3GPP TSG RAN WG1 Meeting No 7 ***TSGR1#7(99)c27***
August 30-September 3 1999,Hannover, Germany

Agenda item: **Ad hoc 9**

Source: **Nortel Networks**

Title: **On the Reliability of the Emulated Small Step Size During Soft Handover**

Document for: **Discussion**

1. Introduction

In the last WG1 meeting, emulated small step size was taken to be a working assumption that enables the UE to implement step sizes less than 1.0 dB. The UE makes a hard decision on the power control commands received over three or five slots and combine them to get a single power command that is +1 if all the commands requested an increase in the transmission powers or a –1 if all the commands requested a decrease in power or a 0, otherwise. In this contribution we investigate if the UE should check the reliability of these power control commands before combining them when they are received from different cells which is the case when the UE is in soft handover.

R1-99B42 proposes a scheme to look at the reliability of the commands that is similar to what is applied for normal step size case. We investigate by simulation the performance of such a procedure.

The UE generates a single power command for each connection based on the following procedure:

"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."

Then each single command is given a reliability figure based on the avergae SIR received over 5 slots. Finally, the different commands are combined in a similar manner to what is done in the normal step size case. We simulate this case and compare it with the case where the commands are combined directly without checking their reliability. In both cases, the 0 commands are ignored. This is because the 0 command has no information about the original 5 TPC commands. That is to say a 1 1 1 1 0 sequence and a 0 0 0 0 1 sequence both result in a TPC_cmd of 0. Thus, unless we look at the individual TPC over each slot, the information about the original TPC commands is lost when we get a TPC_cmd of 0.

2. 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 200 frames.
- In case of no reliability check:
  - The 0 commands are ignored
  - If all the remaining bits are 1's, power is increased, otherwise, power is decreased.
- In case of reliability check
  - The 0 commands are ignored
  - If the SIR of a command measured over 5 slots results in a TPC error rate greater than 30%, the command is ignored.
  - If all the remaining bits are 1's, power is increased, otherwise, power is decreased.

Let cell 1 transmitted power be x and cell 2 transmitted power be y and let z be the UE transmitted power. Table 1 shows the statistics of x, y and z at various speeds for the following cases :

- the UE sends a power control command every slot and the base stations adjust their powers every slot
- the UE repeats each power control command over three slots as described in R1-99B15 and the base stations adjust their power every three slots

The number of slots that the UE uses to send a single power control command is called N.

Table 1

V (Km/h)	Avg(x)	Avg(y)	Avg(z)	N	Reliability Check
5	2.59	4.96	6.53	1	No
5	2.98	4.64	6.66	1	Yes
5	2.31	2.70	6.13	3	No
5	2.30	2.65	6.28	3	Yes
100	4.03	6.00	16.73	1	No
100	3.78	6.29	16.54	1	Yes
100	4.18	3.75	14.65	3	No
100	4.17	3.75	14.93	3	Yes

3. Conclusion

In the case that the combining method does not take into account the original TPC bits over the five slots, the 0 command has to be ignored when combining the different commands received from different cells. This leaves us with the 1 and -1 commands. A TPC command of 1 (-1) means that a sequence of 1 1 1 1 1 (0 0 0 0 0) TPC commands was received over the five slots. If the link is so weak such that the error rate on the power control commands is 30% and a sequence of 1 1 1 1 1 is sent, then the probability of receiving 1 1 1 1 1 (TPC_cmd=1) is 17%. If we check the reliability of this command, then we end up ignoring the command. Ignoring these commands and ignoring the 0 commands results in degrading the power control algorithm performance. The algorithm used to combine the commands received over 5 slots has already some reliability check. If the received commands over 5 slots are not all the same, then the TPC_cmd is set to zero. This either means that there is no need to change the power since the cell is sending different commands or that there is an error in these commands which shows that they are unreliable and again the power should not be changed. Table 1 shows that checking the reliability of the commands that are decoded as 1 or –1 does not improve the system performance and it is better to always include these commands when deciding the power change. A reliability algorithm that's looks into all the TPC bits received over all the slots (not TPC_cmd) might be a better approach but this will be obviously at the expense of more complexity.

4. References

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

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