Agenda item:	7
Source:	Nokia
Title:	Multipath Tx diversity simulation results for closed loop mode 1 extended for multiple antennas
Document for:	Discussion

Summary:

In TSG-R1 meeting #13, a solution how to extent the Rel.-99 closed loop mode 1 for more than 2 Tx antennas was presented [1]. Simulation results in single path Rayleigh fading channel showed quite big gains at low UE speeds.

Multipath simulation results indicate that gains up to 3.5 dB are still possible at low UE speeds. Preliminary results for verification bounds suggest that a verification of some kind need to be applied at UE for a robust performance. Further work on the details of the verification algorithms are needed.

As agreed in the AH26 meeting #1 more input are need also on the following issues [2]:

- Complexity impacts to UE
- Complexity impacts to BTS
- Backwards compatibility
- Impacts to initial synchronization and neighbor cell measurements
- Mandatory/optional support by UEs

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1. INTRODUCTION

In TSG-R1 meeting #13, a solution how to extent the Rel.-99 closed loop mode 1 for more than 2 Tx antennas was presented [1]. Simulation results in single path Rayleigh fading channel showed quite big gains at low UE speeds. In order to get more comprehensive view of the gains multipath results are presented in this document.

2. MULTIPATH SIMULATION RESULTS

2.1 Simulation parameters

Link level simulations were performed using the parameters listed in the Tables 1 and 2.

Table 1. Link level simulation parameters.

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, 10, 40 km/h Modified ITU Veh. A: 10, 40, 120 km/h
CL feedback bit error rate	4 %
CL feedback delay	1 slot
TTI	20 ms
Target FER/BlkER	1 %
Geometry (G)	-3, 0 and 6 dB
Common Pilot	-10 dB total
Correlation between antennas	0
CL feedback rate	1500 bps

Table 2. Additional simulation parameters.

Channel estimation	From CPICH
Weight verification	Ideal (in all cases)

2.2 Simulation results

Two different concepts were simulated. Following the acronyms shown in the legends of the Figures **Error! Reference source not found.** and **Error! Reference source not found.** they are:

- 2-mode-1
  - ★ Closed loop mode 1 according to Rel.-99
  - ★ Number of Tx antennas = 2
- R2F4

- ★ Number of Tx antennas = 4
- ★ Feedback bit rate = 1500 bps
- ★ Phase adjustment calculated separately for the three antennas as in current mode 1 and only one feedback command is signaled to UTRAN during 1 slot
- ★ At UTRAN, four consecutive feedback commands per antenna are filtered (simple averaging)

The results are shown in the Figures 1-6.

In Figures 7 and 8 simulation results with ideal verification and no verification at all are presented. At low speeds the results even with no verification are quite good. Already after speed of 10 km/h the performance seems to collapse indicating a need for a verification algorithm of some kind. As these results are very preliminary further checking will be needed.

2.3 Discussion

For UE speeds up to 10 km/h the gains of R2F4 over 2-mode-1 in modified ITU pedestrian A are still quite high ranging approximately between 2 and 3.5 dB. At a speed of around 20 km/h there is a cross over point after which the 2-mode-1 starts to outperform the R2F4.

In modified ITU vehicular A channel the gain of R2F4 over 2-mode-1 is still at least 1 dB at speed of 10 km/h despite greatly increased path diversity. At higher speeds the 2-mode-1 outperforms R2F4.

Preliminary results for verification bounds indicate that in order to get robust performance verification should be applied at UE.

