TSG-RAN Working Group 2 (Radio layer 2 and Radio layer 3)
Stockholm 8th to 11th March 1999

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Agenda Item: 7.7.1

Source: Ericsson

Title: **Usage of Radio Access Bearer Control Procedures**

Document for: Decision

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1 Introduction

Radio access bearer control procedures are used to control the UE and system resources. This document explains how the system works with respect to these procedures and how e.g. traffic volume measurements could trigger these procedures. It also describes how UE RRC substates and UE configurations are changed due to different Radio access bearer control messages.

First a Radio access bearer setup is shown, where pre-configuration of transport channels are exemplified. Further, the procedures Physical channel reconfiguration and Transport channel reconfiguration are shown in several examples. It is also explained how these last two procedures are used in the system for resource control of services with variable bitrate, i.e. transport channel type switching. Finally, usage of Radio access bearer reconfiguration is shown in an example where the MAC multiplexing is changed.

This document only shows examples of message parameters included in studied RRC procedures. RRC message parameters on a more detailed level are found in Tdoc RAN WG2 143/98, RRC message parameters,
Source: Ericsson and Tdoc RAN WG2 142/98, RRC message contents;
Source: Ericsson.

2 Example of Radio Access Bearer Setup

In order to set up a new Radio access bearer a RRC connection must have been established, and some NAS negotiation has been performed. The Radio access bearer setup message comes from UTRAN and depending on the requirement of the service a common or a dedicated transport channel could be used. In the example below the UE is using a common transport channel for the RRC connection and stays on the common transport channel after the RAB setup.
However, transport channel parameters such as transport formats and transport format combinations are configured not only for the used common transport channel, but also for dedicated transport channel for future use.
All physical parameters are the same before and after the RAB setup in this example.

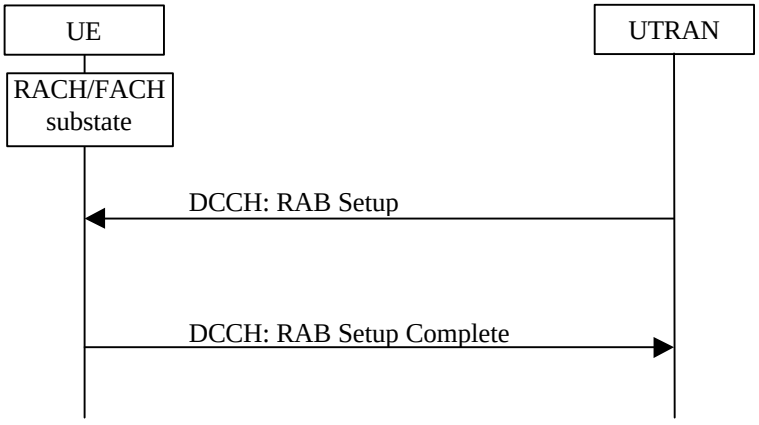

Figure 1 Radio access bearer setup on common transport channel.

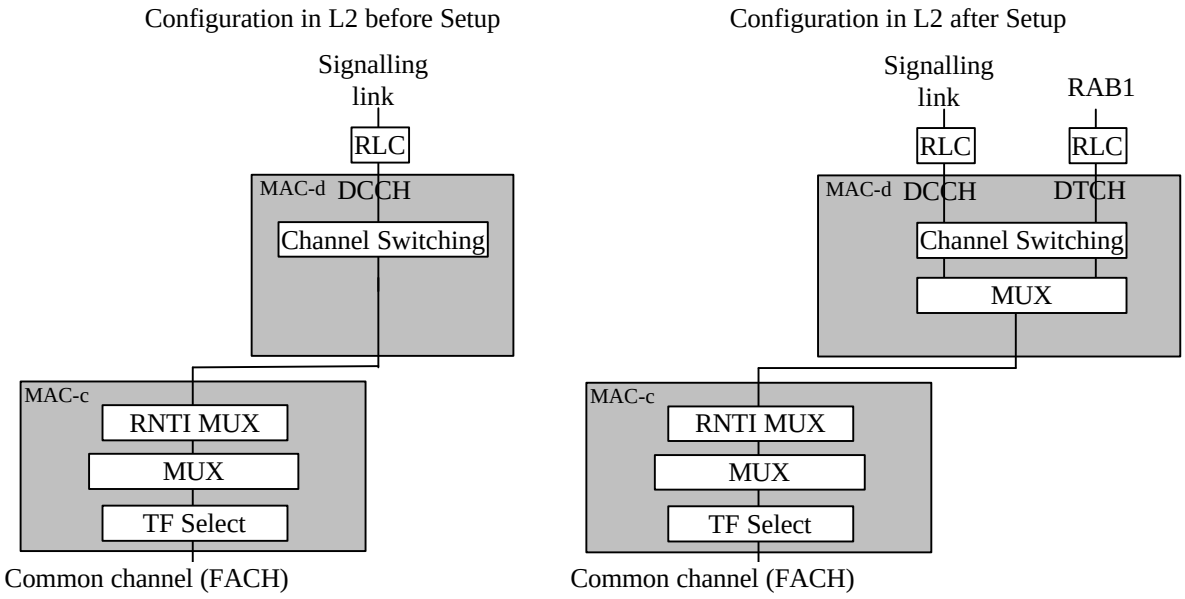

Figure 2 Configuration of L2 in the UTRAN DL before and after the RAB setup.

