Agenda item:

Source: Motorola

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

Document for: Discussion

INTRODUCTION

Currently, different schemes of closed loop transmit diversity are being proposed for more than 2 elements [1], [2], [3]. In this paper we show the benefits of 4 elements closed loop transmit diversity by using progressive refinement (so called UTRAN and UE PR) as described for mode 2 in the Rel.99' specifications for mode 2. The only difference in the mode presented here is that we consider the first element as reference and we apply for the rest of the 3 elements a resolution of 2 bit phase only per element, that is, a constellation of 4 phase states per element

The results shows the capability of this mode to maintain a reasonable trade-off between resolution and feedback delay vs mobile speed. This is of main interest when considering limited feedback bit per slot (1 bit feedback per slot for Release 99 specs).

1. DESCRIPTION OF THE MODIFIED CLOSED LOOP MODE 2 FOR 4 ELEMENTS.

Consider a UTRAN comprising 4 transmitting antennas, numbered as antenna 0, 1, 2 and 3. As mentionned above, we choose antenna 0 to be the reference antenna and for antenna 1, 2 and 3, we consider 4 phase states per element which are defined in Table 1.

Table 1: FSM of modified closed loop mode 2 signalling message per element

FS	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. In this paper we have considered **1 bit feedback per slot (PR-4p-1500)** to demonstrate the effect of feedback delay vs resolution and also for comparison to the current mode 1, i.e. 2 transmit antennas as per Rel 99' specifications.

2. SIMULATION ASSUMPTIONS.

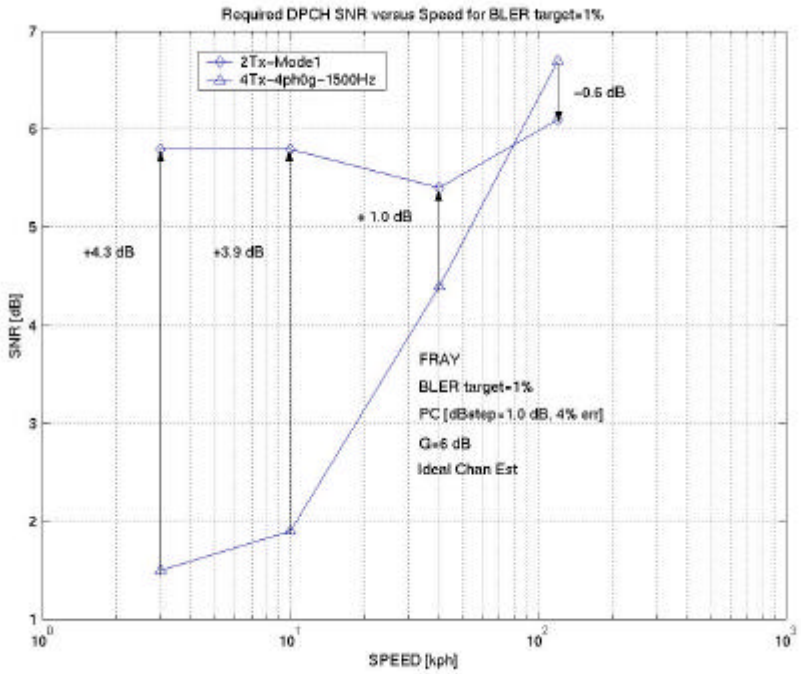
Bit Rate	12.2 kbps
Chip Rate	3.84 Mcps
Convolutional code rate	1/3
Carrier frequency	2 GHz
Power control rate	1500 Hz
PC error rate	4 %
PC Step Size	1 dB total
Channel model(s) and UE velocities	FRAY, Modified ITU Ped. A : 3 to 120 km/h
Number of Rake Fingers	2 fingers for ITU Ped. A Channel
CL feedback bit error rate	4 %
CL feedback delay	1 slot
TTI	20 ms
Target FER/BlkER	1 %, 10%
Geometry (G)	-3, 0 and 6 dB
Common Pilot	-10 dB total
Correlation between antennas	0
Channel Estimation	Ideal
CL feedback rate	1500 bps