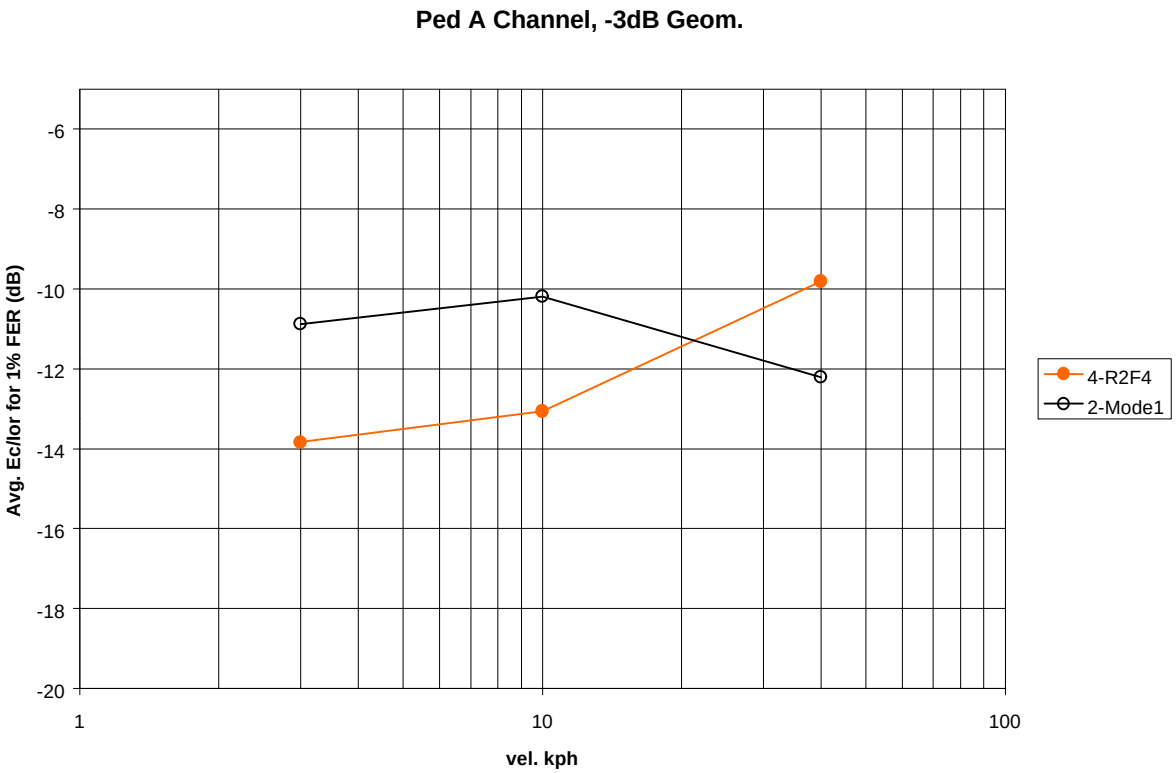

Figure 1. Simulation results for modified ITU Ped. A channel at –3 dB geometry.