RRC Parameters in RAB Setup

This message includes a **RAB ID** for the new RAB and **RLC parameters**. It also includes **two different multiplexing configurations** giving the transport channel this RAB could be mapped onto. One configuration to be used on a common transport channel and one for a dedicated transport channel.

For the common transport channel this message includes a new **Transport format set for FACH**, **and a Transport format set for RACH**.

For the dedicated transport channel (pre-configured, not yet used) this message includes the **transport formats for DCH1 and DCH2**, and also the **transport format combinations** used in e.g. Increased UL data, with switch from RACH/FACH to DCH/DCH, after the switch.

RRC Parameters in RAB Setup Complete

This message includes the ID of the new RAB, **RAB ID #1**.

3 Examples of Physical Channel Reconfiguration

This RRC procedure is used to reconfigure the Physical channel and can by that also trigger Transport channel type switching. Below several examples of Physical Channel reconfigurations are shown, triggered by different amount of UL or DL data.

3.1 Increased UL data, with switch from RACH/FACH to DCH/DCH

A UE that is in the RACH/FACH substate can transmit a small amount of user data using the common transport channels. For larger amounts it is more appropriate to use a dedicated transport channel. Since each UE doesn't know the total load situation in the system UTRAN decides if a UE should use common transport channels or a dedicated transport channel.
The monitoring of UL capacity need is handled by a UTRAN configured measurement in the UE. When the amount of data in the RLC buffer to be transmitted in the UL increases over a certain threshold the UE sends a measurement report to UTRAN. Since, UTRAN has the current status of the total UL need it can decide which UEs that should be switched to a dedicated transport channel. If UTRAN has pre-configured the transport formats and transport format combinations to be used on the dedicated transport channel for the UE, a Physical channel reconguration procedure could be used to assign dedicated physical resources. The spreading factor for the physical channels assigned then give, which transport format combinations that are allowed to use.

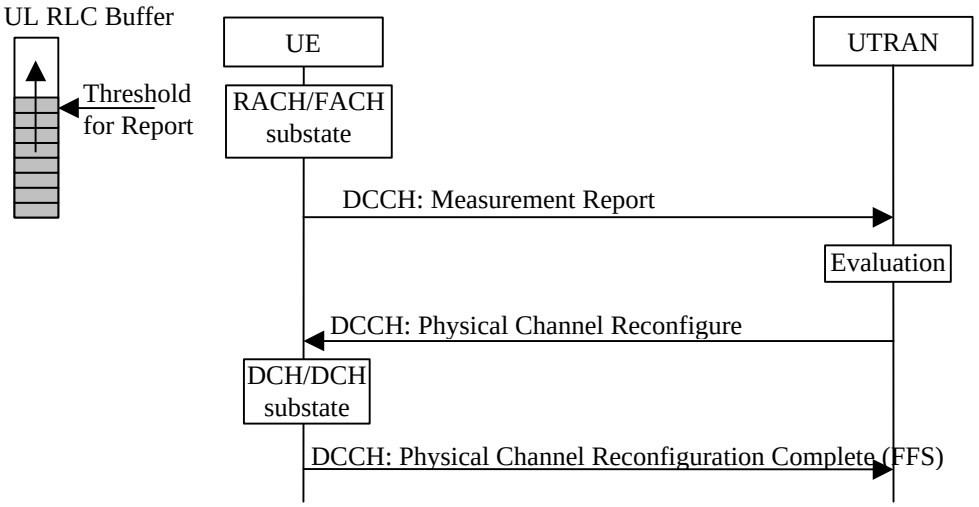

Figure 3 Physical channel reconfiguration triggered by increased UL data and with a switch from RACH/FACH to DCH/DCH.

