COMMENTS ON SIEMENS' EIGENBEAMFORMER PROPOSAL

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Lucent Technologies
Bell Labs Innovations

SIEMENS’ EIGENBEAMFORMER PROPOSAL OVERVIEW

- The original eigen-beamforming proposal (July 2000, TSGR1#14(00)0853) was based on the dominant eigen-modes of the channel correlation matrices for every temporal tap. This seems inappropriate since these eigen-modes cannot be effectively utilized with a conventional rake receiver at the UE.
- This has been modified in a later proposal (March 2001, TSGR1#19 R1-01-0203) to consider the channel correlation matrix averaged over temporal taps.
- The eigen-beamformer employs a few candidate eigen-beams based on the long-term channel correlation matrix. Selection of eigen-modes is done on a short-term basis.
- Eigen-beams are computed at UE, fed-back to Node B and updated at slow rate (1 bit/frame). Fast (14 bits/frame) closed loop is used for selection among eigen-beams based on short-term correlation → eigen-beam based selection diversity.

COMMENTS ON THE APPLICABILITY OF THE SCHEME

- This concept is seemingly geared towards closely spaced antennas. Maintaining a few candidate eigen-beams would be appropriate for spatially correlated channel resulting from a large number of antennas such that only a few dominant eigen-beams essentially capture the effect of the channel.
- For spatially uncorrelated channels, the eigen-beamforming approach ends up selecting one antenna at each selection time and therefore becomes a pure selection diversity scheme.
- In the micro cell environment, where the long term correlation (and, therefore the eigen-beams) could change appreciably, the low update rate of the eigen-beams will adversely affect performance.
- The approach essentially reduces to long-term beamforming in the two antenna case. Effectiveness of short term selection is not apparent.

NON-UNIQUE EIGENMODES

- In the case where the strongest two eigen-modes are of equal strength, there is non-uniqueness in the choice of the eigen-beams.
- Specifically, let $\mathbf{w}_1$ and $\mathbf{w}_2$ be two eigen-modes with the same eigen-value.
- Any vector of the form $\mathbf{w} = \alpha_1 \mathbf{w}_1 + \alpha_2 \mathbf{w}_2$, $\alpha_1^2 + \alpha_2^2 = 1$ is an eigenvector with the same eigen-value.
- Although the long term performance with any $\mathbf{w}$, as defined above, is equivalent, the effect of different choices of α_1, α_2 on short term selection performance is unclear.

COMMENTS ON THE PERFORMANCE CURVES (REFER TO TSGR1#19 R1-01-0203)

- It is unclear if the correlation matrices used in the comparative performance evaluation of the eigenbeamformer and Nokia's R2F2 scheme, for the macro-cell environment (high spatial correlation; i.e., closely spaced antennas) are *identical*. If so, the comparison seems to be unfair, since the eigen-beamformer uses well quantized beamforming weights, as opposed to R2F2 which uses short-term, coarsely quantized transmit diversity weights.
- If the simulations have assumed that all the different paths have the same spatial correlation structure, then performance curves should be presented for the realistic scenario of different dominant paths giving rise to different correlation structures.
- The relatively superior performance of the eigen-beamformer in the micro-cell scenario suggests that a static spatial channel model was used. The results will not be as good when a time-variant spatial channel model is used.