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Source: Nortel Networks

Title: Downlink Power Control Step Size During Soft Handover

Document for: Discussion

1- Introduction

Downlink power control during soft handoff suffers from the problem of the serving NodeBs transmitted powers deviating due to errors on the TPC commands sent by the UE. In this contribution we look into the effect of the step size on the difference in the NodeBs transmitted powers. Conceptually, a small step size should result in a smaller difference. We also look into the effect of the serving NodeBs applying different step sizes to adjust their powers. In order to reduce the deviation in the transmitted powers, the adjustment loop as described in R1-99e69 is employed.

Assuming the UE to be communicating with two NodeBs simultaneously and the transmitted power of NodeB1 to be *P1* and of NodeB2 to be *P2*, we define Z to be

$$z = |P1 - P2|$$

We look into the average and variance of the serving NodeBs transmitted powers and the complementary cumulative distribution function (CCDF) of z to compare the performance of different step sizes.

2- Simulation Assumptions

- 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 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 Transmitted powers are assumed to be equal at the beginning of the simulations.
- *For the adjustment loop (see R1-99e69): P_{REF} =0 and r= 0.96.*
- *The power control step size at the UE is fixed to 1dB.*
- The performance of the adjustment loop algorithm is investigated for two cases:

1. The UE sends a unique TPC command per slot (DPC_mode=0)
2. The UE repeats the same TPC command over three slots (DPC_mode=1)

3- Results

The following table shows the average and variance of the NodeBs transmitted powers.

Velocity Km/h	Δ_{TPC1}	Δ_{TPC2}	E(P1)	E(P2)	Var(P1)	Var(P2)	DPC_mode
5	0.5	0.5	3.66	3.65	3.09	3.00	1
5	1.0	1.0	3.35	3.36	4.99	4.94	1
5	2.0	2.0	3.42	3.41	6.86	6.80	1
50	0.5	0.5	5.39	5.35	2.12	2.10	1
50	1.0	1.0	4.86	4.82	4.02	3.99	1
50	2.0	2.0	4.97	4.99	7.89	8.09	1
5	0.5	0.5	3.37	3.24	4.16	3.77	0
5	1.0	1.0	3.33	3.21	6.39	5.42	0
5	2.0	2.0	3.36	3.30	7.81	7.39	0
50	0.5	0.5	4.83	4.71	2.97	2.91	0
50	1.0	1.0	4.70	4.63	5.88	5.82	0
50	2.0	2.0	4.93	4.88	12.20	12.16	0
5	0.5	1.0	2.32	5.89	0.79	22.31	1
5	1.0	2.0	2.37	5.77	1.50	25.90	1
5	0.5	2.0	1.76	8.27	0.35	51.33	1
50	0.5	1.0	3.18	10.37	0.52	21.9	1
50	1.0	2.0	3.18	9.97	1.11	35.23	1
50	0.5	2.0	2.11	14.23	0.21	59.4	1

Figures 1 through 4 show the CCDF of the difference in the NodeBs transmitted powers (*z*) for two UE speeds: 5 km/h and 50 km/h where both NodeBs use the same step size to change their powers. Figure 5 shows the CCDF of *z* where the two serving NodeBs use different step sizes. From figures 4 and 5 we can see that the probability of the difference in the NodeBs transmitting powers exceeding 3dB is 0.002 if both NodeBs use a step size of 0.5dB while this probability is greater than 0.90 when the two NodeBs use different step sizes.

4- Conclusion

Simulations show that using a small step size results in reducing the variance in the transmitted powers which reduces the interference. Simulations also show that the serving NodeBs have to use the same step size. This can be achieved by either standardizing the step size to be used during soft handover or by making sure that the RNC will signal to the serving NodeBs which step size to be used during soft handover. This chosen step size has to supported by all the serving NodeBs (0.5 dB is optional).

5- Reference

[1] TSGR1#7bis(99)E69: Adjustment Loop in downlink power control during soft handover, NEC

[2] TSGR1#799b15 : Downlink Power Control Rate Reduction during Soft Handover, Nortel Networks.