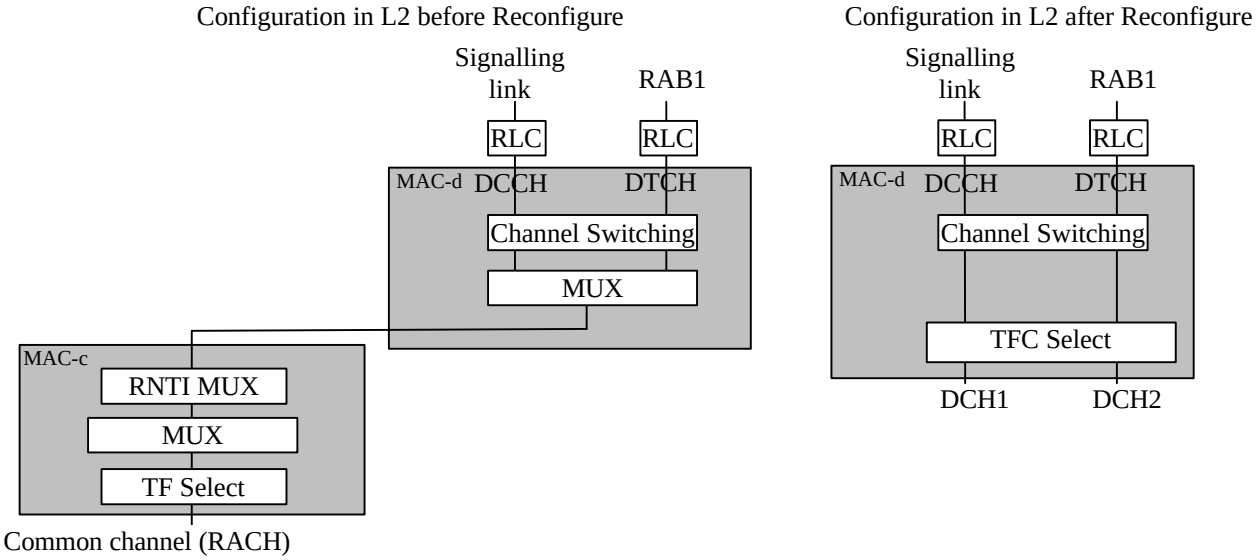

Figure 4 Configuration in the UTRAN UL before and after the Physical channel reconfigure.

RRC Parameters in Measurement Report

This message includes a **Measurement ID** so that UTRAN can associate this report with a Measurement control message. It also includes the measurement of **RLC buffer size**.

RRC Parameters in Physical Channel Reconfigure

This message includes **DL channelization codes** and **DL scrambling code** for the DPCH. It also includes **UL channelization codes** and **scrambling code** for the DPCH.

RRC Parameters in Physical Channel Reconfiguration Complete

No identified parameters

3.2 Increased DL data, no Transport channel type switching

If the RLC buffer increases above a certain threshold *[Note: This is only one of many possible implementations of the network]* in the network the UTRAN can do a physical channel reconfiguration. Here the UE uses a dedicated transport channel, and this procedure is used to decrease the spreading factor of the physical dedicated channel. This way this variable bitrate service increases the throughput on the downlink.

A variable bitrate service that has large traffic variations should have transport formats and transport format combinations defined for lower spreading factors than currently used on the physical channel. Then after the physical channel reconfigure that lowers the spreading factors these transport formats and transport format combinations could be used to increase the throughput for this user.

However, if the transport formats and transport format combinations have not been previously defined to support a lower spreading factor, a Transport channel reconfiguration must be used instead in order to get any increased throughput.

Only downlink physical parameters are changed here since the uplink in this scenario doesn't need to increase its capacity.

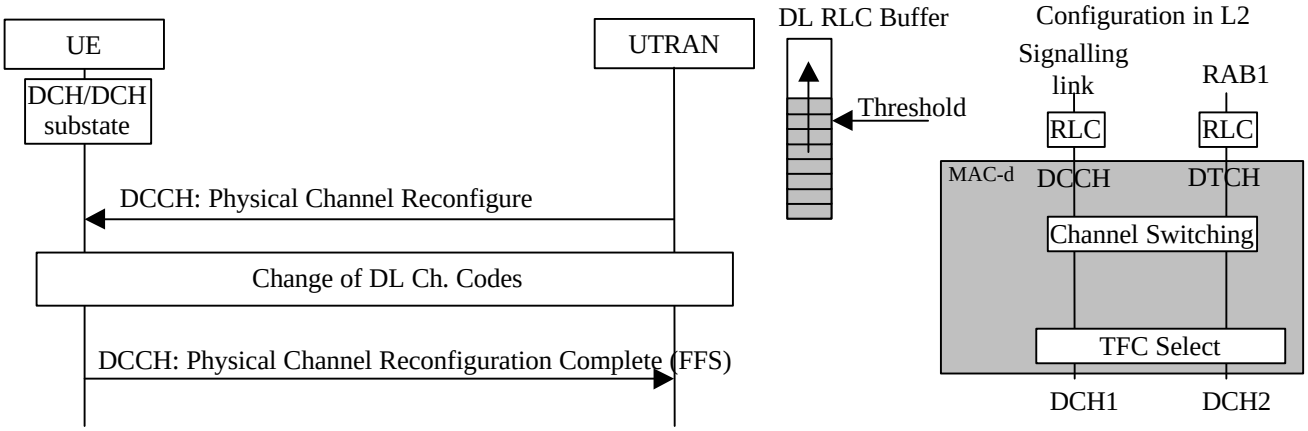

Figure 5 Physical channel reconfiguration triggered by increased DL data and configuration in UTRAN DL.

