TSG-RAN Working Group 1 meeting #9 **TSGR1#~~9~~(99)k01**
Dresden, Germany
Nov. 30 - Dec.3, 1999

Source: Nortel Networks

Title: Adjustment Loop Performance

Document for: Discussion

1- Introduction

The adjustment loop algorithm was introduced in R1-99e69 as a way to reduce the power drifting problem when the UE is in soft handover with more than one NodeB. More simulation results were seen to be needed to investigate the performance of the algorithm. In this contribution, we provide some simulation results that show the effect of the adjustment loop in reducing the difference in the NodeBs transmitted powers.

2- Adjustment loop

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*, R199e69 proposed updating the NodeBs transmitted powers based on the following equations:

$$P_1(i+1) = P_1(i)+(1 - r)(P_{REF} - P_1(i))+S_{INNERLOOP1}(i) \qquad (1)$$
$$P_2(i+1) = P_2(i)+(1 - r)(P_{REF} - P_2(i))+S_{INNERLOOP2}(i) \qquad (2)$$

Based on the simulation results in R199e69, a good value of P_{REF} is 0 and the used value for r is 0.96. We will use these two values in our simulations. The change in the transmitted powers (from the inner loop and from the adjustment loop) will be limited to steps of 1dB. Hence, when updating the transmitted powers values (equations 1 and 2), the previous calculated value will be used and not the actual previous transmitted power.

Let z be defined as

$$z = \left| P1 - P2 \right|$$

We look into the complementary cumulative distribution function (CCDF) of z as an indication of the difference in the NodeBs transmitted powers. 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)

The performance of the adjustment loop is also compared with the synchronization algorithm where the RNC signals to the different NodeBs what power level all of them should be transmitting at. The synchronization process is repeated every *S* frames.

3- Simulation results

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 cells transmitted powers are synchronized every *S* frames for the synchronization algorithm. No synchronization is done for the adjustment loop algorithm. The Transmitted powers are assumed to be equal at the beginning of the simulations.
- P_{REF} =0 and r= 0.96.

Figures 1 and 2 show the CCDF of the difference in the NodeBs transmitted powers for two UE speeds: 5 km/h and 50 km/h. Looking at figure 1 we see that the probability of the difference in the two NodeBs transmitted powers (*z*) exceeding 4 dB is :

- 0.003 if the NodeBs transmitted powers are synchronized every 2 frames (S=2)
- 0.013 if the NodeBs transmitted powers are synchronized every 8 frames (S=8)
- 0.13 if the NodeBs transmitted powers are synchronized every 100 frames (S=100)
- 0.005 if the adjustment loop is applied in combination with the rate reduction algorithm
- 0.05 if the adjustment loop is applied alone.

4- Conclusion

In this contribution we looked into the performance of the adjustment loop algorithm as a mean to reduce the power drifting problem when the UE is in soft handover with more than one NodeB. The change in the transmitted power was limited to 1 dB steps. The algorithm seems to be useful in reducing deviation the NodeBs transmitted powers. The rate reduction algorithm was shown to be useful in reducing the difference in the transmitted powers.

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.

