3GPP TSG RAN WG 1 ***TSGR1#17 R1-00-1360***
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Agenda Item:

Source: Siemens

Title: Results of Tx diversity simulations using the eigenbeamformer in a static propagation environment

Document for: Information and discussion

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1 Introduction

In AH 26 different methods of closed-loop transmit diversity techniques with more than two antenna elements are discussed. With increasing the number of antenna elements more information must be fed back to the Node B to adjust the weights of the antenna elements. This causes, due to limited feedback bandwith in the uplink, a bound for the velocity of the UE at which beamforming gains can still be achieved. For a fast moving UE eventually the feedback would be to slow to set the appropriate antenna weights at the Node B on time.

To reduce this problem Siemens has proposed the eigenbeamformer concept at TSG RAN WG1 #14 [4]. The main principle behind this method is that long-term spatial channel properties are exploited. This is done by calculating a set of eigenvectors based on the averaged covariance matrix between antenna elements. The eigenvectors are fed back by long-term signalling. Every slot the UE decides which eigenvector shall be used and signals the decision back to the Node B (short-term feedback). This way transmit diversity can be achieved at higher velocities. One inherent advantage of the eigenbeamformer is that it would require no additional short-term feedback if even more than 4 antennas are used.

With this paper simulation results are shown to compare the performance of different methods for closed-loop transmit diversity. The simulations show the performance of the Release ’99 mode 1, Nokia R2F2 (see [5]) and the Siemens eigenbeamformer.

2 Simulation parameters

The channel model was chosen according to [2] and the parameters are defined in [1] and [3]. For convenience the parameters are listed in the following table:

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 per antenna
Channel model(s) and UE velocities	1-path Rayleigh: 3, 10, 40, 120 km/h Modified ITU Ped A: 3, 10, 40 km/h Modified ITU Veh. A: 10, 40, 120 km/h
CL feedback bit error rate	short-term 4 % long-term 0 %
CL feedback delay	0 slots
TTI	20 ms
Downlink DPCH slot format	#10 or #11
Min. # of RAKE fingers for modified Vehicular A channel	5
Target FER/BlkER	1 %
Geometry (G)	0 dB
Common Pilot	-10 dB total
Correlation between antennas	different models apply, see [1]
Performance measure	T_x E_b/I_{or}
CL feedback rate	1500 Hz

Table 1. Simulation parameters for simulations.

For the correlation between antenna elements three scenarios have been defined in [1] and were used for the simulations. The number of eigenbeams was chosen to be $N_{beam} = 2$.

For the feedback delay, no additional delay besides the delay to ensure causality was used.

The feedback error for short-term bits for switching the eigenbeams was 4%. The long-term feedback to transmit the eigenvectors was assumed to be error free. The eigenvectors were quantized with 5 bits for phase and 3 bits for amplitude of each vector element. Ideal antenna verification was assumed at the UE.

3 Simulation results

3.1 Uncorrelated case

As defined by the model the antenna elements are uncorrelated. Therefore there are no spatial channel properties that can be exploited. All the eigenvalues have about the same size. Therefore the eigenbeamformer degrades at velocity 3 km/h and 10 km/h as can be seen in Figure 1. At 40 km/h all three methods perform approximately the same.

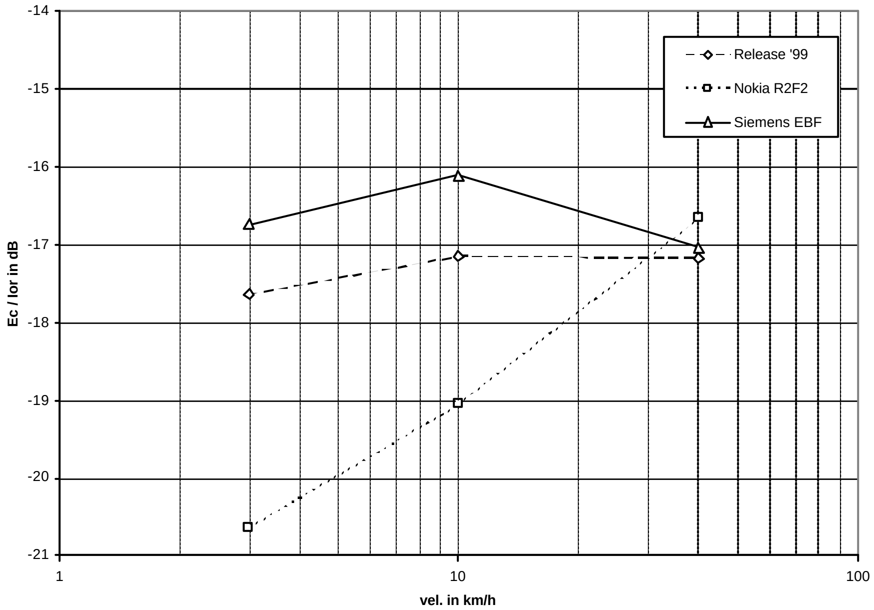

Figure 1: Required Ec / Ior for 1% FER in uncorrelated scenario

3.2 Micro cell

Here, the eigenbeamformer method can take advantage of the spatial correlation and provide an improvement of about 2.6 dB at velocity 40 km/h (Figure 2). At 10 km/h the Nokia method and the eigenbeamformer perform about the same. At 3 km/h the Nokia proposal shows better performance. However, the eigenbeamformer performs about 1.6 dB better than the Release '99 closed-loop mode 1 at all three velocities.