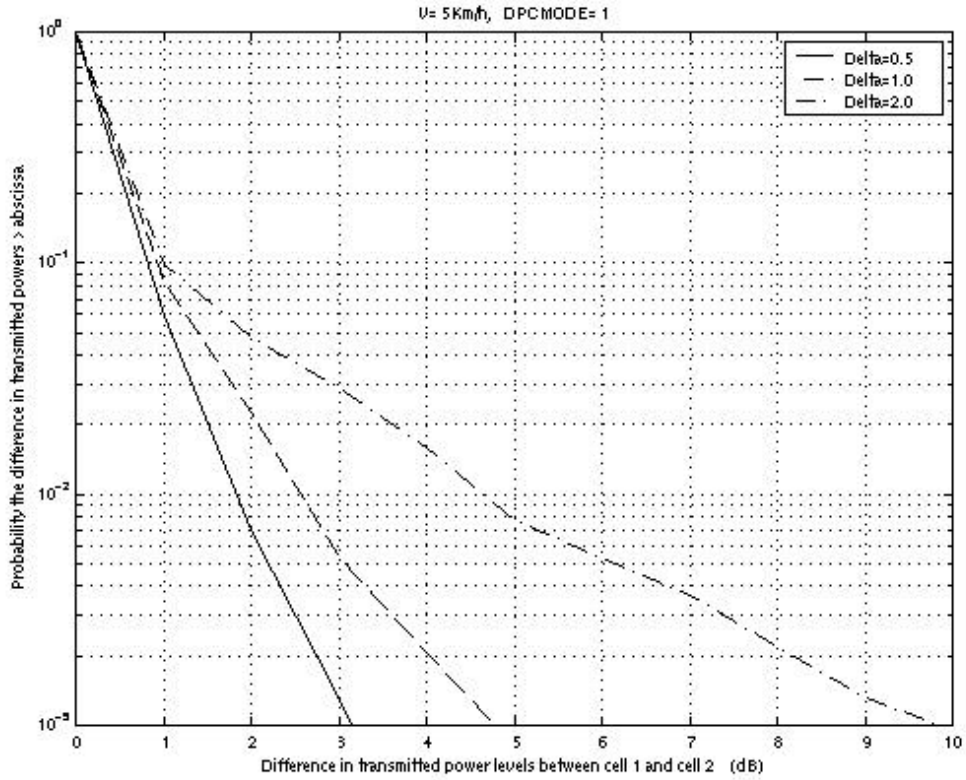

Figure 1

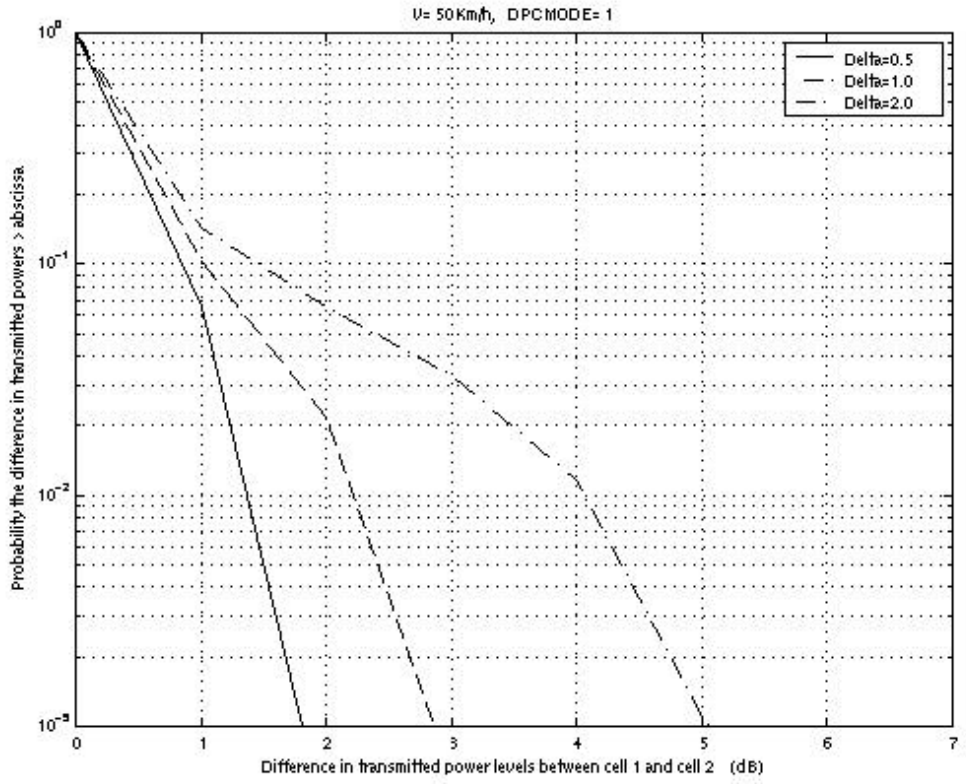
V= 50Km/h, DPCMODE= 1
Delta=0.5
Delta=1.0
Delta=2.0
Probability the difference in transmitted powers > abscissa
Difference in transmitted power levels between cell 1 and cell 2 (dB)