RRC Parameters in Physical Channel Reconfigure

This message includes **new DL channelization codes** for the DPCH with lower spreading factor for all cells that the UE is connected to.

RRC Parameters in Physical Channel Reconfiguration Complete

No identified parameters

3.3 Decrease DL data, no Transport channel type switching

Since downlink channelization codes are a scarce resource a UE with a too high, allocated gross bit rate (low spreading factor) must be reconfigured and use a more appropriate channelization code. This could be triggered by a threshold for the RLC buffer content and some inactivity timer, i.e. that the buffer content stays a certain time below this threshold. *[Note: This is only one of many possible implementations of the network]*.

After the physical channel has been reconfigured, some of the transport formats and transport format combinations that require a low SF can not be used. However, these are stored and could be used if the physical channel is reconfigured later to use a lower spreading factor.

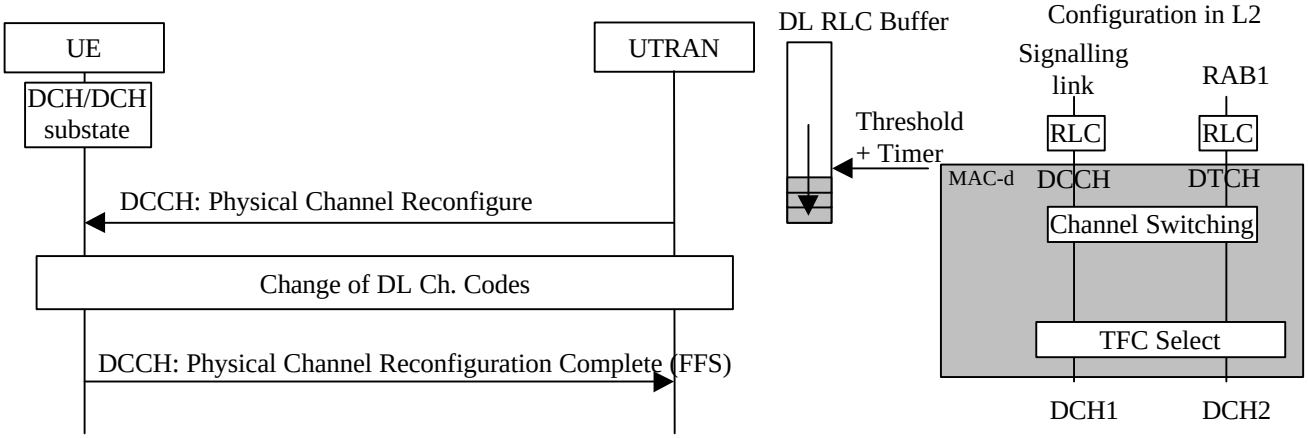

Figure 6 Physical channel reconfiguration triggered by decreased DL data and configuration in UTRAN DL.

RRC Parameters in Physical Channel Reconfigure

This message includes new **DL channelization codes** for DPCH with higher spreading factor for all cells that the UE is connected to.

RRC Parameters in Physical Channel Reconfiguration Complete

No identified parameters

3.4 Decreased UL data, with switch from DCH/DCH to RACH/FACH

In the network the UE traffic can be evaluated and the network can observe which transport format combinations that are used in the UL. The network could also simply look at how much data the UE transmits or use measurement reports *[Note: Which way for the network to trigger this is a matter of implementation]*.

If the UE is transmitting a low amount of data in the uplink and there is little traffic in the downlink, this could trigger a switch from a dedicated transport channel to a common transport channel. Depending on if the already defined RACH/FACH configuration is possible/preferred in the cell that the UE will be in after the switch, a Transport channel reconfigure or a Physical channel reconfigure procedure is used.

In the example below the UE has stayed in cells with a similar RACH and FACH configuration when using a dedicated transport channel. Therefor, the Physical channel reconfigure procedure can be used. In Decreased DL data, with switch from DCH/DCH to RACH/FACH this is not the case and a Transport channel reconfiguration is used instead.

After the UE has performed the transport channel type switch to the RACH/FACH substate, all transport channel parameters such as transport formats for the dedicated transport channel are stored. The same configuration of the dedicated transport channels could then be reused if the UE switches back to the DCH/DCH substate.