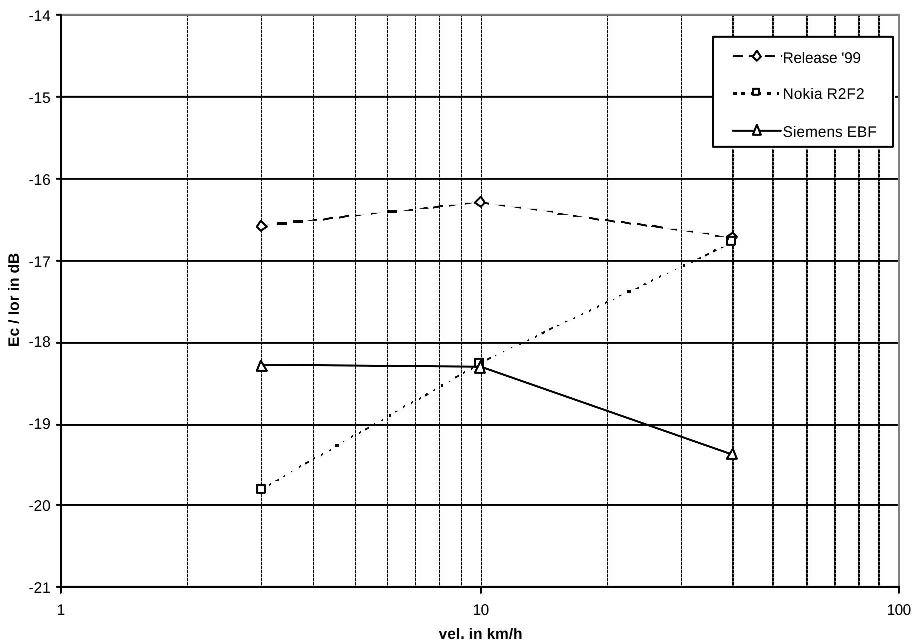

Figure 2: Required Ec / Ior for 1% FER in micro cell scenario

3.3 Macro cell

In this scenario the angular spread was defined to be small (10°). The performance gain of the Nokia and the eigenbeamformer method will be in the order of 2 dB compared to Release '99 mode 1. The performance of the eigenbeamformer is slightly better, since with the long-term feedback the weight vectors can be quantized with more bits which results in a better beamforming resolution.

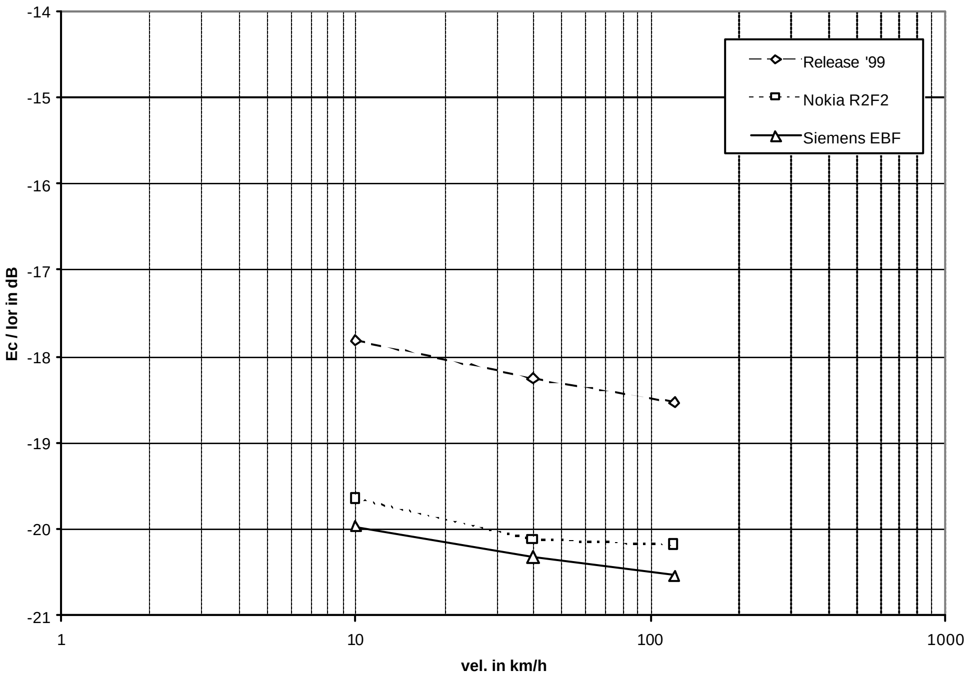

Figure 2: Required Ec / Ior for 1% FER in macro cell scenario

4 Conclusions

The principal performance of the eigenbeamformer related to the Release '99 mode 1 and the extension by Nokia (R2F2) has been shown for the three scenarios uncorrelated case, micro cell and macro cell. The advantages for each method at the different scenarios could be seen.

It may be subject for further study if using both methods mapped to the velocity of the UE could be a solution to get the benefits from the Nokia proposal as well as from the Siemens proposal. Further simulations need to be done to find out about the right procedure and velocity threshold.

In addition, the impact of real antenna verification needs to be investigated. So far ideal antenna verification has been assumed. The effect of feedback errors on long-term updates needs still to be investigated. For this a time varying channel model needs to be defined.

5 References

[1] Siemens, "Simulation parameters for Tx diversity simulations using correlated antennas", Tdoc R1-00-1180

[2] Siemens, "Channel model for Tx diversity simulations using correlated antennas", Tdoc R1-00-1067

[3] Nokia, "Recommended simulation parameters for Tx diversity simulations", Tdoc R1-00-0867

[4] Siemens, "Advanced closed loop Tx diversity concept (eigenbeamformer)", Tdoc R1-00-0853

[5] Nokia, "An extension of closed loop Tx diversity mode 1 for multiple Tx antennas" Tdoc R1-00-0712