3GPP TSG RAN WG 1 ***TSGR1#20 R1-01-0442***
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Agenda Item: E-mail discussion on TX Diversity solutions with multiple antennas

Source: Siemens

Title: Simulation result regarding adaptive antennas without feedback

Document for: Discussion

In this discussion paper simulation results are presented for an adaptive antenna system with four antennas without feedback. The antenna weights at the Node B are obtained based on measurements on the uplink channel.

Based on the results system level calculations are performed to obtain a rough estimate of the cell capacity.

It is shown that in the case of the micro cell scenario with partially correlated antennas, the capacity of the system using an adaptive antenna system without feedback is about 50 % of the capacity using a system with Rel99 mode 1. With the eigenbeamformer the capacity can be almost doubled compared to the Rel99 mode 1.

1 Simulation results

The simulation assumptions as defined in Tdoc R1-00-1180 have been used for the micro cell scenario. For the adaptive antenna solution without feedback the following assumptions have been made:

- Calibration: the phase calibration due to different transmission paths in uplink and downlink is assumed to be perfect. The covariance matrix for the uplink and the downlink are assumed to be the same.
- Uplink measurements: The measurements on the uplink channel to obtain the covariance matrix are perfect. The covariance matrix is assumed to be perfectly known at the Node B.
- Frequency transformation: The transformation of the measurements in the uplink to antenna weights for the downlink to compensate the FDD frequency gap is assumed to be perfect.
- Since the UE does not know the applied antenna weights it can only use the dedicated pilot bits for channel estimation and not the CPICH.

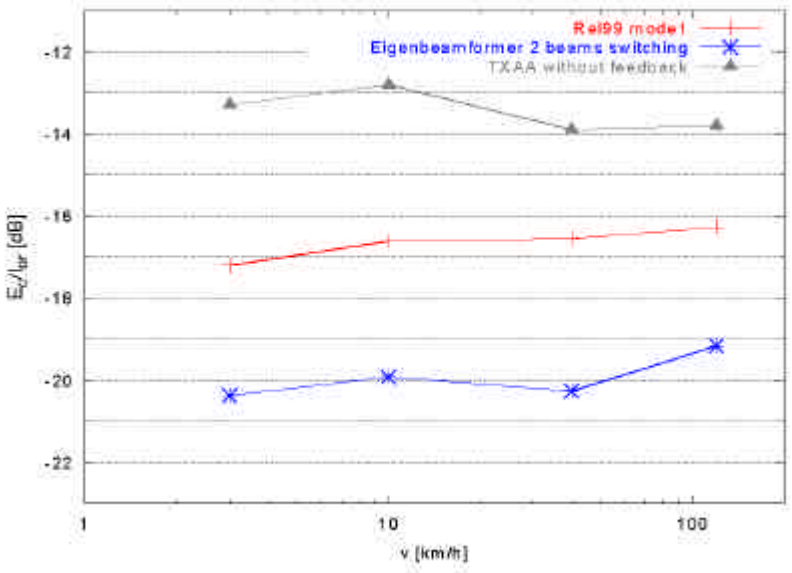

Figure 1: Simulation result for micro cell scenario

As can be seen from Figure 1, the adaptive antenna solution with four antennas performs about 3 dB worse than Rel99 mode 1 with 2 antennas. This is mainly due to the fact that the UE can do a channel estimation on the dedicated pilot bits only. The case of transmitting a s-CPICH for each beam is not considered here. Another reason for the performance loss is that diversity gain cannot be achieved, as the antenna weights cannot be adapted to the fast fading channel of each antenna.

2 System level considerations

From the above link level simulation results system level calculations can be done in order to achieve a rough estimate of the cell capacity. In this simple calculation, the cell capacity is derived by subtracting the transmit power used for the CPICH and the power for other common channels from the total transmit power, leaving some available power for all the DPCHs. This is then divided by the necessary power needed for the DPCH to achieve 1% FER. Note that this value also depends on the UE speed, therefore we give a range of values in the sequel. The different location of each UE is neglected. In average a geometry of 0 dB is assumed as it has been used in the simulation.

For each TX diversity scheme, the capacity in terms of number of DPCHs can be calculated as

$$n ? \frac{Total\_TX\_Power ? CPICH\_Power ? Other\_Common\_Ch\_Power}{DPCH\_Power}$$

The power of the other common channels (P-CCPCH, PICH, SCH) has been chosen to be 10% of the total transmit power of Node B. Depending on the TX diversity scheme the appropriate power for the CPICH (15 % or 12.5 %) was used. This is explained in more detail in the respective subclause.

2.1 Release 99 mode 1

For the Rel99 mode 1 system with two antennas the values in the range of –17.5 to –16 dB, depending on the UE speed, can be taken from Figure 1 for the necessary DPCH Ec/Ior. The CPICH power is set to 10% of the total transmit power as in the regular simulation assumptions.

