TSG-RAN Working Group1 meeting #5 ***TSGR1#5(99)715***
Cheju (Korea), June 1st – 4th 1999

Agenda Item : ad-hoc 9

Source : Nortel Networks

Title : Delta modulation for fast power control in compressed mode

Document for : Discussion

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1. Summary

In this paper, we introduce a new method to control the power of the transmitter after a transmission gap . The idea is similar to the concept of the delta modulation. This scheme is an enhancement of the Alcatel proposal. It consists in applying a possibly different PC step in a recovery period following the transmission gap, but the normal PC step is though used if consecutive TPC commands received are in opposite direction. This scheme aims at avoiding the use of higher steps if the experienced conditions lead to some instability of the TPC, as might happen for high speed or very low speed. This scheme does not require any modification of the signaling to support power control, since the step is adjusted by the transmitter on the basis of the analysis of consecutive TPC commands. Results are not available yet but we would appreciate feed-back from ad-hoc 9 participants on the perceived interest of this scheme.

2. Introduction

The problem we face after there is a gap in the transmission is how to adjust the power of the transmitter fast enough to compensate for the change in the channel condition. One proposal is to use a different step size for a given recovery period where this step size is usually larger than the normal step size. Such a scheme was proposed by Alcatel in [1]. Simulations were performed by Alcatel in [1] to compare a regular step size of 1dB with a step size of 2dB during the recovery period. It seems that a larger step size is needed when the channel is changing fast.

The large step size is known to cause more variations in the interference seen by other users. The larger this variation is, the lower the system capacity will be. Thus, we might want to use the large step size only when needed. One way to achieve this without any additional signalling overhead is to use something similar to the concept of delta modulation during the recover period. This is explained in the following section..

3. Proposed scheme for uplink power control in compressed mode

3.1 Description of the scheme

Assume the first power command that the transmitter receives after the transmission gap to be TPC_1 and power control received at slot k to be TPC_k, where slot k is the kth slot immediately following the transmission gap, then the UE for a given recovery period (N_{rec} slots) can apply the following rule:

If (TPC_1==Up)
Power = Power + Δ; where Δ is the regular step size that is used at normal mode

If (TPC_1==Down)
Power = Power - Δ;

If (TPC_k == Up) {
If (TPC_{k-1} == Up)

Power = Power + δ ; where δ is larger than Δ
If (TPC_{k-1}== Down)
Power = Power + Δ;
}

If (TPC_k == Down) {
If (TPC_{k-1} == Down)
Power = Power - δ ; where δ is larger than Δ
If (TPC_{k-1}== Up)
Power = Power - Δ;
}

This is an example to clarify the idea which has a memory of one previous power control command.
Two consecutive power up (down) commands indicate to the receiver that it needs to adjust its power by a larger step since there might be a large change in the channel condition during the transmission gap. The number of consecutive commands taken into account in the decision should be optimised, 2 is provided here as an example. However it is clear that the number of commands in the decision cannot be high either depending on the recovery period.

By applying such an algorithm, the transmitter can compensate fast for a large change in the channel condition when it occurs. However, when the change in the channel is small, the normal step size is applied. The channel condition will not change much when the mobile is moving slowly or when there are many multipath components that result in a smoother channel.

3.2 Impact of the scheme

The proposed scheme is very similar to another scheme that we propose for the normal mode in a companion document [3]. In the same fashion, the scheme that we propose consists in having the transmitter adjust the power control step size based on the sequential analysis of the TPC commands. For the compressed mode the memory is smaller, in our example only 2 slots.

The impact of the scheme is as follows :

- There is no modification of the downlink signalling for the PC
- There is no need to introduce any power offsets on the different fields on the downlink
- The PC step sizes are assumed to be in the set of allowed steps, the steps to apply in the compressed mode are either the normal one or a higher one
- There is a need for the UE to keep the last TPC command in memory, which is a negligible impact.

3.3 Applicability to the downlink power control

Although the scheme was described in section 3.1 for the UE, the scheme is equally applicable for the downlink PC. The PC on the downlink is not part of the specifications, however the proposed scheme can be considered as one example.

4. Conclusions

In this paper we have introduced a new way to control the transmitter power after there is a gap in the transmission. The concept is similar to the delta modulation concept. The idea is very easy to implement and does not require any additional signaling overhead. The objective is to use a larger step size only when needed. When there is a big change in the channel, the large step size is needed so that the target power level is achieved quickly. However, when there is no such big change in the channel condition, the large step size will be causing only large deviations in the SIR which is known to reduce the system capacity.

The scheme is equally applicable to the uplink and downlink power control. The scheme can be seen as an enhancement of the Alcatel proposal in [1], the modification consisting in applying a power control step larger than in the normal mode, only if several consecutive commands are identical, the normal step being applied when consecutive commands go in opposite directions.

Evaluation results of the scheme are not available at this time. We hope to be able to present soon simulation results and would like though to get some comments from ad-hoc 9 and WG1 as a whole on our proposal.

5. References

[1] :Improved power control in slotted mode, R1-99342, Alcatel,
[2] : C. Lee and R. Steele “Closed-loop power control in CDMA systems” IEE Proc. Comm., Vol. 143. No. 4. August 19963] : Variable step size for power control over-shot protection based on sequential analysis of power control bits, R1-99666, source Nortel Networks