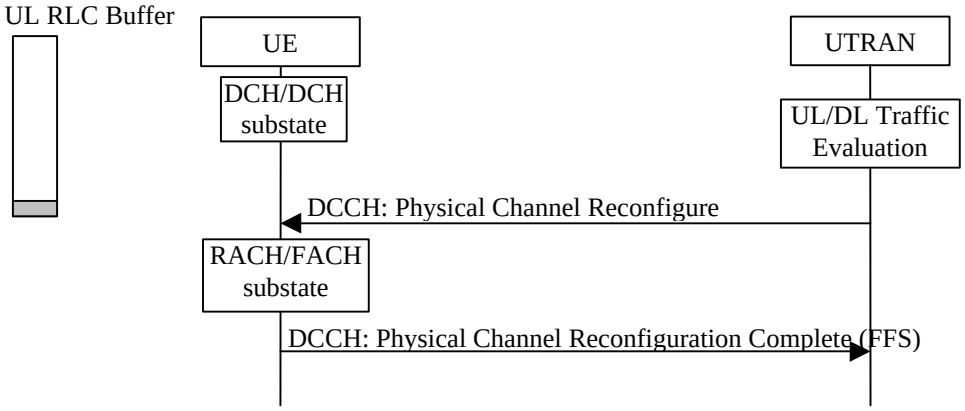

Figure 7 Physical channel reconfiguration triggered by decreased UL data and with a switch from DCH/DCH to RACH/FACH.

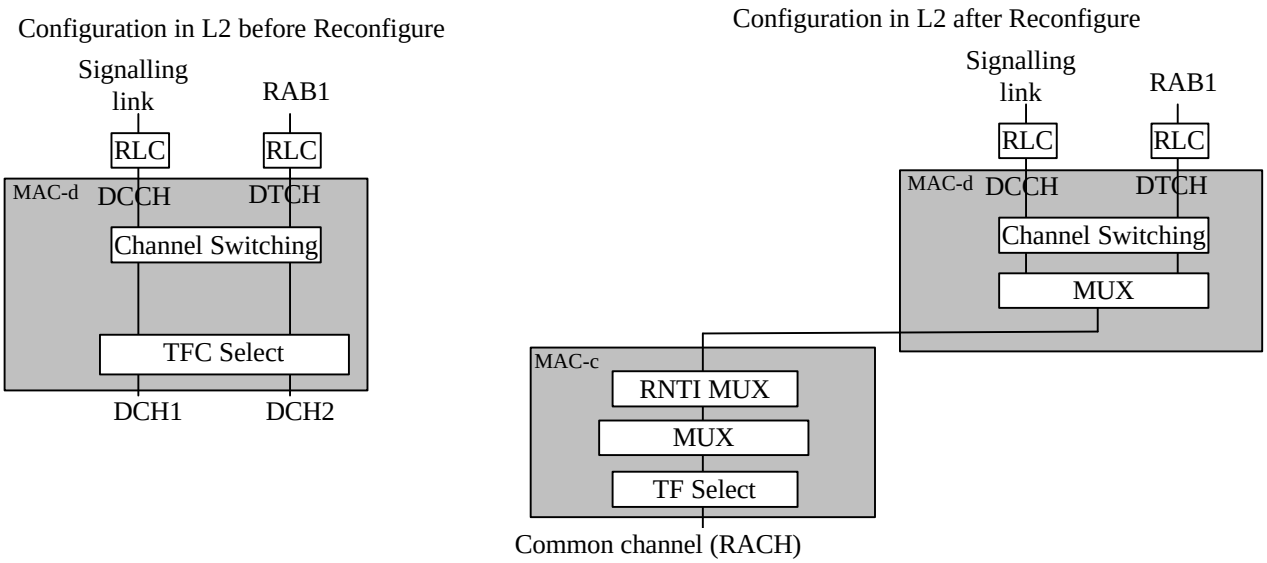

Figure 8 Configuration in the UTRAN UL before and after the Physical channel reconfigure.

RRC Parameters in Physical Channel Reconfigure

This message includes a **channelization code** for the UL i.e. stating the minimum spreading factor to be used on PRACH, and the **PRACH signatures** that are allowed. Further, for the PRACH which **access slots** that are allowed and the **preamble code** is included.

For the DL the message includes **scrambling code**, i.e. indicating to which cells FACH the UE should be connected to, and a **channelization code** for the secondary CCPCH.

[Note: The common channel parameters are the same that is transmitted on the BCCH. The reason to send it in this message is to remove the necessity for the UE to read BCCH at this switch.]

[Note: The necessity of an immediate cell-update when moving to RACH/FACH or if a valid RNTI is given to the UE before making the switch to allow immediate usage of DCCH is FFS.]

RRC Parameters in Physical Channel Reconfiguration Complete

No identified parameters

4 Examples of Transport Channel Reconfiguration

This RRC procedure is used to reconfigure the transport channel and the physical channels, and can by that also trigger Transport channel type switching.
Below, several examples of Transport channel reconfiguration are shown, triggered by different amount of UL or DL data.

4.1 Increased UL data, with no transport channel type switching

When a UE RLC buffer content increases above a certain threshold, a measurement report is sent to UTRAN. Depending on the overall load situation in the network the UTRAN could decide to increase the uplink capacity for a UE. Since every UE has its "own" code tree, there is no shortage of UL codes with a low spreading factor, and all UEs can have a low spreading factor code allocated.

Therefor, instead of channelization code assignment as used in the DL, load control in the UL is handled by the allowed transport formats and transport format combinations for each UE. To increase the throughput for a UE in the uplink, UTRAN could send a Transport channel reconfiguration or a TFC Control message.