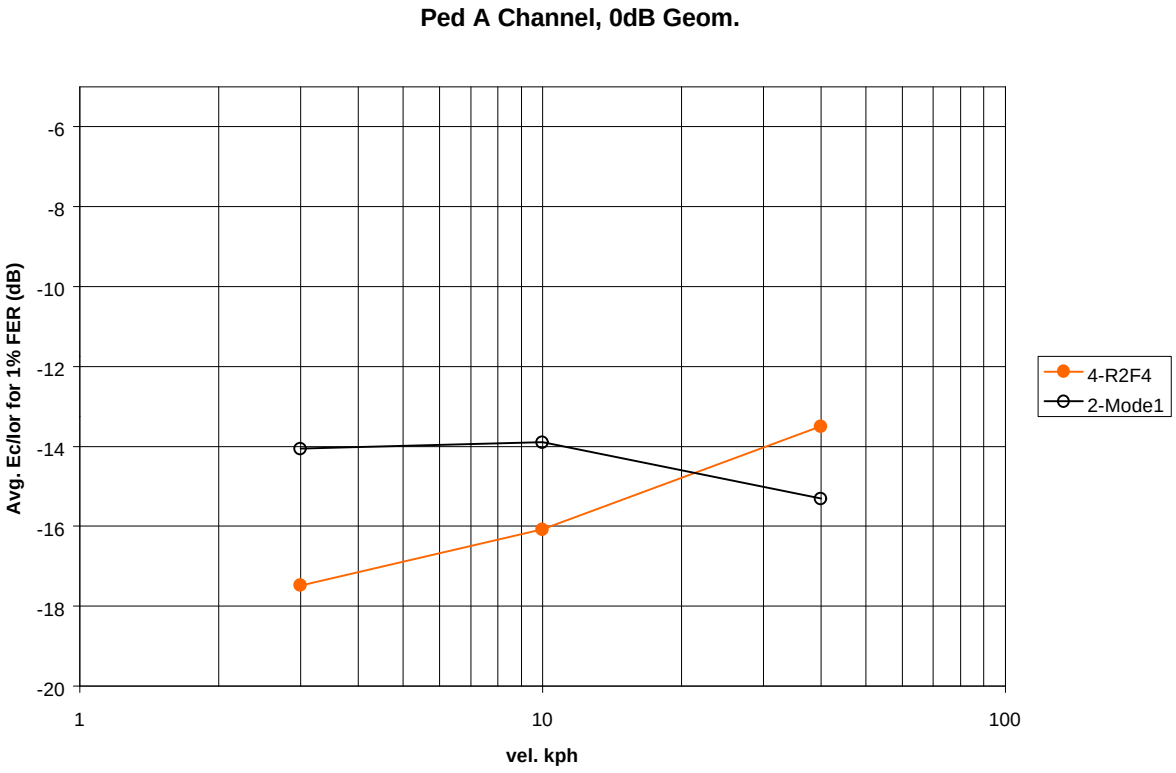

Figure 2. Simulation results for modified ITU Ped. A channel at 0 dB geometry.

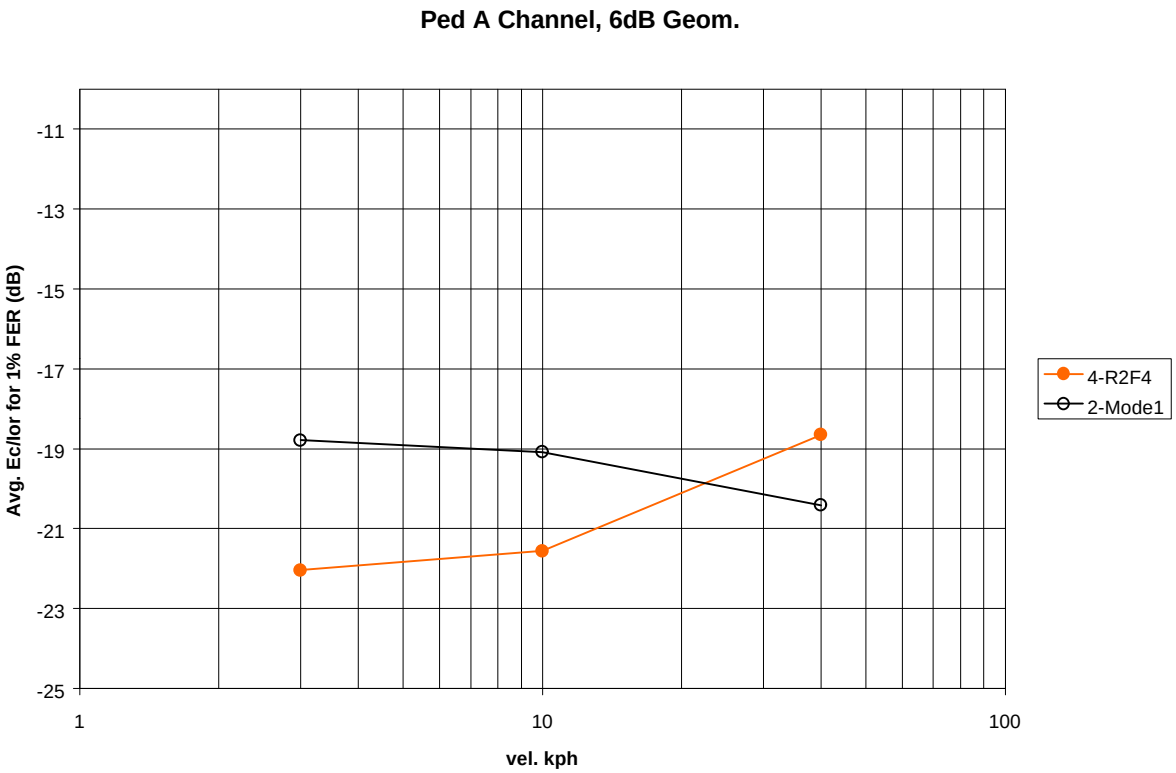

Figure 3. Simulation results for modified ITU Ped. A channel at 6 dB geometry.

