3GPP TSG RAN WG1 Meeting No 7 ***TSGR1#7 99b15***
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Agenda item:	**Ad hoc 9**
Source:	**Nortel Networks**
Title:	**DownLink Power Control Rate Reduction during Soft Handover**
Document for:	**Decision**

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1. Introduction

In the last WG1 meeting, we have proposed to reduce the power control rate on the downlink during soft handover (R1999-951). The UE sends one power control command to all cells that are in soft handover. If the power control command is received differently by the cells (due to errors), the cells transmitted powers will start to deviate which reduces the soft handover gain. What we propose is to allow the UE to repeat each power control command over three slots instead of sending a single command per slot. This will reduce the real power control rate from 1500 to 500 commands /sec. Two benefits are gained: the error on the power control commands is reduced since they are repeated three times and the frequency at which the cells adjust their powers is reduced. In this contribution, we evaluate the performance of such a scheme.

2. Performance of proposed scheme

The simulation assumptions are:

- The UE is in soft handover with two cells. The paths loss difference (not including the multipath fading) between the two cells and the UE is 2dB.
- The multipath fading channel is two Raleigh paths fading channel.
- The signal is received using a four fingers RAKE receiver.
- Power control is employed on both uplink and downlink links. This includes both the inner loop and the outer loop algorithms.
- The step size for the inner loop power control is 1.0 dB.
- The change in the transmitted power due to the closed loop is limited to ±15dB.
- The error rate on the power control commands is not fixed but rather function of the link quality.
- The FER on both the downlink and the uplink is 1%.
- The Eb for the power control command is assumed to improve by 4.8dB when it is transmitted over three slots compared to the case where it is transmitted over one slot only.
- The cells transmitted powers are synchronized every 200 frames.

We evaluate the proposed scheme performance compared to the conventional scheme by looking at the cells transmitted powers. We look at both the average and the variance of the cells transmitted powers.
Let cell 1 transmitted power be x and cell 2 transmitted power be y, we define z to be $|x-y|$.
Table 1 shows the statistics of x and y while Figures 1 to 3 show the complementary cumulative distribution function of z.

Table1: Statistics of the cells transmitted powers

Speed(Km/h)	Command repetition	Avg(x)	Var(x)	Avg(y)	Var(y)
5	1	3.73	19.28	4.43	28.86
5	3	3.27	7.06	3.65	9.34
25	1	4.54	18.72	4.98	24.37
25	3	4.43	6.79	4.04	6.22
50	1	5.38	17.63	5.00	23.71
50	3	4.94	6.13	4.96	7.99

Looking at Table 1, we notice that proposed scheme results in a considerable decrease in the variance of the transmitted powers at all speeds. This is due to the fact that the power commands have less errors and that the cells powers are adjusted less frequently. Also, we note that the average transmitted power is reduced by applying the proposed scheme which results in lowering the interference. Looking also at Figures 1-3, we see that the difference in the two base stations transmitted powers is much smaller when the proposed scheme is applied. For a speed of 5 Km/h, the probability that the difference in the transmitted powers exceeds 5dB is only 15% for the proposed scheme while it is 50% for the conventional scheme.

It is important to notice that these results take into consideration the degradation due to reducing the power control rate from 1500 to 500. This is because the outer loop algorithm is activated. If the closed loop is not tracking the fading channel, the outer loop will set the SIR target to a higher value which requires the cells to transmit more power. It should also be noted that the efficiency of the closed loop is not a function of the power control rate alone but also of the rate of change in the propagation channel. The fading channel (as seen by the UE) will be smoother when both cells transmitted powers do not deviate from each others.

3. Proposed implementation of the reduction in the power control rate

We recommend introducing a new parameter that is called DPC_MODE (down link power control mode) that is used to determine the down link power control rate. This parameter can have two values: 0 and 1. A zero will indicate that the UE should send a unique power control command each slot while a one indicates that the UE has to repeat the same power command over three slots. When a command is repeated over three slots, there should be a new command at the beginning of the frame. This is needed to help the base station to know where to find the three repeated commands. TSGR1#7 R1-99b16 has a text proposal to add this new parameter and to use it during soft handover.

4. Conclusion

As a conclusion, the proposed scheme of reducing the downlink power control rate during soft handover allows to reduce the transmitted powers of the cells at small and moderate speeds and therefore reduces the amount of interference in the network. The mobile can also fully benefit from soft handover, as the gain is maximum when the received powers are close.

5. References

[1] TSGR1#6 99-951 Downlink Power Control during Soft Handover, Nortel Networks.

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FIGURE 1

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FIGURE 2

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FIGURE 3