Here a Transport channel reconfiguration is used. Although, the TFC Control procedure is believed to require less signalling it can only restrict or remove restrictions of the assigned transport format combinations and that may not always be enough. If a reconfiguration of the actual transport formats or transport format combinations is required, the Transport channel reconfiguration procedure must be used instead.

In the example below, the UE is allowed to send more data in the UL when on dedicated transport channel, although the common transport channel configuration is still the same. To make use of the new transport format combinations the physical channel must also be reconfigured to allow a lower spreading factor.

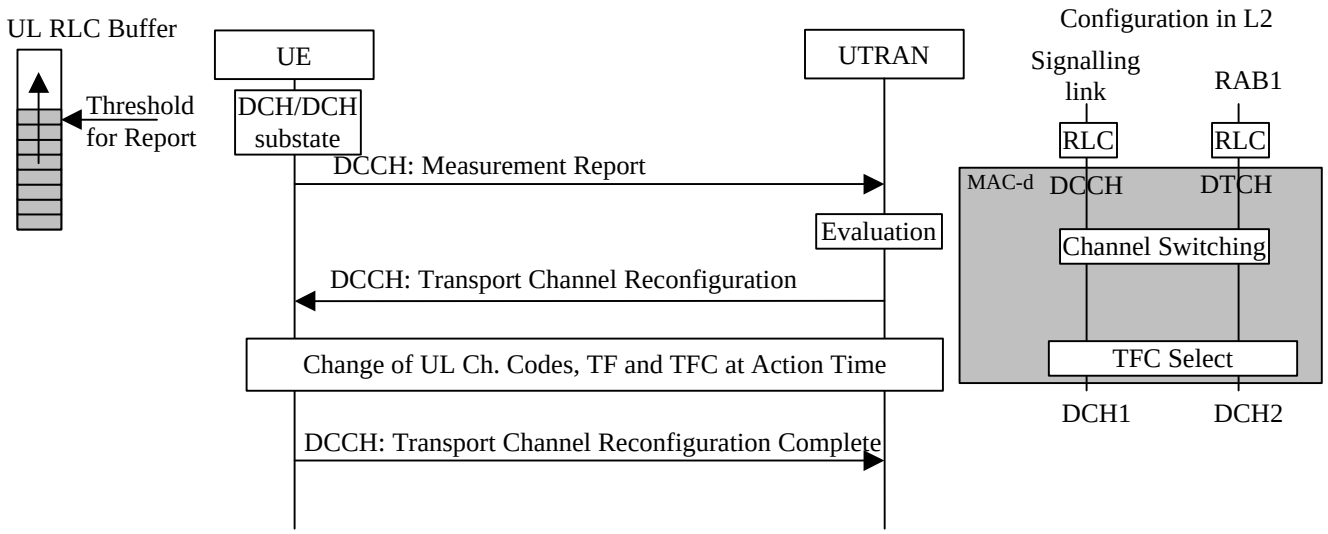

Figure 9 Transport channel reconfiguration triggered by increased UL data and configuration in UTRAN DL.

RRC Parameters in Measurement Report

This message includes a **Measurement ID** so that UTRAN can associate this report with a Measurement control message. It also includes the measurement of the **RLC buffer size**.

RRC Parameters in Transport Channel Reconfiguration

This message includes a new **Transport format set** for DCH2 and a new **Transport format combination set**. An **Action time** must also be included if the different TFCIs can not coexist during the reconfiguration.

It also includes **UL channelization codes** for the DPCH.

RRC Parameters in Transport Channel Reconfiguration Complete

This message includes the ID of the reconfigured Transport channel, **DCH2 ID**.

4.2 Decreased DL data, with switch from DCH/DCH to RACH/FACH

In the network the downlink traffic to a UE can be evaluated and the network can observe which transport format combinations that are used *[Note: This is only one of many possible implementations of the network]*.

If a low amount of data is sent to the UE in the downlink and there is little traffic in the uplink, this could trigger a switch from a dedicated transport channel to a common transport channel. Depending on if the already defined RACH/FACH configuration is possible/preferred in the cell that the UE will be connected to after the switch, a Transport channel reconfigure or a Physical channel reconfigure procedure is used. In this example the UE has moved to cells with a different FACH or RACH configuration when using a dedicated transport channel, so a Transport channel reconfigure procedure must be used.

When the UE do the switch from a dedicated transport to a common transport channel the RACH and FACH transport channels are reconfigured with new transport formats if the old configuration is not supported in the new cell. What physical common channel to be used is pointed out in the physical channel parameters.