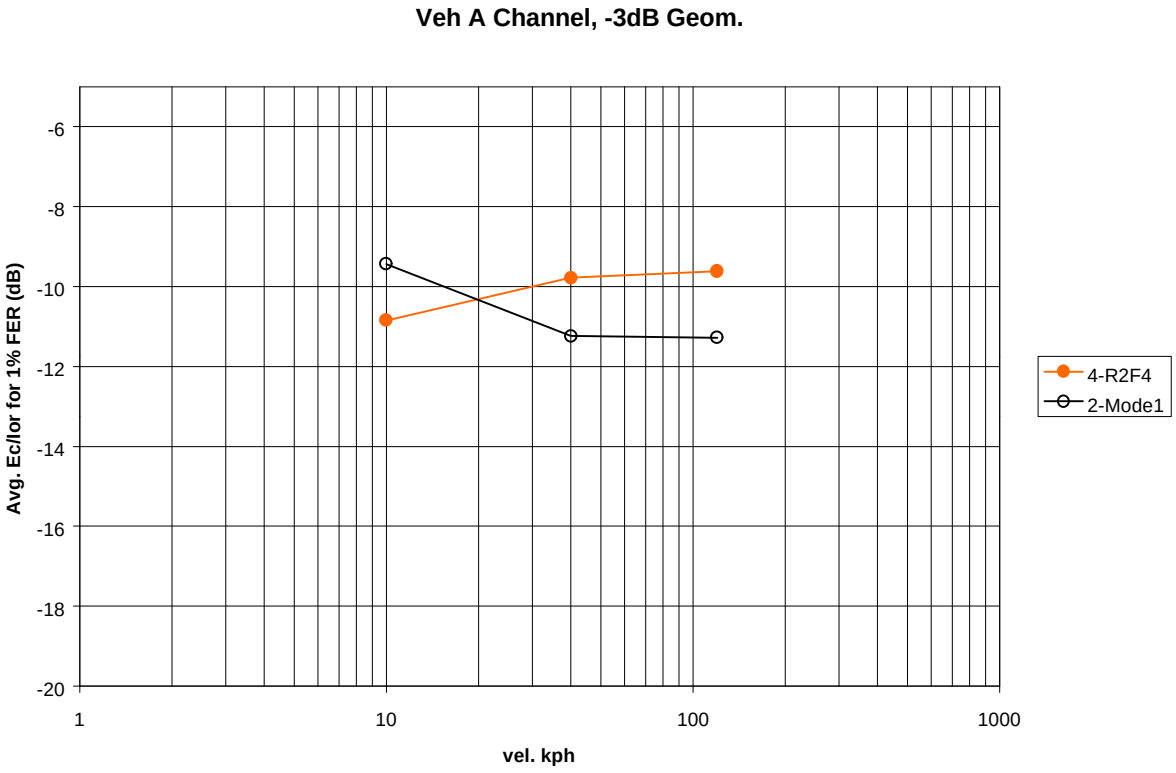

Figure 4. Simulation results for modified ITU Veh. A channel at –3 dB geometry.