DPCH Ec/Ior (from Figure 1)	-17.5 ... -16.0 dB	1.78 ... 2.51 %
CPICH Ec/Ior	-10 dB	10 %
Other Common Channel Ec/Ior	-10 dB	10 %

Table 2: Split of total transmit power of Node B (Ior) for Rel99 mode 1

Taking the above formula the number of dedicated channels can be calculated as

$$n ? \frac{100\% ? 10\% ? 10\%}{[1.78..2.51]\%} ? [31..45]$$

2.2 TX Diversity using adaptive antennas without feedback

Here, the needed DPCH Ec/Ior for the target FER of 1% reads to –14 to –13 dB. Despite the fact that the CPICH is not used for channel estimation the power of the CPICH for this system level calculation is kept to be 10% since it is needed as phase reference for other channels.

DPCH Ec/Ior (from Figure 1)	-14.0 ... -13.0 dB	3.98 ... 5.01 %
CPICH Ec/Ior	-10 dB	10 %
Other Common Channel Ec/Ior	-10 dB	10 %

Table 3: Split of total transmit power of Node B (Ior) for the Eigenbeamformer

Taking the above formula the number of dedicated channels can be calculated as

$$n ? \frac{100\% ? 10\% ? 10\%}{[3.98..5.01]\%} ? [16..20]$$

As already mentioned, the performance degrades mainly because no diversity gain can be achieved (fast fading) and the channel estimation is done on the dedicated pilot only.

2.3 Eigenbeamformer

As can be seen in Figure 1, the necessary DPCH power in terms of Ec/Ior to achieve a target FER of 1% is about –20.5 to -19.0 dB, depending on the UE speed. Using four antennas with feedback additional power is needed for the CPICH to enable the UE to perform channel estimation of antennas 3 and 4. Therefore an additional amount of cell power is assigned for the CPICH in the order of 2.5%. So for this system level consideration the total CPICH power is assumed to be 12.5% of the total transmit power.

DPCH Ec/Ior (from Figure 1)	-20.5 ... -19.0 dB *)	0.89 ... 1.26 %
CPICH Ec/Ior	- 9 dB	12.5 %
Other Common Channel Ec/Ior	-10 dB	10 %

Table 1: Split of total transmit power of Node B (Ior) for the Eigenbeamformer

*) Note: The performance difference due to 12.5% CPICH power is not taken into account yet in the simulation. The curve shows the performance for 10% CPICH power.

Taking the above formula the number of dedicated channels can be calculated as

$$n \in \frac{100\% \setminus 12.5\% \setminus 10\%}{[0.89..1.26]\%} \in [61..87]$$

3 Conclusion

The capacity values are summarised in Figure 2. The light blue parts of the columns indicate the capacity range resulting from the performance at different UE speeds.

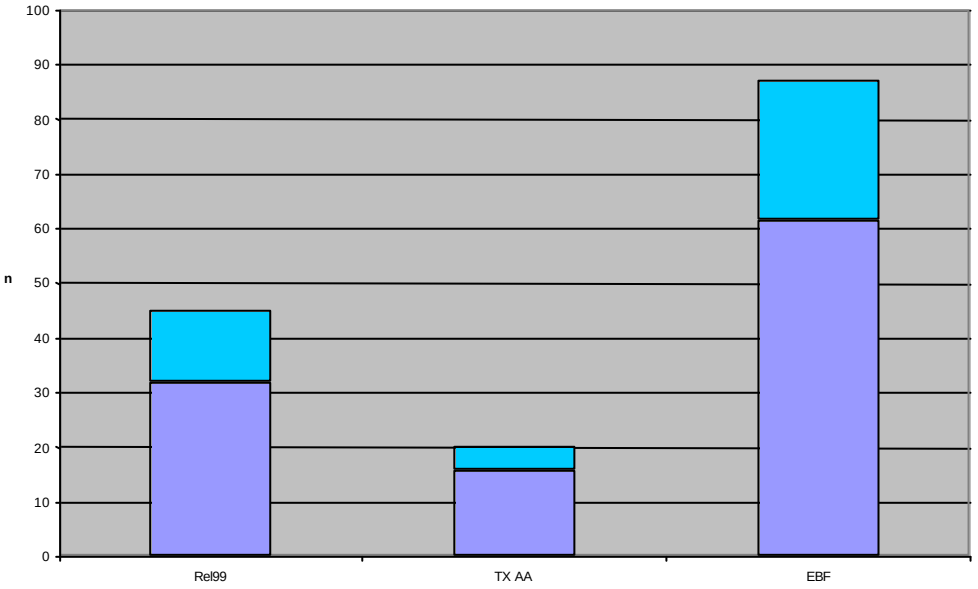

Figure 2: Comparison of cell capacity (in numbers of DPCH) between Rel99 mode 1, adaptive antennas without feedback and the eigenbeamformer

It can be seen that the capacity of the system using an adaptive antenna system without feedback is about 50 % of the capacity using Rel99 mode 1. With the eigenbeamformer the capacity can be almost doubled compared to the Rel99 mode 1.