TSG-RAN Working Group 1 ***TSGR1#8(99)f26***
New York, U.S.A., 12 – 15 October 1999

Source : TSG-RAN-WG3
To: TSG-RAN-WG1
Title : Liaison statement to RAN-WG1 regarding Adjustment Loop for DL power drifting

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RAN-WG3 in principle accepts the standardization of Adjustment Loop for DL power drifting. However WG3 would like to have an indication from WG1 if the standardization of Adjustment Loop has been completed or not. In this context, WG3 also would like to clarify the benefit of the key parameter of convergence coefficient “r” used in this function and the benefit of adjusting “r” parameter per UE .
Tdoc-R3-99B46 is attached for reference.

TSG-RAN Working Group 3 meeting #7 *TSGR3#7(99)B46*
Sophia Antipolis, France
September 20-24, 1999

Agenda Item:
Source: NEC and Telecom Modus
Title: A method utilizing DL reference power to avoid power drifting
Document for: Discussion/Decision

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1. Introduction

In TSG-RAN WG1 meeting #6, downlink (DL) power control during soft handover was considered as a major study item, and it was requested to consider use of DL reference power and power drifting problem. This contribution explains a method to utilize DL reference power to solve power drifting problem. The method, which is called "adjustment loop", was introduced in the annex of ARIB specification, and was also included the annex of TS 25.214. In order to facilitate the use of the method, a new information element is proposed.

2. Adjustment Loop

(1) Algorithm

For adjustment loop, DL reference power P_{REF} and DL power convergence coefficient *r (0r1)* are set in the active set cells during soft handover so that the two parameters are common to the cells. For simplicity, DL powers of two cells are considered in this explanation. Adjustment loop works in addition to inner loop power control, and DL power at slot *i* of two cells, $P_1(i)$, and $P_2(i)$, are updated at a certain interval (typically in every slot as in this explanation) as follows:

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

The difference is derived from equations (1) and (2) if TPC error does not occur i.e. $S_{INNERLOOP1}(i)$ and $S_{INNERLOOP2}(i)$ are equal.

$$P1(i+1) - P2(i+1) = r(P1(i) - P2(i)) = r^i(P1(1) - P2(1)) \quad (3)$$

Equation (3) means that the difference converges at zero when *r* is smaller than one.

(2) Performance

The performance of adjustment loop is evaluated by means of computer simulation. The assumptions of the simulation are as follows:

- Active set is determined when a call is originated. During the call, sector average of path loss does not change, and the active set is not updated.
- Maximum active set size is three. Relative threshold for soft handover is 6 dB.
- Initial DL power is set to a value common to all active set cells.
- During a call, DL power is not synchronized by messages from RNC.
- Average holding time is 10 sec.
- Path loss of 3.5th power law, log-normal shadowing, and equal level 4 path Rayleigh fading are considered.
- Both uplink and downlink power is updated by inner loop power control in every slot.
- Delay of inner loop power control is one slot.
- Outer loop power control is employed, in which target FER is 0.01.
- Step size of inner loop power is 1 dB.
- When the SIR of TPC command is smaller than a threshold, the degraded TPC command

is not used for inner loop power control.

- Reception error of TPC commands is generated in accordance with received SIR.
- Power control range is 20 dB.
- DL reference power P_{REF} is the center value of power control range.
- DL power convergence coefficient r is 0.96.

Figures 1 shows average of DL power difference among cells during soft handover, Figure 2 shows FER, and Figure 3 shows average DL power of all calls. During soft handover, DL power is the sum of DL powers of the active set cells. In these figures, performance with adjustment loop (ON) is compared with the performance without adjustment loop (OFF). The performance depends on the DL reference power i.e. the center value of the power control range. In this result, ratios of active set size of two and three were both 0.22, and both degraded TPC command rate and TPC error rate were approximately 2 percent.
When the reference power is between –9 dB and 6dB, FER is maintained at a target value and average DL power stays relatively low. However, when the reference power is less than –9dB, FER becomes large due to small maximum DL power. On the other hand, when the reference power is more than 6 dB, average DL power is increased due to large minimum DL power.
When adjustment loop is not employed, average DL power depends on the center value of power control range. With adjustment loop, average DL power is not sensitive to the center value of power control range. This means that it is possible to keep DL power low quite easily.