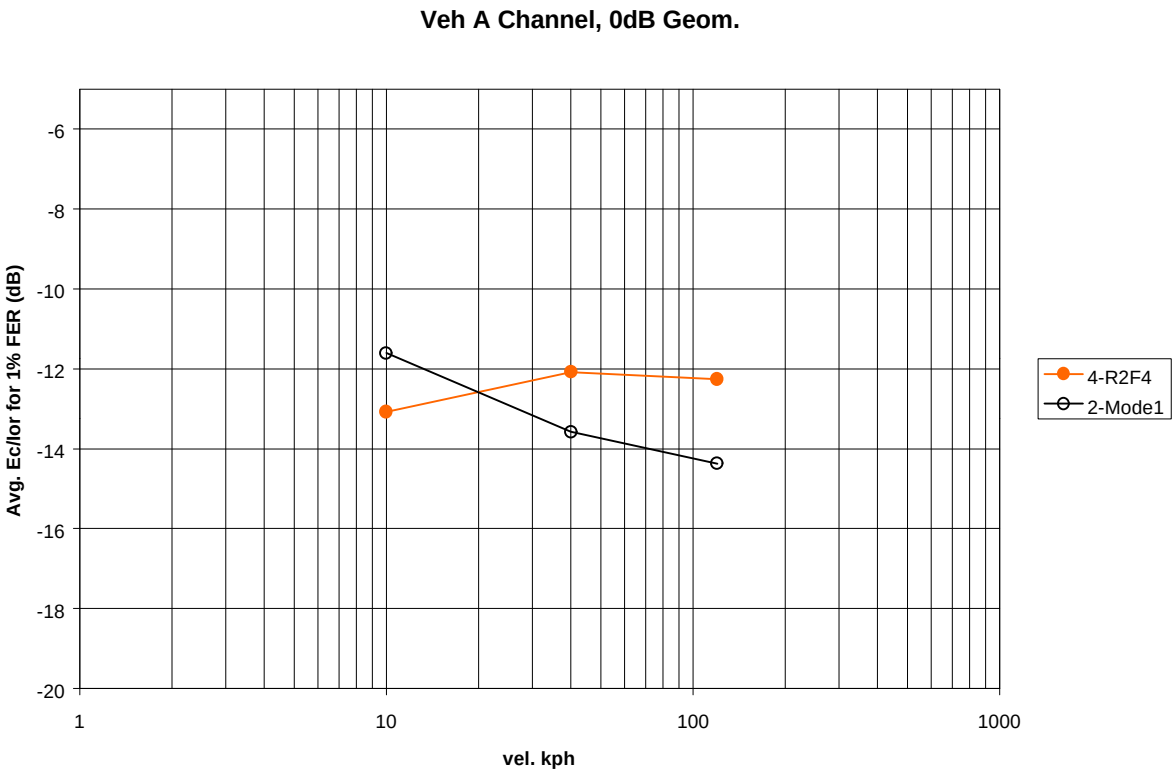

Figure 5. Simulation results for modified ITU Ped. A channel at 0 dB geometry.