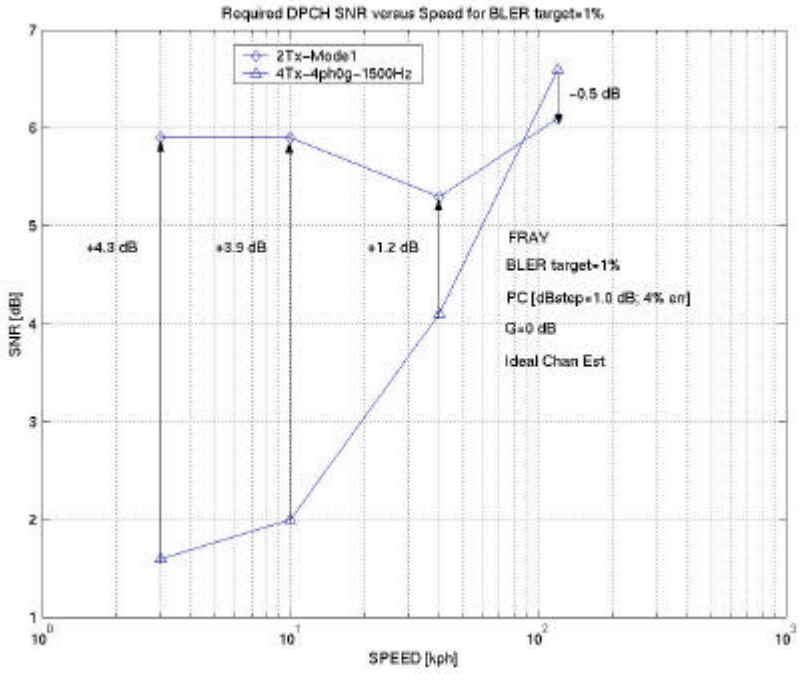
3. SIMULATION RESULTS

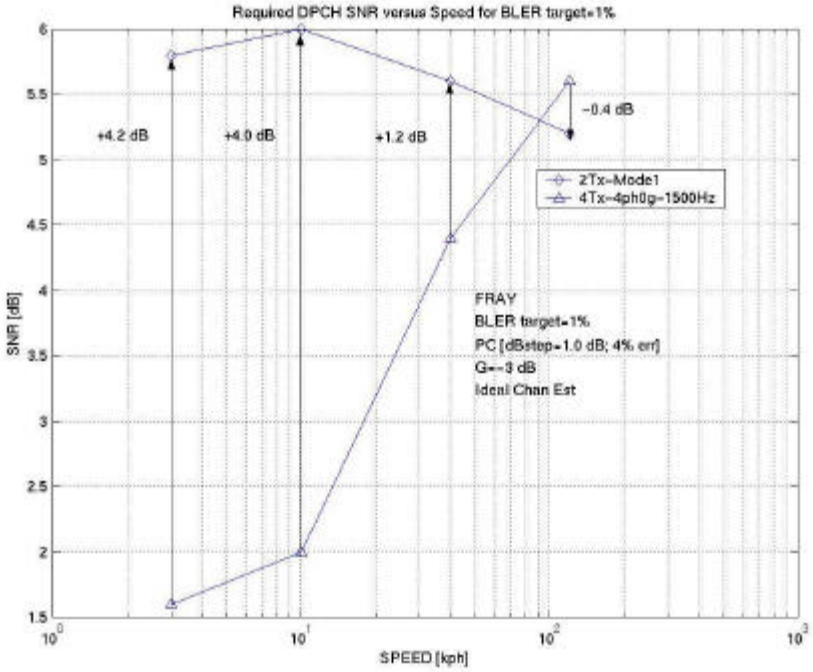
Based on the above simulation assumptions results were generated for the 2 cases as described above :

- 2 transmitting antennas : Mode 1
- 4 transmitting antennas : PR-4ph-1500

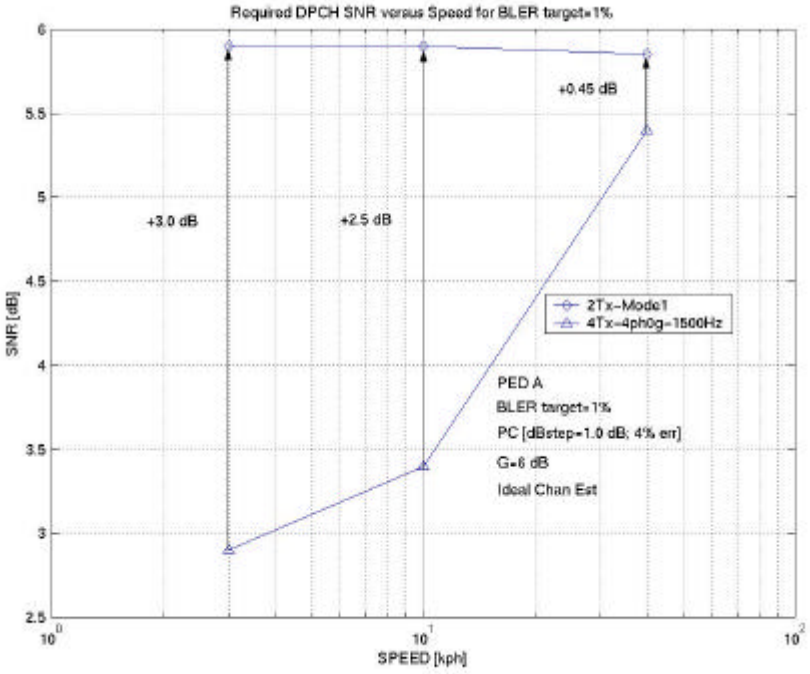
3.1 Single path flat Rayleigh Channel (FRAY)