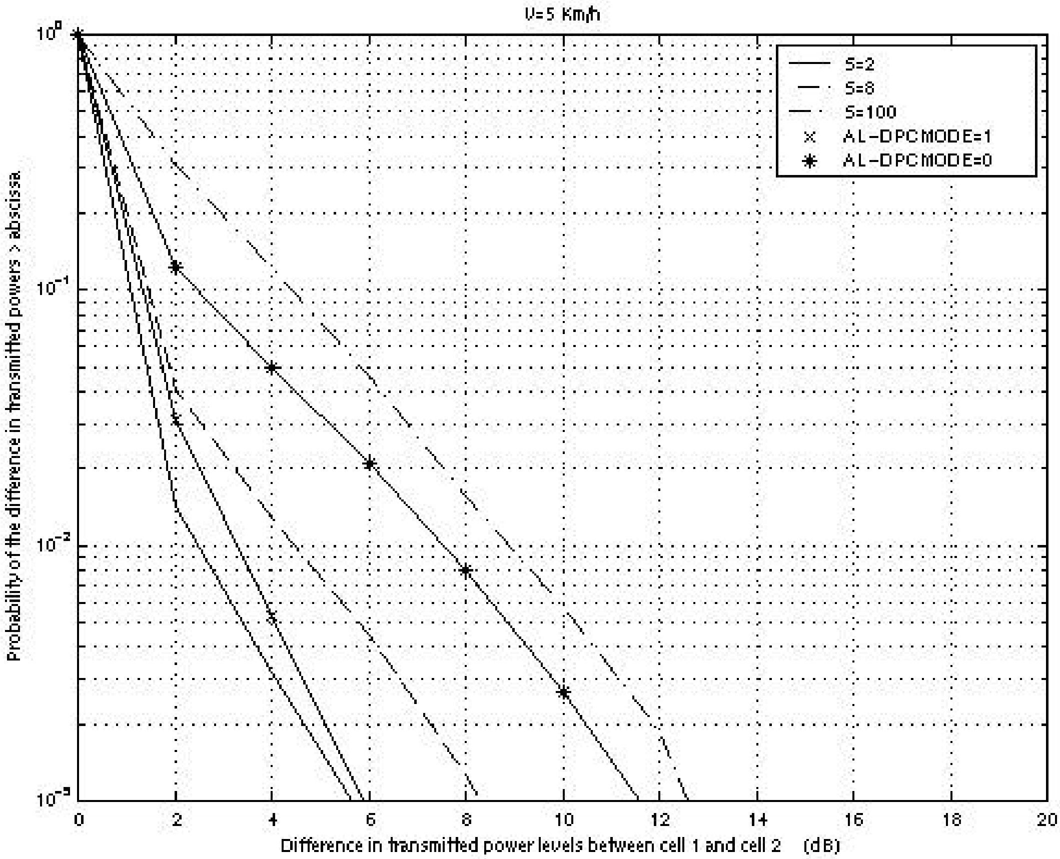
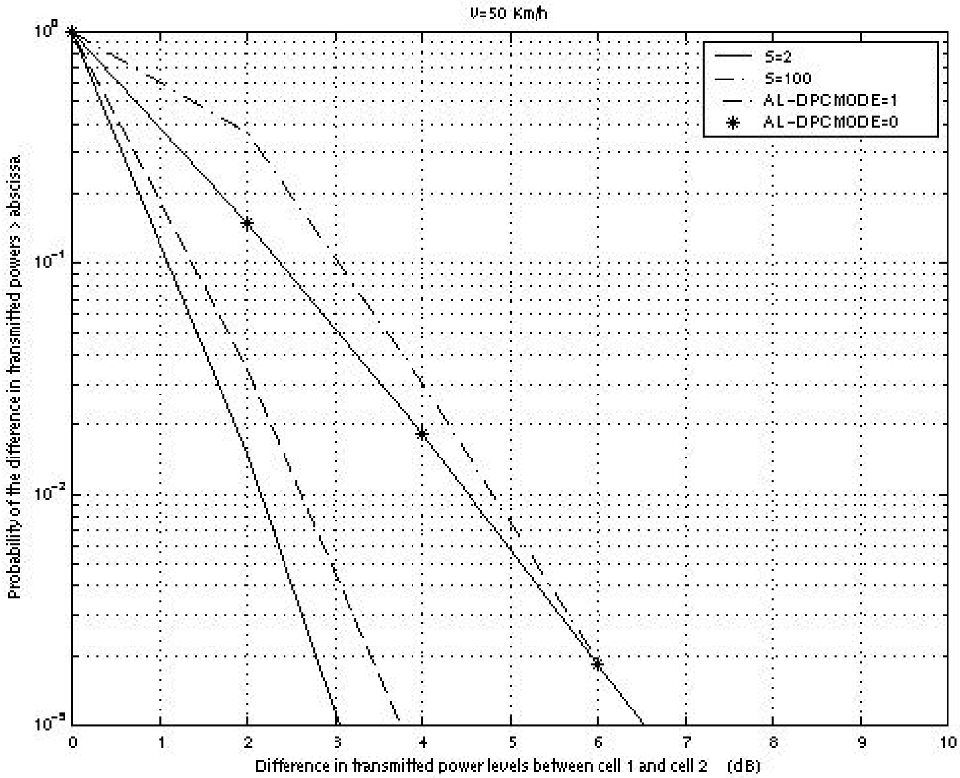

V=5 Km/h
S=2
S=8
S=100
AL-DPCMODE=1
AL-DPCMODE=0
Probability of the difference in transmitted powers > abscissa
Difference in transmitted power levels between cell 1 and cell 2 (dB)
0
2
4
6
8
10
12
14
16
18
20

Figure 1



V=50 Km/h
S=2
S=100
AL-DPCMODE=1
AL-DPCMODE=0
Probability of the difference in transmitted powers > abscissa
Difference in transmitted power levels between cell 1 and cell 2 (dB)

Figure 2