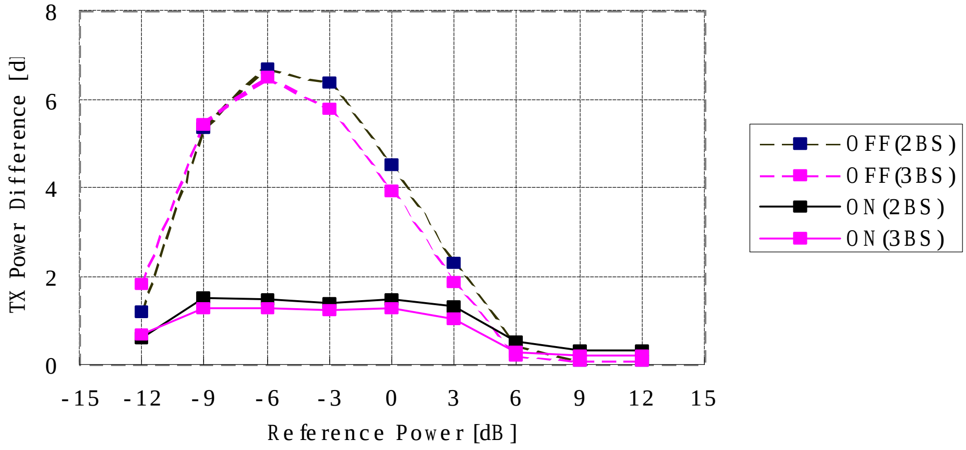


Figure 1 DL power difference.
Figure 2 Frame Error Rate.

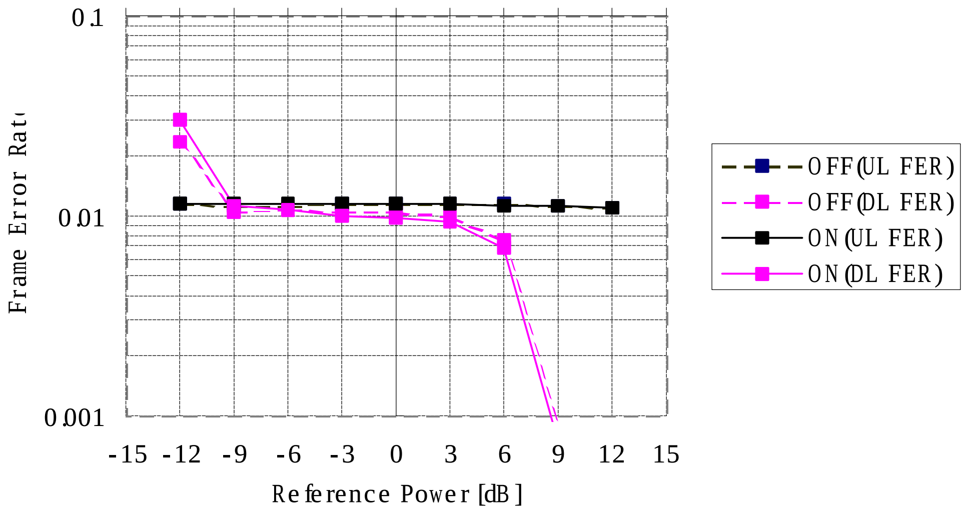
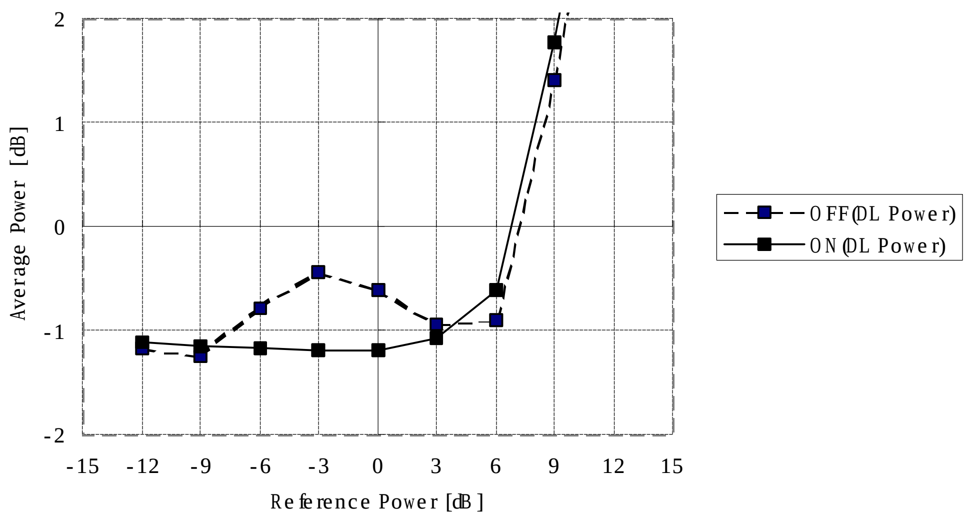