Figure 2

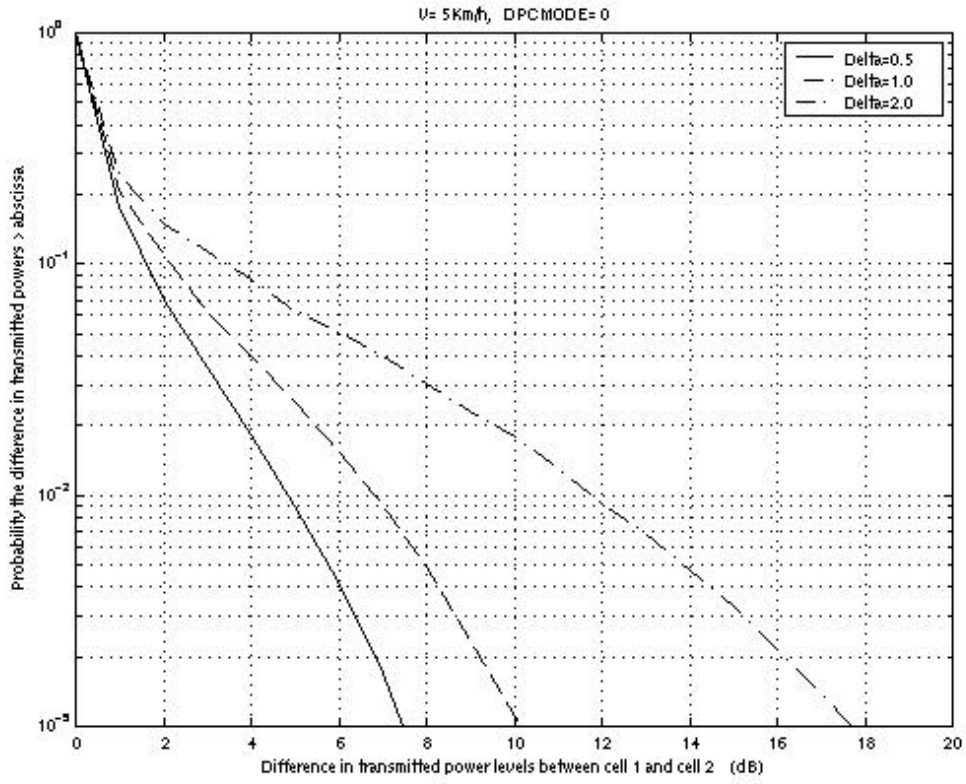
V= 5Km/h, DPCMODE= 0
Delta=0.5
Delta=1.0
Delta=2.0
Probability the difference in transmitted powers > abscissa
Difference in transmitted power levels between cell 1 and cell 2 (dB)
10^{0}
10^{-1}
10^{-2}
10^{-3}
0
2
4
6
8
10
12
14
16
18
20

