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Agenda item: **Ad hoc 9**

Source: **Nortel Networks**

Title: **Emulated Small Step Size during Soft Handover**

Document for: **Discussion**

1. Introduction

The physical change of power at the UE was agreed to be 1 dB. In [1], an algorithm was proposed to enable the UE to realise a smaller step sizes by accumulating more than one command (N commands) before adjusting its power(emulated step size). In order to align the TPC commands with the frame boundary, the two possible values of N were 3 and 5. In [2], the system performance was compared and it was concluded that it is always better to have N as 5. A text proposal was presented in [3] where N is taken to be 5. The results presented in [2] looked at the normal mode performance and not the soft handover performance. The emulated small step size will be implemented when the channel is not changing fast (or too fast). During soft handover, the UE combines the signal from more than base station and that's why the channel will be smoother and we may need to apply the emulated small step size algorithm. However, during soft handover, the data bits sent by the cells are the same which means that each cell will transmit lower power to achieve the required FER. The TPC bits are not necessarily the same and are decoded separately which results in increasing the error rate on these bits. Also, during soft handover, one link can be weak compared to the other which also increases the errors on the TPC commands. If 5 TPC commands are required to be the same, the UE may end up decoding each 5 TPC as a 0 where:

"The value of TPC_cmd is derived as follows:
- For the first 4 slots of a set, TPC_cmd = 0.
- For the fifth slot of a set, the UE uses hard decisions on each of the 5 received TPC commands as follows:
- If all 5 hard decisions within a set are 1 then TPC_cmd = 1 in the 5^{th} slot.
- If all 5 hard decisions within a set are 0 then TPC_cmd = -1 in the 5^{th} slot.
- Otherwise, TPC_cmd = 0 in the 5^{th} slot."

The UE can end up not adjusting its power most of the time. The fading channel may not be changing fast but still power control is needed. Thus, we compare the case of N=3 with N=5 during soft handover.

2. 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 UE repeats the same TPC over three slots [4]
- 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 and UE transmitted powers. Let cell 1 transmitted power be x and cell 2 transmitted power be y and the UE transmitted power to be z. Table 1 shows the statistics of x, y and z.

Table 1

V (Km/h)	Avg(x)	Avg(y)	Avg(z)	Var(z)	N
5	2.27	2.95	5.73	27.8	3
5	2.31	2.70	6.13	28.6	5
100	3.86	3.36	14.44	42.09	3
100	4.18	3.75	14.65	68.47	5

3. Conclusion

Looking at the above table, it seems that accumulating three TPC commands (N=3) results in better performance during soft handover compared to the case where we accumulate five TPC commands (N=5). This is because the tracking of the multipath fading is degraded when N=5 which makes the outer loop set the target Eb/No to a higher value and hence increases the average transmitted power. Thus, we suggest allowing N to be either 3 or 5 instead of restricting it to 5.

4. References

[1] TSGR1#5(99)553 “Implementation of small power control steps”, Philips, June 1999

[2] R1- 99b42, Philips, Algorithm 2 Power Control in Normal Mode

[3] R1- 99b42, Philips, Text proposal on power control

[4] R1- 99951, Nortel, Downlink Power Control during Soft Handover