TSG-RAN Working Group 1 – TSGS4 joint meeting **TSGR1-99i45**

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Agenda Item	**:**	AMR Adaptation
Source	**:**	Nortel Networks[1]
Title	**:**	Discussion on AMR adaptation requirements for UTRA
Document for	**:**	Discussion

1. Introduction

The AMR speech codec will be used in UTRA. It had been defined for GSM, and some level of adaptation were required in GSM. However, the level of adaptation might be different for UTRA. These requirements for adaptation have an impact on the design on AMR traffic and signalling transmission. Thus, this document discusses the level of adaptation that would be useful in UTRA and the consequences on the UTRA design.

2. Adaptation to radio conditions and requirements

In GSM, adaptation is done in order to compensate the variations in C/I during the communication, since this C/I can vary a lot during one communication.

In UTRA, power control will compensate the variations of the radio link. However, there are some cases where the power control will not be able to cope with the degradation or improvement of the radio link. For instance when the limit of the power dynamic range is reached, or when the UE is in limit of cell coverage and thus in limit of power also. In these cases, it might be useful to change codec mode according to radio conditions. For instance, when the radio link degrades too much, the codec mode could be changed to a mode with a lower bit rate and use a more robust channel coding scheme, or when radio conditions improve significantly, the codec mode could be changed to a mode with a higher bit rate, and a channel coding less robust. It might be necessary in particular for downlink, since the power dynamic range is only 30dB. This case of adaptation has to be taken into account.

The requirements for this adaptation are the following:

- Reliability : This adaptation needs to be reliable. This means that the control commands need error correction, and error detection.
- This adaptation needs to be done quickly, i.e. little time must occur between the decision of change and the application of the command, or else the radio conditions will have already varied too much and the mode change may not be suitable.
- Also, it must be possible to issue mode change commands frequently in case the radio conditions change quickly (shadowing, high UE speed) and we are still in limit of power control range, e.g. on a speech frame by speech frame basis (20ms).

3. Adaptation due to Tandem Free Operation

Another case where adaptation will be needed in UTRA is when Tandem Free Operation occurs between a GSM MS and a UTRA UE. In this case, the codec mode used in the downlink of UTRA must be the same as

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the one on the uplink of GSM, and the codec mode used on the uplink of GSM must be the same as the one used on the downlink of UTRA. This means that some synchronisation between GSM and UTRA is needed regarding these mode changes. The two cases mentioned here are not identical.

3.1 Adaptation of DL GSM and UL UTRA :

When the GSM BTS asks for a codec mode change for its downlink, the UTRA uplink mode must change accordingly. This means being able to transmit some commands on the UTRA downlink to order the uplink change, at the same speed as on the GSM side. If we want the adaptation to be as quick as in GSM-GSM TFO, a different mode command must be allowed to be applied every 40ms. This does not mean that the mode command must necessarily be repeated every two frames, but that between the reception by RNC of the mode command and the transfer of it to the UE, no more than two frame transmissions should occur.

Thus the requirements are the following.

- On one side the delay for transmitting the mode command between the RNC and the UE must be short so that the radio conditions on the DL GSM side have not varied too much, and the new mode is still useful.
- On the other side, the frequency at which these commands can be sent must be once every two frames.
- Also, the transmission of the command must be robust, which means there is a need for error correction and error detection on the command.

3.2 Adaptation of UL GSM and DL UTRA :

For adaptation of the uplink GSM and thus of the downlink UTRA, it must be possible to change the codec mode on the downlink of UTRA quickly.

The requirements are the same as before. Since this will be done by changing the TFCI on the downlink for the wanted frame, the requirements of rapidity, and low delay are met.

4. Adaptation due to CN rate control

Another adaptation scenario is when the Core Network commands the codec mode on uplink and downlink for its own reasons (for instance ATM traffic load adaptation).

On the downlink, the adaptation command is the TFCI of the frame indicating the format of each TrCh. The only requirement is that there is an agreement found at the start of the communication regarding the codec modes potentially used, and thus the Transport Format Combinations. This requirement is met by the current downlink rate control protocol defined between the TC and the SRNC On the uplink, the SRNC must be able to indicate to the UE the mode that would correspond to the request of the CN. In this case, a slow signalling would be enough (1seconde delay would be acceptable). There is no requirement for very fast or frequent signalling. The current uplink rate control protocol defined between the SRNC and the UE is satisfactory

5. Consequences on UTRA design

5.1 AMR Mode Command transmission in downlink :

As stated previously, there is a need for the case of radio adaptation and TFO to transmit some codec mode commands on the downlink of UTRA, with possibly a high frequency (every one or two frame), and with a low delay.

