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1 Introduction

This document addresses the control of the downlink outer loop power control function. It is stated in TS25.401 that this function is implemented in the UE, but some control may be needed from the UTRAN. It is stated in TS 25.301 that the outer loop power control function is a RRC function, and this shall therefore be specified in TS 25.331.

This document proposes some requirements on downlink outer loop power control and some control mechanisms. Corresponding change requests to TS 25.331 are also proposed.

2 Proposal

The downlink outer loop power control function has the task to set the Eb/No target value for the downlink closed loop power control running in the UE. The setting of the Eb/No target value is based on quality measurements performed in the UE. Basically the Eb/No target is increased if the FER or BLER is above a given threshold, and it is decreased when it falls below this threshold. In order to be efficient, the adjustment of the Eb/No target value needs to be based on recent quality measurements, and this explains why the downlink outer loop power control shall be implemented in the UE.

However, some requirements shall be put on this function, in order to get similar behaviour for all UEs, and the UTRAN should also be able to control it in order to avoid some divergences, especially in case of overload.

Indeed, some problems may occur in case of overload on the downlink. In order to get reasonable capacity, the UTRAN network may rely on some statistical multiplexing, assuming for instance that all UEs will not be always active. In some (rare) occasions, it may happen that too many UEs will be active at the same time in downlink, thus creating too much data to transmit in some cells. In such cases, one or several Nodes B may not be able to deliver all the transmission power needed to satisfy the power control commands from the UEs. Also some transport blocks may even be discarded before being sent on the radio interface thus increasing the FER or Block error rate. When such events occur, the UE will detect that quality degrades, and the outer loop may wish to increase the Eb/No target. Since there is an overload in the UTRAN, increasing the Eb/No target will probably be inefficient to improve the radio quality, and the UTRAN will continue to ignore the power control commands during the overload. However, leaving the UEs running their outer loop during the overload period may lead to large increase of the Eb/No target value in each UE. Therefore, when the overload situation will be resolved, all UEs may still have very large Eb/No target values, and the network may not be able to reach a stable situation very quickly. Indeed all UEs will continue to require too much transmission power to get their required quality, thus creating too much interference.

In order to avoid such problems, the following requirements and control mechanisms have been identified as possible solutions :

1. The UTRAN shall set a range for Eb/No target values and an initial value that can be used, depending on RAB parameters, in order to prevent the UE to set too extreme values. However this range might need to be large to account for large variations of required Eb/No values due to mobile's speed for instance (the required Eb/No may vary up to 6 dB depending on mobile's speed). These parameters should therefore be added in all RRC messages which permit to set up a physical channel. Alternatively, they could be broadcast on the BCH, as part of system information, in case the RAB

setup messages sizes would already be to large to allow adding these parameters. It is believed that the Eb/No parameters will mainly depend on the static parameters of the transport formats, and that only a limited number of transport formats will be defined, so that the broadcast of these parameters would remain manageable.

2. The downlink outer loop power control function in the UE shall ensure that it does not increase the Eb/No target value, when the current Eb/No target value has not been reached yet. The way to evaluate whether a Eb/No target value has been reached may be implementation dependent. It may be done for instance by comparing the averaged Eb/No measured to the Eb/No target value. Some margins need to be taken to account for the inaccuracy of the measurements, so that the DL outer loop algorithm is not too much restricted. At this stage, a requirement shall be specified in the UE specific function for DL outer loop power control.

3. However both previous schemes may not be fully reliable because some margins need to be taken for the range of Eb/No target values. Also in case of general overload, all UEs may increase their Eb/No target values by a few dB, thus creating quite a large bunch of unnecessary extra interference when the overload will cease. Therefore it is proposed that the UTRAN shall also be able to control the downlink outer loop power control, when it knows that quality can not be maintained during a short period due to overload. This may be done for instance through a specific dedicated message (similar to the one allowing the UTRAN to limit the TFC in uplink), allowing the UTRAN to control whether the UE can increase or not their Eb/No target value. A message would be sent at the start of the overload period by the UTRAN to prevent UEs from increasing their Eb/No target value, and another message would be sent at then end to release this interdiction. It is proposed to send this message on the DCCH in acknowledged mode towards UEs for which this limitation applies.

The next section proposes some new text to be included in TS 25.331 in order to capture these proposals. 3 types of changes are proposed and may be treated almost independently. However it is believed that the 3 mechanisms are needed to ensure a secured control of the DL outer loop power control. These are :

- Proposal for new parameter in RRC connection set up, RAB set up, RAB reconfiguration, and transport channel reconfiguration messages, in order to set the initial Eb/No target value.
- Proposal for a new RRC procedure, in order to control the operation of the DL outer loop power control from the UTRAN.
- Proposal for new specific function on UE downlink outer loop power control, to specify requirements for the UE, and behaviour on reception of the RRC message for DL outer loop.

3 Change proposal in TS 25.331 related to the setting of the DL Eb/No target value

A new parameter called Downlink DPCH power control information is proposed as an optional PhyCH information element in the following messages : RRC connection setup, RAB setup, RAB reconfiguration, transport channel reconfiguration and physical channel reconfiguration. Its definition is proposed to be added in section 10.2.6.15 :

10.2.6.15 Downlink DPCH power control information

This information element indicates the range of Eb/No target values and the initial Eb/No target value to be set in the UE on this physical, channel for the downlink closed loop power control.