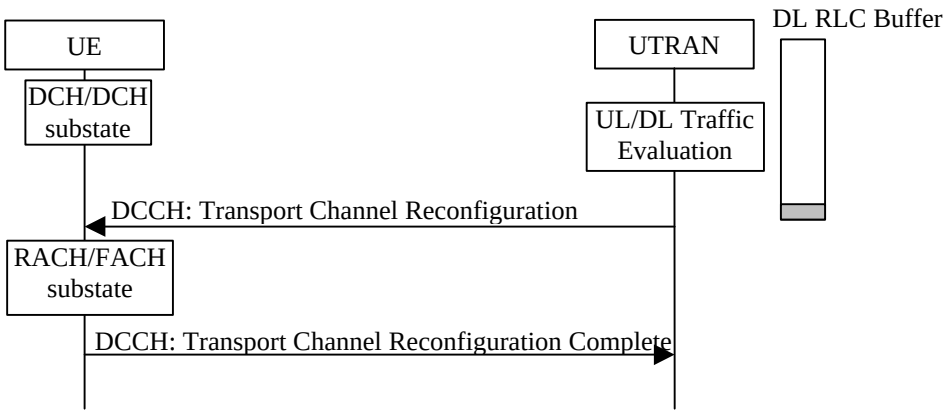

Figure 10 Transport channel reconfiguration triggered by decreased DL data and with a switch from DCH/DCH to RACH/FACH.

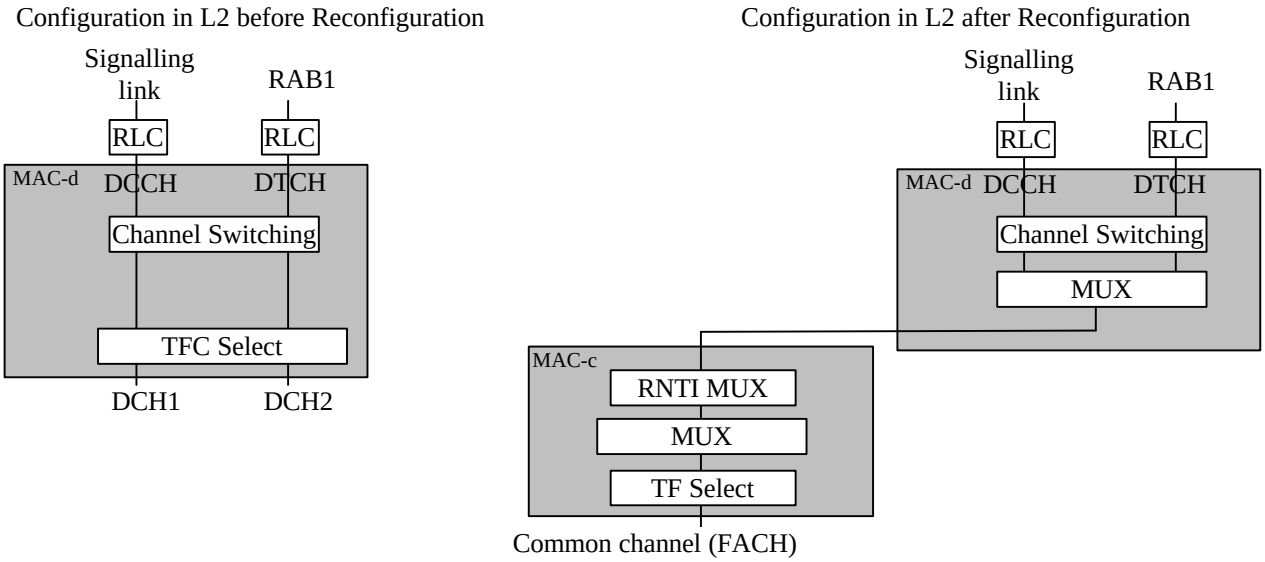

Figure 11 Configuration in the UTRAN DL before and after the Transport channel reconfiguration.

RRC Parameters in Transport Channel Reconfiguration

This message includes new **Transport format set for RACH**, a **channelization code** i.e. stating the minimum spreading factor to be used on PRACH, and the **PRACH signatures** that are allowed. Further, for the PRACH which **access slots** that are allowed and the **preamble code** is included.

For the DL the message includes a new **Transport format set for FACH**, the **scrambling code**, i.e. indicating to which cells FACH the UE should be connected to, and a **channelization code** for the secondary CCPCH.

[Note: The common channel parameters are the same that is transmitted at the BCCH. The reason to send it in this message is to remove the necessity for the UE to read BCCH at this switch.]

[Note: The necessity of an immediate cell-update when moving to RACH/FACH or if a valid RNTI is given to the UE before making the switch to allow immediate usage of DCCH is FFS.]

RRC Parameters in Transport Channel Reconfiguration Complete

This message includes the ID of the reconfigured transport channels, **RACH ID** and **FACH ID**.

5 Example of RAB and Signalling link Reconfiguration

A Radio access bearer reconfiguration is here used to change how the MUX in MAC of logical channels belonging to different RABs is configured.

The RAB Reconfiguration message includes parameters for the new multiplexing configuration in MAC, and a reconfiguration of the Transport channel that both RABs will use. The old obsolete transport channel is also removed (here DCH3 is removed). All other parameters associated with the RABs are unchanged.

