TSG-RAN Working Group 3 meeting #6*TSGR3#6(99)935*
Sophia Antipolis, France, 23rd-27th August 1999

Agenda Item: 9.1

Source: **Ericsson**

Title: Downlink Rate Control over Iu

Document for: Decision

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1. Introduction

This contribution discusses downlink rate control over the Iu interface. It is based on a previous contribution [1] presented at the last RAN2 meeting in Sophia Antipolis, which proposes uplink rate control in UTRAN. The architecture and arguments of [1] are supported to a large extent. The aspect of Transcoder Free Operation is added.

This contribution explores the aspects of:
- AMR in GSM and recalls some fundamentals principles of interest for the discussion
- AMR in UMTS with the essential differences with GSM and significant opportunities given to UMTS
- Need for rate control with special emphasis on TFO
- Location of the rate control function
- Technical realisation at a high level of rate control over Iu
- Iu protocol high level impacts

The conclusion is to incorporate downlink rate control procedure into 25.415.

Without consequent in-band signaling, TFO between UMTS and GSM is impossible and a substantial change in the strategy of the smooth GSM-UMTS evolution is given up.

The AMR Codec is seen as the first of many future applications that will be able to adapt their source-coding rate to the dynamically varying radio link capacity. The solution should therefore be general and not only valid for AMR.

2. Discussion

2.1 AMR in GSM

The AMR standard supports eight different Codec_Modes plus one additional Speech_Pause Mode. An arbitrary change of the Codec_Mode is possible every 20ms.

In GSM, at maximum four of these eight Modes can be within a given configuration, the Codec_Mode may change at the earliest, every 40ms. The GSM radio channel does not support fast power control and therefore the AMR Codec_Mode Adaptation does partly compensate link loss variations by a (fast) inband signalling. The “Master” of control is the BSC, represented by the serving BTS. TRAU and MS act as “slaves”.

The Transcoder in GSM is part of the radio access network, therefore is always within the signal path and no “Transcoder Free Operation” is possible. The rate control of the transcoder is done by inband signalling in TRAU frames (see TS GSM 05.09, 08.60, 08.61).

2.2 AMR in UMTS

In UMTS, the Transcoder is not longer part of the UTRAN, but part of the CN. Thus the CN can include or exclude the transcoder from the call path based on service criteria. Transcoder Free Operation is therefore possible, with the associated benefits (i.e. reduced transmission costs, higher speech quality in UE-UE calls, reduced transcoder resources) and care shall be taken in the technical realisation of AMR over UMTS not to jeopardize this opportunity.

Another major conceptual difference with GSM is that UTRAN does not know Codec_Mode AMR mode adaptation. UTRAN knows about different **rates** for a RAB with given attributes, and whether those pre defined rates can be controlled from UTRAN.

Note: *From now in this contribution, only rate control will be mentioned, which in the case of AMR can be understood as Codec_Mode control.*

The restrictions for the operation of the AMR are not the same as in GSM: all eight rates (+DTX) can be within the configuration (i.e. active codec set) and the rate can theoritically change at any time between all eight rates or goes into Speech_Pause mode.

2.3 Need for rate control

In GSM, slow rate control is used already. Indeed, some operators apply change between Half Rate and Full Rate coding at certain time of the day to gain cell capacity.

In UMTS, slow rate control will be used in a similar fashion. To gain coverage, cell capacity or statistically lower the packet-based transport radio and core network load, a selected set of rates (from 1 to N) can be given to the transcoder or the UE or both (UL and DL rates are controlled separately). This can be controlled at RAB establishment by providing the set permitted rates to the UE (UL rate control) and to the transcoder (DL rate control, initialisation) that the rate control function will be using.

2.4 TFO aspects

In the communication phase, if the rate control function decides to change the permitted DL rates set, then a downlink rate control procedure control is perfomed. The rate control procedure and initialisation procedures are very similar except that the SDU size information is not passed during rate control procedure.

An essential aspect of rate control is the link capacity control in case of transcoder or tandem free operation. In these cases both radio links need to be taken into account: the link with the lowest link capacity constraining the entire call: “A chain is as strong as its weakest member”. The rate should not be higher than the weakest link can carry.

In GSM this “Minimum Principle” is formulated and this should also be considered by UMTS. Both radio links (uplink on the first radio leg and downlink at the second radio leg) are estimated according to their current link capacity. Both sides (BTSs) propose a new Codec_Mode by a local “Codec_Mode_Request”. The final decision is taken by the BTS that controls the uplink direction: it just takes the minimum of both Codec_Mode_Requests and sends it as Codec_Mode_Command down to the MS.

In GSM these Codec_Mode_Requests are exchanged by pure inband signalling, both on the terrestrial links between the two BTSs as well as on all radio links.

In UMTS, inband signalling is proposed over Iu (i.e. between the RNCs in TFO). The receiving RNC could take the remote DL rate control request into account, derive the final decision and send the result to the local UE.

For that reason, the Iu DL rate control commands need to bi-directional over Iu, although they are always originated from the rate control function master (see below).

2.4 Location of the rate control function

For the reasons given in [1], the **location of the Rate Control** function should be within the UTRAN and because of the macro diversity, the only possible node is the **RNC**.