Figure 3

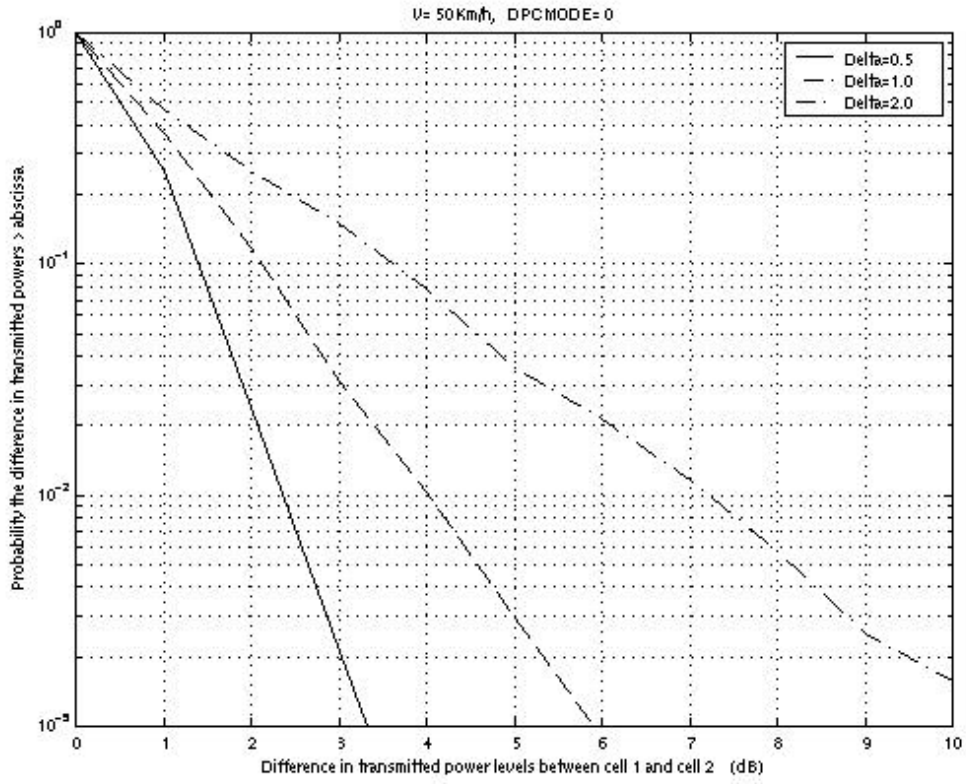
V= 50Km/h, DPCMODE= 0
Delta=0.5
Delta=1.0
Delta=2.0
Probability the difference in transmitted powers > abscissa
Difference in transmitted power levels between cell 1 and cell 2 (dB)

Figure 4

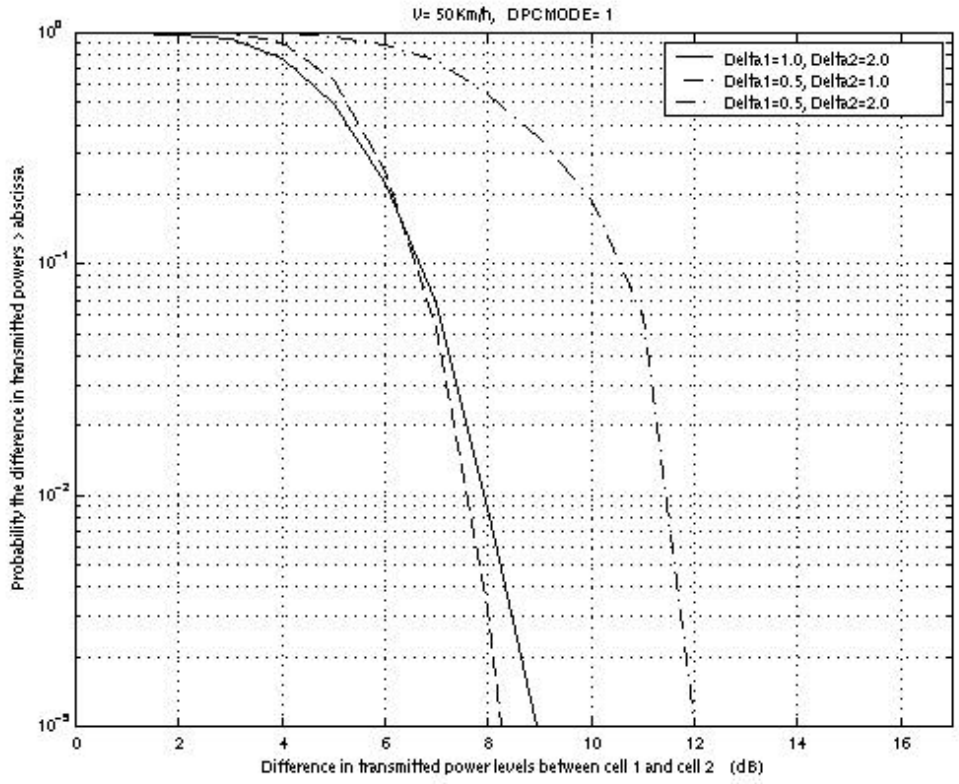
V= 50Km/h, DPCMODE= 1
Delta1=1.0, Delta2=2.0
Delta1=0.5, Delta2=1.0
Delta1=0.5, Delta2=2.0
Probability the difference in transmitted powers > abscissa
Difference in transmitted power levels between cell 1 and cell 2 (dB)

Figure 5