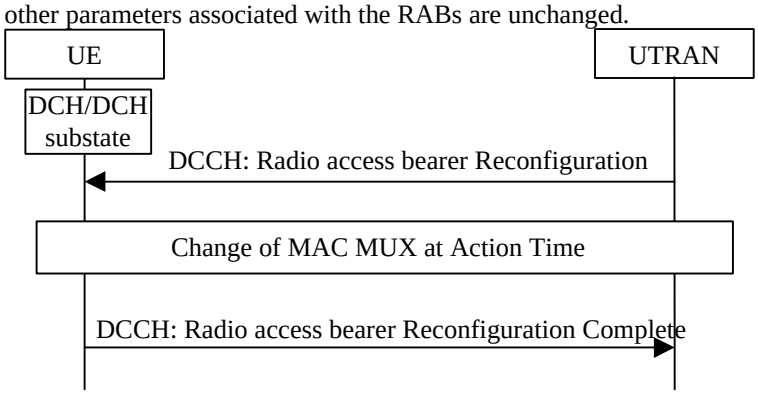

Figure 12 RAB reconfiguration.

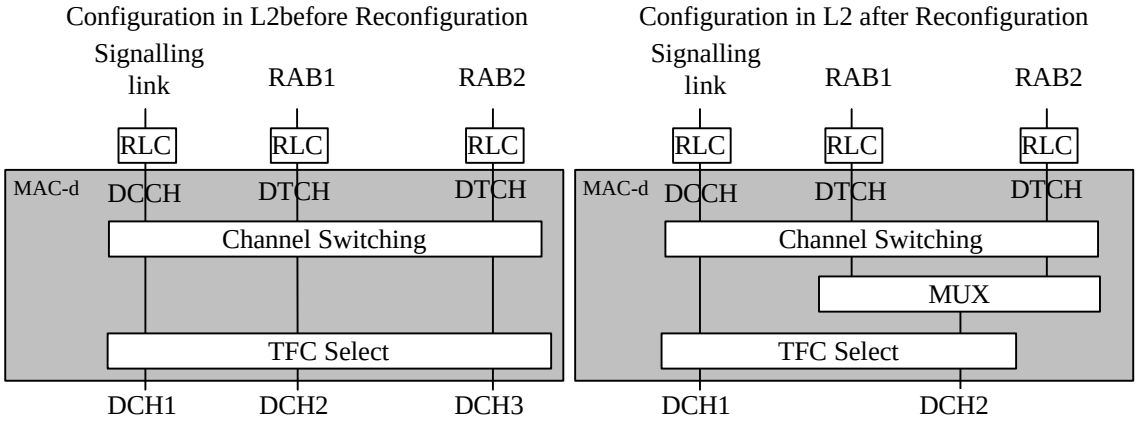

Figure 13 Configuration in the UTRAN DL before and after the RAB reconfiguration.

RRC Parameters in Radio access bearer reconfiguration

This message includes a multiplexing option with **Transport channel ID DCH2 for both RAB1 and RAB2,** stating that both these RABs should use the same transport channel. For each of these two RABs a **Logical channel ID value** and a **priority** must be given to define the MAC MUX.

Also included is a new **Transport format set** for DCH2 and a new **Transport format combination set** (both for UL and DL if the multiplexing is changed both in UL and DL).

It is also possible to reconfigure the physical channel and include new **channelization codes** for the DPCH with different spreading factor for all cells that the UE is connected to.

RRC Parameters in Radio access bearer reconfiguration Complete

This message includes **RAB1 ID** and **RAB2 ID** to indicate that these RABs have been reconfigured.

6 Conclusion and Proposal

We have in this document presented and clarified how several Radio access bearer procedures are used in the system to control the resources for a UE, and how to use pre-configuration of transport channels. We have also showed examples on how these procedures could be triggered by e.g. different measurements in the network or in the UE.

We propose that this document should be used as a basis when continuing with specifying these RRC messages content. Further, we propose to remove the FFS, stated in S2.31 TS RAN S2.31 V0.0.1, RRC protocol specification;
Source: Temporary editor (Motorola) section 8.3.2 in option c), about the usage of pre-configuration for the Transport channel reconfiguration procedure.
We also propose to include the examples presented in chapter 2-5 in an output document, for instance S2.03 TS RAN S2.03 V0.0.1, UE Functions and Interlayer Procedures in Connected Mode;
Source: Temporary editor (Nokia).

7 References

[1] TS RAN S2.31 V0.0.1, RRC protocol specification;
Source: Temporary editor (Motorola)
[2] TS RAN S2.03 V0.0.1, UE Functions and Interlayer Procedures in Connected Mode;
Source: Temporary editor (Nokia)
[3] Tdoc RAN WG2 143/98, RRC message parameters,
Source: Ericsson
[4] Tdoc RAN WG2 142/98, RRC message contents;
Source: Ericsson