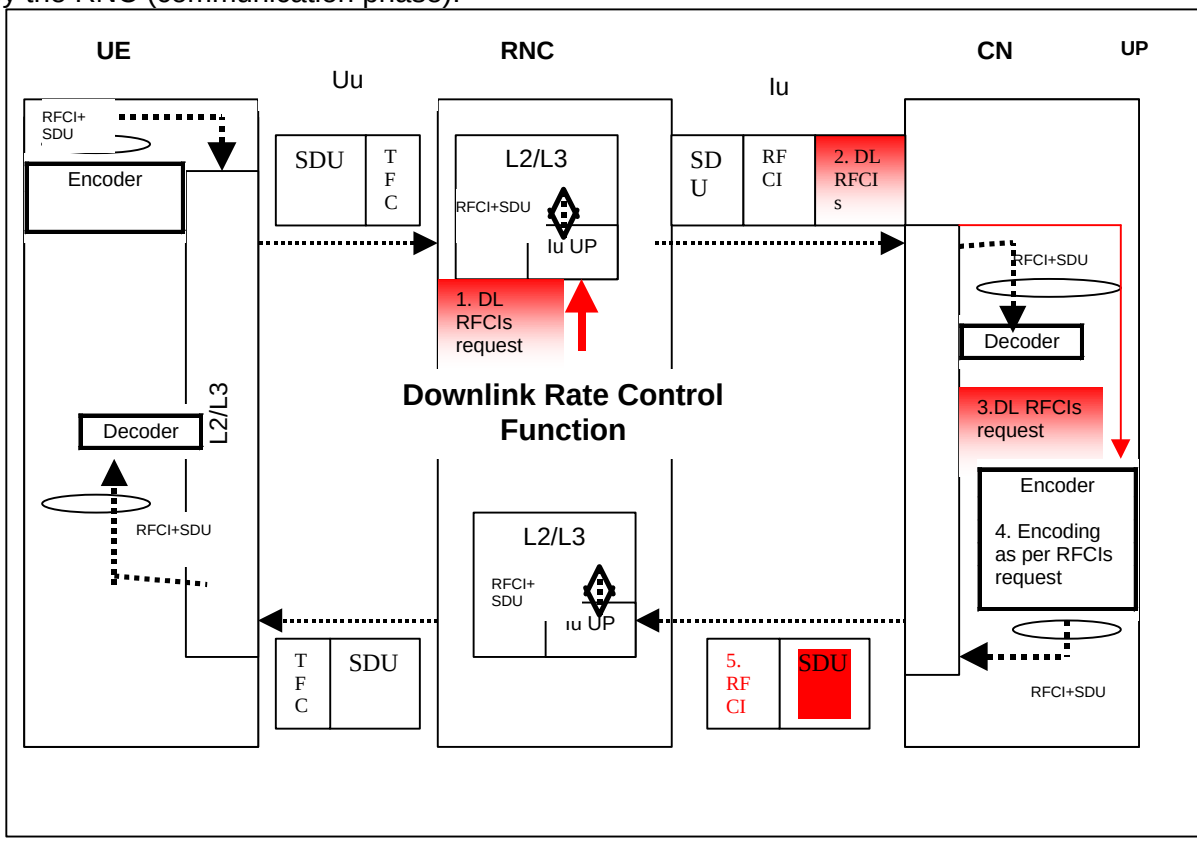
The RNC will act as the rate control master.

The only exception is the decision to use Speech_Pause mode, which resides at the source encoder.

2.5 Technical Realisation of rate control

Downlink Rate Control

The following figure illustrates the **downlink rate control** operated in the **user plane** (UP) by the RNC (communication phase).



Note: Usage of RFCI over Uu and in the UE is to be agreed in RAN WG2.

1. ***DL RFCIs request****: the downlink rate control funciton in the RNC determines that the permitted DL rate(s) need to be changed. A DL rate control frame procedure is perfomed in the UL direction using the frame procedure control part of an Iu frame header. One or several RFCIs are listed according to the algorithm decision made by the DL rate control function*

2. ***Uplink transfer of DL RFCIs request over Iu****: an Iu UP frame (containing or not payload) is sent in the UL direction including DL RFCIs with indication in the procedure control bitmap that a DL rate control is being performed.*
3. ***DL RFCIs request transfer to transcoder:*** *upon reception of the Iu UP frame containing the DL rate control, the IU UP passes the command to the upper layer (transcoder). The transcoder stores the informaiton and uses it to encode DL frames at the permitted rate. In the case where several rates (in addition to DTX) are signalled, then the internal logic to decide which rate to use on is left unspecified.*
4. ***Enoding as per RFCIs request:*** *the command is passed to the encoder to encode at the selected rate. The next encoded frame is passed down to the Iu UP protocol as Iu UP payload with its corresponding RFCI as Iu UP frame control.*
5. ***Downlink Transfer of encoded speech SDU and RFCI over Iu****: the DL Iu UP frame contains a encoded payload according to the command nd identified with the RFCI.*

Iu UP protocol

The current Iu UP protocol already contains provisions for DL rate control over Iu using in-band signalling within the Iu frames (i.e. support mode for predefined SDU sizes).

The proposed solution is to have:

1. Capabilities to set a bit in Procedure control bitmap for Downlink Rate Control

2. Pass a set of values (RFCIs), indicating explicitly all RFCs allowed (e.g. if one rate only is allowed and DTX, then the two corresponding RFCIs would be passed).

3. Capabilities to pass the rate control command to the upper layers

3. Proposal

It is proposed to support DL rate control over Iu, using Iu UP protocol.

If such a proposal is accepted, the editor will propose a set of modifications to [2].

4. References

[1] R2-99601, AMR Mode Adaptation in UTRAN, Source: Nokia

[2] 25.415, Iu User Plane protocol, Source: Editor