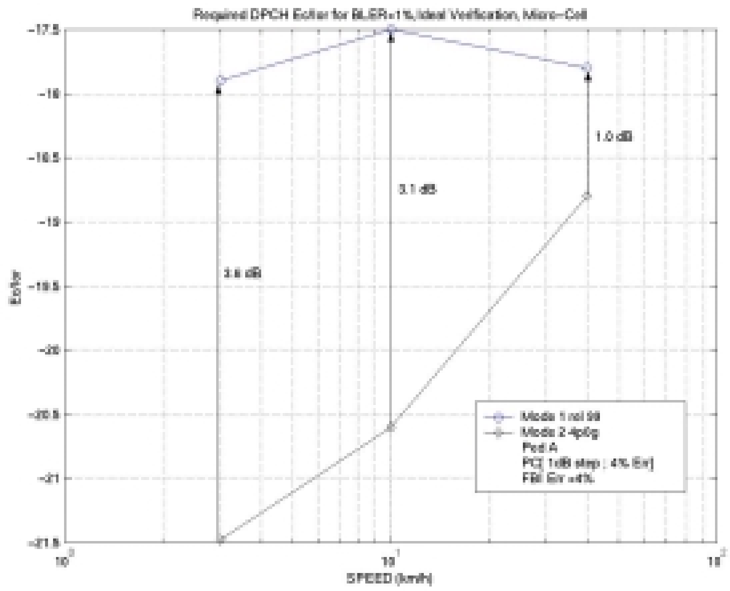

Figure x+3 : 4-elements reduced state mode 2 for micro-cell channel

6.4.1.3 DISCUSSIONS

<u>6.4.1.3.1 Dedicated pilot channel estimation</u> :

Based on the results shown , it can be observed that for the case of **1500 bps**, i.e 1 bit feedback per slot, the gain obtained by the extended mode 2 with reduces phase states relative to Rel 99 Mode 1, ranges from **3.6 dB to 0.4 dB** within the range of **3 to 40 km/h,** for the uncorrelated channel model. Moreover, typically a gain of **1 dB @ 10kmh** is observed relative to the current other proposed schemes [R2F2 and Eigenbeamformer in R1-01-0203]. This shows that this mode, with limited quantization resolution, gives relatively high gains at very low speeds and maintain acceptable gains up to relatively high speeds given this low feedback rate.

6.4.1.3.2 Correlated channel case (micro cell case)

In the correlated channel conditions, the results shown here are for a 4-phase states constellation per antenna. It is clearly shown that, this limited phase resolution mode 2 provide gains relative to Rel 99 Mode 1, from **3.6 dB to 0.9 dB** within the range of **3 to 40 km/h,** for the micro-cell channel model. Moreover, typically a gain of **1 dB @ 10kmh** is observed relative to R2F2 and same performance as the Eigenbeamformer [R1-01-0203]

However, relative to the eigenbeamformer, for the mode 2-4p0g limited phase resolution is obtained, while performance highly depends on the quantization and transmission quality of the optimum antenna coefficients [see typically peformance of the eigenbeamformer in R1-01-0203]. Thus antenna coefficients with higher phase resolution, similar to the current Rel-99 mode 2 should improve the performance accordingly. It should also be noted that particularly for the eigenbeamformer, the feedback information on the beam selection is error free, thus further degradation in R1-01-0203 should be expected. Finally, for narrow angular spread, i.e. macro cell, sectorisation in conjunction with closed loop transmit diversity schemes (Rel 99 and their extensions) should also bring additional gains.

Another remark is that Open loop Adaptive Antenna with 0.5 wavelength spacing does not provide diversity gain, whereas with Closed loop transmit diversity modes, both beamforming and diversity gain are obtained and moreover there are calibration/installation issues with OL AA, which are not issues with closed loop transmit diversity.

6.4.1.3.3 Ideal verification :

The results shows that when ideal verification is assumed, there is no significant change in behaviour other than improved performance for both 2 elements and 4 elements schemes due to the use of channel estimates from the CPICH channel.

6.4.1.4 CONCLUSIONS

The results above are presented for a simple extension of mode2, with reduced phase states per antenna coefficient. These results basically shows that :

- the existing Rel'99 closed loop transmit diversity can be extended to the case of more than 2 elements with reasonable trade-off between resolution and feedback delay vs mobile speed.

- The 4 elements extensions of mode 2 does bring "beamforming" gain too, without the need of calibration as for the case of "OL AA".

- For the correlated channel cases, higher phase resolution (similar to the 2 elements Rel 99 Mode 2) should enhance the beamforming gain and thus perform relatively well, given the already reasonable trade-off between resolution and feedback delay vs mobile speed.