Parameters	REFERENCE	TYPE	NOTE
Initial Eb/No target value		M	Initial Eb/No value to be used for the DL closed loop power control.
Min Eb/No target value		M	Minimum Eb/No value that can be set by the DL closed loop power control.
Max Eb/No target value		M	Maximum Eb/No value that can be set by the DL closed loop power control.

An example of its definition in the above listed messages is presented below. It should of course be duplicated to each of the messages.

10.1.4.7 RRC CONNECTION SETUP

This message is used by the network to accept the establishment of an RRC connection for an UE, including assignment of signalling link information, transport channel information and optionally physical channel information.
RLC-SAP: t.b.d.
Logical channel: CCCH
Direction: UTRAN → UE

Information element category	Information elements	REFERENCE	TYPE	NOTE	
	Message Type		M		
UE information elements	Initial UE identity		M	FFS whether conveyed on RRC or MAC.	
	S-RNTI		M		
	SRNC identity		M		
	C-RNTI		O	Only if assigned to a common transport channel	
	Activation time		O		
RAB information elements	RAB identity		M	Indicates the signalling link	
	Signalling link type		M		
	RAB multiplexing info		M	For the signalling link	
TrCH information elements	TFCS		O	Uplink TFCS	
	TFCS		O	Downlink TFCS	
	TFC subset		O		
	Transport channel identity		M	For each new transport channel	Uplink transport channels
	TFS		M		
	Transport channel identity		M	For each new transport channel	Downlink transport channels
	TFS		M		
PhyCH information elements	Frequency info		O		
	Uplink DPCH power control info		O		
	Uplink DPCH info		O	Maximum one of these	Uplink radio resources
	PRACH info		O		
	Uplink timeslot info		O		
	Primary CCPCH info		O	For each radio link	Downlink radio resources
	Downlink DPCH info		O		
	Downlink DPCH power control info		O		
	Secondary CCPCH info		O		
	Downlink timeslot info		O	Note 1	
	SSDT indicator		O	Necessity is FFS	
	Gated Transmission Control info		O	FFS	
	Default DPCH Offset Value		O		

Note 1: It is assumed that the DL timeslot configuration is the same for all radio links, whether or not macro-diversity is supported for TDD.

4 Change proposal in TS 25.331 related to the DL outer loop power control procedure

A new procedure to allow the UTRAN to control the downlink outer loop is proposed to be added between section 8.3.5 and 8.3.6. Text proposal is as follows :

8.3.6 Downlink Outer Loop Control

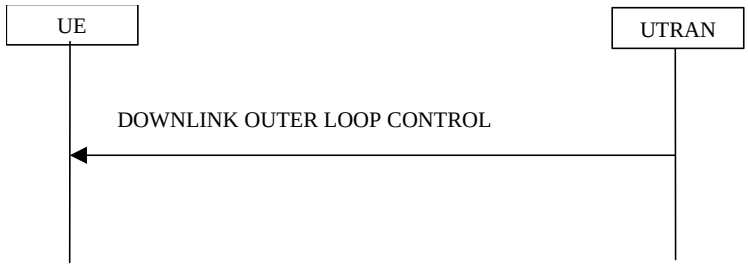

Figure 1) Downlink Outer Loop Control Procedure

The network uses this procedure to control the downlink outer loop power control running in the UE. An example of when this procedure might be used is when a congestion situation occurs in downlink such that it is desirable to temporarily prevent the UE to increase its Eb/No target value, even if quality can not be maintained.

This procedure is initiated with a DOWNLINK OUTER LOOP CONTROL message sent from the network to the UE. This message indicates either that the UE is allowed to increase the Eb/No target value above its current value, or that the UE is not allowed to increase the Eb/No target value above its current value. On reception of this message, the UE applies or releases the restriction, according to the contents of the message.

The DOWNLINK OUTER LOOP CONTROL message shall be sent as acknowledged data transfer.

The message corresponding to this procedure is proposed as follows for inclusion in 10.1.5.11 :

10.1.5.12 DOWNLINK OUTER LOOP CONTROL

<Functional description of this message to be included here>
RLC-SAP: AM
Logical channel: DCCH
Direction: UTRAN→UE

Information element category	Information elements	REFERENCE	TYPE	NOTE
	Message Type		M	
PhyCH information elements	Downlink Outer Loop Control		M	Indicates whether the UE is allowed or not to increase its Eb/No target value above its current value

The information element DL Outer Loop Control should also be defined in section 10.2.6.16.

10.2.6.15 Downlink Outer Loop Control

This information element indicates whether the UE is allowed or not to increase its downlink Eb/No target value above the current value.

5 Change proposal in TS 25.331 related to the UE specific function related to DL outer loop power control

A new UE specific function is proposed as 15.5 :

15.5 Downlink outer loop power control

This function is implemented in the UE in order to set the Eb/No target value used for the downlink closed loop power control. This Eb/No value is set according to some quality measurements performed in the UE, in order to maintain the quality requirements (FER or BER).

The UE shall set the Eb/No within the range allocated by the RNC when the physical channel has been set up or reconfigured. It shall not increase the Eb/No target value before the closed loop power control has converged on the current value. The UE may estimate whether the closed loop power control has converged on the current value, by comparing the averaged measured Eb/No to the Eb/No target value.

If the UE has received a DL outer loop control message from UTRAN indicating that the Eb/No target value shall not be increased above the current value, it shall record the current value as the maximum allowed value for the outer loop power control function, until it receives a new DL outer loop control message from UTRAN indicating that the restriction is removed.