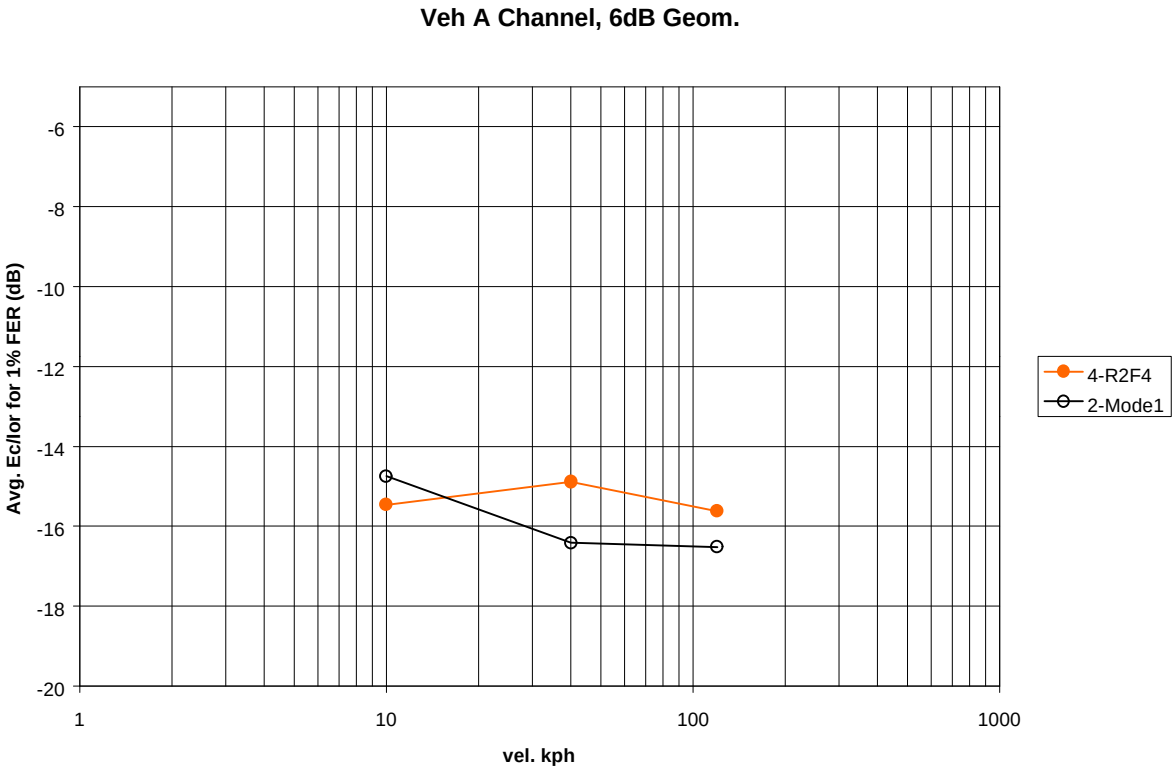

Figure 6. Simulation results for modified ITU Ped. A channel at 6 dB geometry.

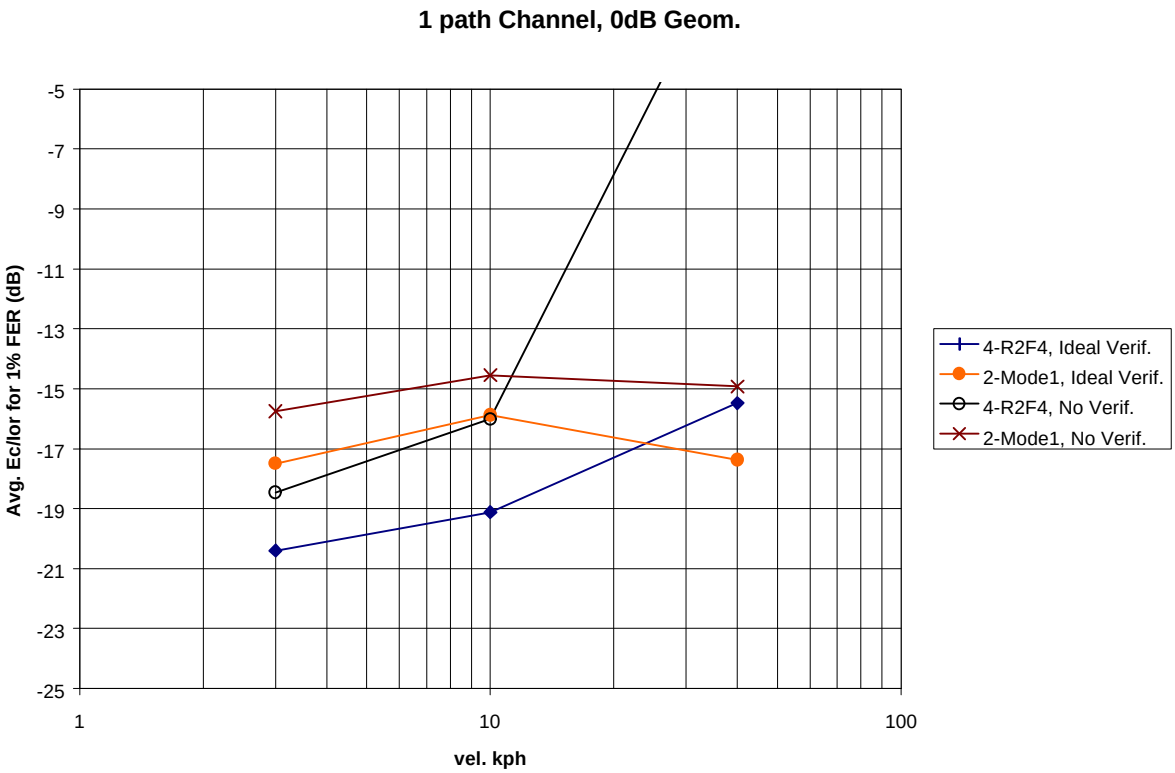

Figure 7. Bounds for verification in 1-path Rayleigh fading channel (0 dB geometry).