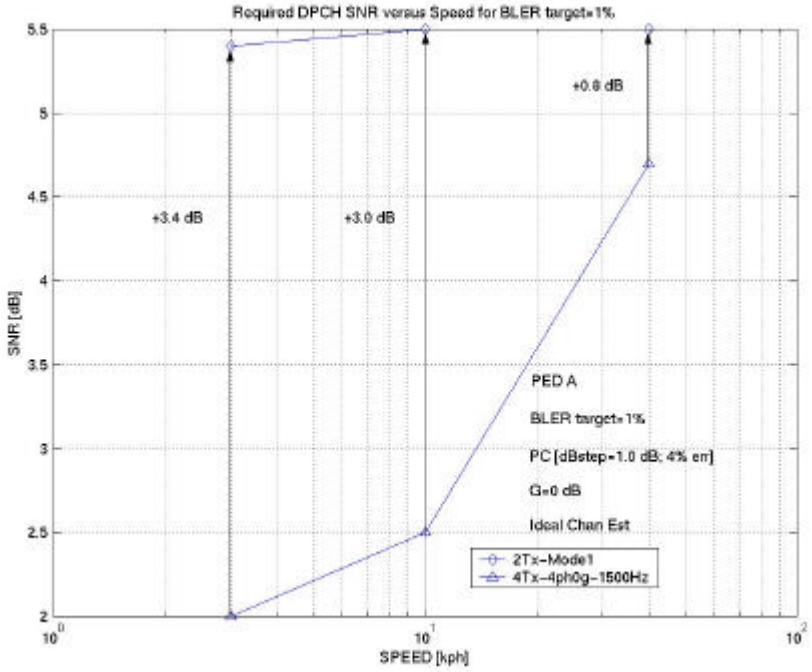


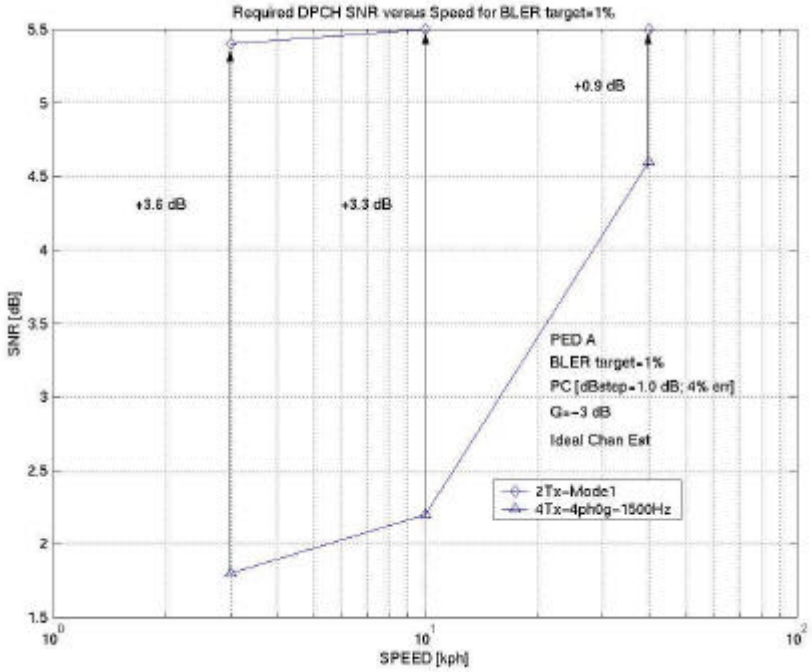




3.2 Modified ITU Ped. A (ETRP)







4. DISCUSSIONS

Based on the results shown for FRAY and ETRP case, 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 states, ranges from **4.3 dB to 0.45 dB** within the range of **3 to 40 km/h,** depending on the channel models and geometry. This shows that this mode gives relatively high gains at very

low speeds and maintain acceptable gains up to relatively high speeds given this low feedback rate.

Note, however, that these figures are given for ideal channel estimation for all cases. Therefore, degradation due to channel estimation should be included for both 2 antennas and 4 antennas cases.

Futhermore, equal average power is allocated to all four transmitting antennas. For backward compatibility sake to Rel. 99 the allocation of CPICH power to the extra 2 antennas should be assessed in order to reduce pilot overhead versus capacity gain.

5. REFERENCES

[1] Nokia, An extension of closed loop Tx Diversity mode 1 for multiple Tx antennas, TSGR1#13(00)0712, 22-25th May, Tokyo, Japan.

[2] Siemens, Advanced closed loop diversity concept (eigenbeamformer), TSGR1#14(00)0853, 4-7th 7th July, Oulu, Finland

[3] Samsung and Seoul National University, Preliminary version of algorithm and simulation results for Tx diversity with more than 2 Tx Antennas, TSGR1#14(00)0882, 4-7th July, Oulu, Finland.