Figure 3 Average DL power.



(3) Discussions

With adjustment loop, it is possible to eliminate power drifting problem without the need of frequent signaling of DL Reference Power, and without negative impact on DL inner loop power control.

During soft handover, DL Reference Power is reported from RNC to Node-Bs in NBAP messages. If synchronized Radio Link Reconfiguration is not used, power drifting cannot be eliminated since it is not possible to set the DL Reference Power at all Node-Bs at the same time. If synchronized Radio Link Reconfiguration is used, there is a high probability that the difference of the DL Reference Power and the current DL power is large due to large delays. In such cases, if DL power is set equal to DL Reference Power in a slot in each Node-B, the DL power may become too low or too high. Therefore this may have significant negative impact on DL inner loop power control. It should be also noted that frequent signaling of DL Reference Power will have significant increase of control traffic from RNC to Node-B.

With adjustment loop, DL power adjustment is much smaller than a step of inner loop power control even when the difference of the DL Reference Power and the current DL power is large. This means that it is possible to achieve the high performance of DL inner loop power control.

3. Proposal of information element

(1) Proposed changes to 25.423

We propose to introduce a new information element “DL Power Convergence Coefficient”. The IE should be introduced in the following messages:

RADIO LINK SETUP REQUEST
RADIO LINK ADDITION
RADIO LINK RECONFIGURATION PREPARE
RADIO LINK RECONFIGURTION
DL POWER CONTROL

The type (i.e. Mandatory or Option) of the IE should be the same as DL Reference Power in each message. We also propose to include the following text:

9.2.xx DL Power Convergence Coefficient

DL Power Convergence Coefficient is a coefficient that Node Bs utilize during soft handover to reduce DL power imbalance gradually at a common rate among cells.

(2) Proposed changes to 25.433

We propose to introduce a new information element “DL Power Convergence Coefficient”. The IE should be introduced in the following messages:

RADIO LINK ADDITION REQUEST
RADIO LINK RECONFIGURATION PREPARE
RADIO LINK RECONFIGURTION REQUEST
DL POWER CONTROL

The type (i.e. Mandatory or Option) of the IE should be the same as DL Reference Power in each message. We also propose to include the following text:

9.2.xx DL Power Convergence Coefficient

DL Power Convergence Coefficient is a coefficient that Node Bs utilize during soft handover to reduce DL power imbalance gradually at a common rate among cells.