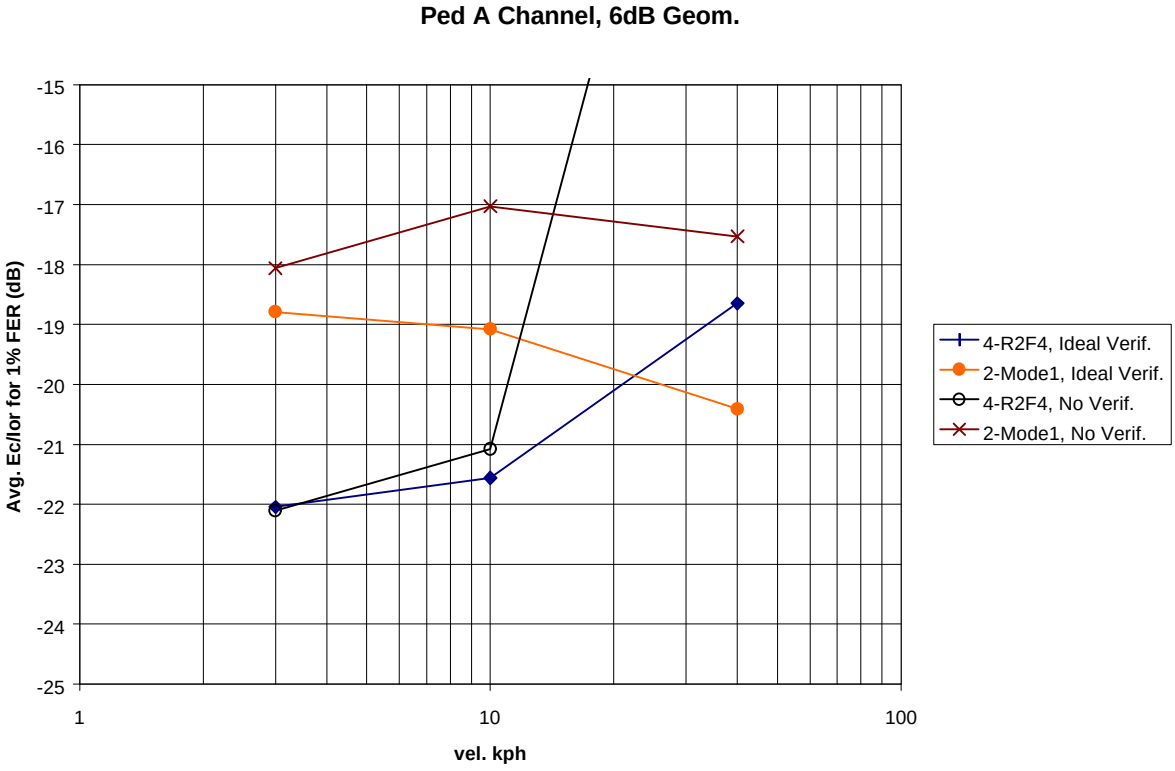

Figure 8. Bounds for verification in modified ITU Ped. A channel (6 dB geometry).

3. CONCLUSIONS AND FURTHER STUDIES

The results indicate that even in multipath channels gains up to 3.5 dB are possible at low UE speeds. Preliminary results for verification bounds suggest that a verification of some kind need to be applied at UE for a robust performance. Further work on the details of the verification algorithms are needed.

As agreed in the AH26 meeting #1 more input are need also on the following issues [2]:

- Complexity impacts to UE
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- Backwards compatibility
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REFERENCES

[1] Nokia. An extension of closed loop Tx diversity mode 1 for multiple Tx antennas. TSG-R WG1 document, TSGR1#13(00)0712, 22-25th, May, 2000, Tokyo, Japan, 8 pp.

[2] AH26. AH26 report to RAN WG1 meeting #13. TSG-R WG1 document, TSGR1#13(00)0747, 22-25th, May, 2000, Tokyo, Japan, 5 pp.