Given that transmission of the commands between the SRNC and the UE by higher layers (RRC) would require at least 100ms, and given that the required frequency would require lots of higher layer messages, it does not seem feasible to transmit these command via higher layer signalling. Thus these commands should be transmitted in-band.

For the CN adaptation, the signalling required is slower. Thus it might be possible to use higher layer

signalling in this case, unless we want to unify the way to transport adaptation commands, in which case, they should all be transmitted in-band.

Regarding the in-band transmission of AMR Mode Command, Nortel's understanding is that WG2 has decided to use a separate Transport Channel. The reason is that the only multiplexing in RLC is serial multiplexing, i.e. it is not possible to mix bits from different services in one RLC PDU. Thus in order to multiplex AMR mode commands with voice bits, some specific design should be done in higher layers than RLC layer. This is certainly not desirable. It is thus likely that these AMR mode commands are delivered in one separate TrCh by L2 to L1. Thus L1 has to ensure the transmission of this TrCh. The characteristics of this TrCh are that only a few bits are transmitted at a time, and good error correction and error detection must be provided.

5.2 AMR Mode Request transmission in uplink :

As seen previously, there is a need to be able to change the codec mode and the channel coding of the downlink UTRA in order to cope with the low dynamic range of power control, to adapt to radio conditions in limit of power control.

Basically there are two ways to do that. Either the SRNC takes the decision, and then indicates to the CN the new mode to use on the downlink. This method does not require to transmit any AMR Mode Command on the UTRA uplink. However, first, the SRNC must have all the necessary information to take the decision. It is unlikely that it gets the whole set of measurement results from the UE for each TTI. This impacts its reaction time. Second, this processing will represent a high computation load for the SRNC.

Another solution, that would reduce the load of the RNC, would be that the UE gives some indication of the codec mode that would fit the radio conditions of the downlink, based on the measurements it performs regularly. This solution would enable a quick adaptation and would significantly reduce the load at the RNC for processing all the measurements, since this would be done in the UE. This method would require to be able to transmit AMR Mode Commands on the UTRA uplink.

Adaptation of the downlink of UTRA for TFO and CN do not have any impact on the uplink of UTRA

5.3 Impact of adaptation on maximum number of Transport channels that can be defined for a communication

In uplink and in downlink it was seen that it would be necessary to change the codec mode and the channel coding scheme of the different classes of bits during one communication to cope with radio conditions in some cases. However, the channel coding scheme and the rate matching ratio which determines the relative protection of the TRcHs multiplexed are static parameters, which do not change during a communication. Thus, it is necessary to define more than one TrCh per class of bits to be able to have different coding of one class according to the mode, and to allow to have different relative protection of the classes. Of course, only three TrChs would be used during one TTI to transport the speech encoded frames. This means that a transport channel combination would correspond to 3 TrCh for the speech bits only. In other words the TrChs defined to provide different coding for one class are used in an exclusive way.

At a very maximum we would need to define 19 TrChs for voice in case of adaptation to radio conditions. For other adaptation scenario, four TrChs would be sufficient.

6. Conclusion

In this document, scenarios where adaptation is needed in UTRA, and the impact on UTRA design, have been identified. The cases, identified for TFO or adaptation to radio conditions, where the codec mode needs to be changed on the uplink of UTRA, require to transmit some AMR Mode Command on the downlink in a separate TrCh. Changing the codec mode of the downlink is also necessary in some cases of adaptation to radio

conditions. This can be done either by having the SRNC to take the decision, or by letting the UE indicate a Mode Request, in which case some AMR Mode Request should be sent on the uplink. Moreover for all cases of adaptation to radio conditions, it is necessary to be able to change the channel coding scheme for each class of bits according to the codec mode in use. This requires defining as many TrChs per bits class as potential channel coding schemes for this class. However the TrChs defined for a same bit class are used in an exclusive way, and only three TrChs are used to transport speech frames in each TTI.