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Technical Report

3rd Generation Partnership Project;
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Signalling enhancements for Circuit-Switched (CS) and Packet-Switched (PS) Connections;
Analyses and recommendations
(Release 7)

Keywords

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Contents

Foreword

This Technical Report has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

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y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

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1 Scope

The present document captures different techniques to improve CS and PS call setup and reconfiguration procedures in UTRA.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TS 25.322: "RLC Protocol Specification".

[2] 3GPP TS 25.331: "Radio Resource Control (RRC); protocol specification".

[3] 3GPP TS 25.306: "UE Radio Access Capabilities".

[4] 3GPP TS 25.304: "User Equipment (UE) procedures in idle mode and procedures for cell reselection in connected mode".

[5] 3GPP TR 25.993: "Typical Examples of RABs and RBs Supported by UTRAN".

[6] 3GPP TS 34.108: "Common test environments for User Equipment (UE); Conformance Testing".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply.

Default configuration: Configurations that are defined in standards to be included into the UEs memory.

Pre-configuration: General term referring all possible predefined configuration possibilities: default, predefined, and stored configuration

Predefined configuration: Configurations that are broadcasted in SIB16 from Release 5 and onwards.

Stored Configuration: Configurations that the network stores in the UE by RRC or higher layer signalling

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

CS Circuit-Switched
PS Packet-Switched
RTT Round Trip Time
SCI Stored Configuration Identity
SCSI Stored Configuration Set Identity

UE	User Equipment
UMTS	Universal Mobile Telecommunications System
UTRA	UMTS Terrestrial Radio Access
UTRAN	UMTS Terrestrial Radio Access Network
VT	Video Telephony

4 Background and Introduction

For CS video and voice calls, the setup delay is one important measure of quality of the service experienced by the subscriber. To ensure constant improvements on this, it is necessary to ensure that UMTS specifications are involving form this perspective.

For many PS services the transmission delay is often smaller than the call set up delay. Moreover, due to long call setup delay and reconfiguration of PS DCH the activity factor becomes low for these radio bearers, which leads to low efficiency and poor service due to high admission control blocking rates. The efficiency will be especially low for VoIP and HTTP services.

In addition as the data rates of UMTS system are increased by new high-speed downlink uplink channels namely HSDPA and E-DCH, the delay caused by RB setup and channel allocation will contribute larger portion of total data transfer delay of the user data experienced by the subscriber.

The work item Signalling Enhancements for CS and PS connections concentrates on RAN related aspects and the work includes:

To review the CS and PS Call and session Setup procedures in UMTS

To highlight the improvements where call and session setup, including session reactivation, process can be improved from both idle state and from "dormant" state, i.e. a data session that had not been generating user traffic in the recent past

Consider impacts to the relevant specifications

To review performance requirements for e.g. RRC procedures

To review current RRM procedures

5 Requirements

The evaluation of the signalling and procedural delays should ensure that optimisations meet following requirements. The numbers are for reference only and assume a best-case scenario (e.g. good radio conditions) and make no assumptions of efficiency or complexity/cost, which will be taken into account when evaluating the proposals for enhancements.

The trigger points are defined with based on the ones used in chapter 6.

Following side conditions apply:

CN DRX = 1280ms UTRAN DRX = 320ms

Complete SIB schedule = 640 ms SIB7 cycle = 80 ms

Table 5-1: Signalling Procedures with Associated Delay Requirement

No	Procedures to be analyzed	Requirement
1	Mobile Originated CS Voice call, originated while the UE is in idle mode (MO-PSTN) *Trigger: T1 – T0 in 6.1.2.1*	1500 ms

2	Mobile Originated CS Voice call, originated while the UE is in idle mode to Mobile terminated call (MO-MT)	2000 ms (1280ms DRX)
3	Mobile Originated Packet Connection (64Kbps UL / 384Kbps DL) setup from PMM-idle state (cold start) to a local server - Combination 32 in 34.108 *Trigger: T0 – T2 in 6.1.3*	1500 ms
4	Idle to CELL_DCH state transition into 64Kbps UL / 384Kbps DL due to UL data transmission (from PMM idle mode)	700 ms
5	HS-DSCH activation from idle mode to CELL_DCH 64 kb/s UL/max HSDPA depending UE category DL (from PMM idle mode)	500 ms
6	Mobile Originated CS Voice call, originated while the UE is in xxx_PCH *Trigger: RRC: CELL UPDATE/URAUPDATE -> CC:ALERT*	800 ms
7	Mobile Originated CS Voice call, originated while the UE is in CELL_FACH *Trigger: RRC: CELL UPDATE/URAUPDATE -> CC:ALERT*	500 ms
8	Mobile Originated CS Video Telephony call to a mobile on the same network, while both UE are in idle mode – Combination 13 in 34.108 *Trigger: T1 – T2 in 6.1.2.2*	2200 ms (1280ms DRX)
9	CELL_FACH to CELL_DCH state transition into 64Kbps UL / 384Kbps DL due to UL data transmission *Trigger: T0 – T2 in 6.1.4*	200 ms
10	xxx_PCH to CELL_DCH state transition into 64Kbps UL / 64 (128 or 384) Kbps DL due to UL data transmission	350 ms
11	Reconfiguration of DPCH 64/64 <--> 64/384 *Trigger: T0 – T2 in 6.1.5*	100 ms
12	HS-DSCH activation: CELL_FACH -> CELL_DCH state transitions into 64 kbps UL / [max bit rate depending on HSDPA UE category] DL *Not included in TR 25.815 yet*	200 ms
13	HS-DSCH activation: xxx_PCH to CELL_DCH state transition into 64Kbps UL / [max bit rate depending on HSDPA UE category] DL due to UL data transmission	250 ms
14	HS-DSCH & E-DCH activation: CELL_FACH -> CELL_DCH state transitions into [max bit rate depending on E-DCH UE category] kbps UL / [max bit rate depending on HSDPA UE category] DL	200 ms
15	Mobile Originated CS Voice call, originated while the UE is in CELL_DCH *Trigger: RRC: IDT -> CC:ALERT*	300 ms
16	PDP context activation (one primary PDP context), while the UE is in idle mode *Trigger: T0 – T1 in 6.1.3*	1000 ms
17	HS-DSCH & E-DCH activation: xxx_PCH -> CELL_DCH state transitions into [max bit rate depending on E-DCH UE category] kbps UL / [max bit rate depending on HSDPA UE category] DL	250 ms

6 Analyses of Current Procedures

6.1 Call Setup time for CS and PS Calls

In this section, the setup delays for MO CS AMR voice call to PSTN are analysed when UE is moved from idle mode to CELL_DCH state immediately in RRC connection setup procedure and when CELL_FACH state is used until the Radio Bearer Setup procedure. The RRC connection establishment delays are presented in subclause 6.1.1 and the setup delays of CS AMR call are presented subclause 6.1.2.1 for CELL_DCH case and for CELL_FACH case.

In addition, mobile originated video telephony call setup delays are analysed in subclause 6.1.2.2 assuming that the UE is in CELL_DCH state. Therefore, the total video telephony setup delay from Idle mode is obtained by adding the setup delays from 6.1.1 and 6.1.2.2.

6.1.1 RRC Connection Setup

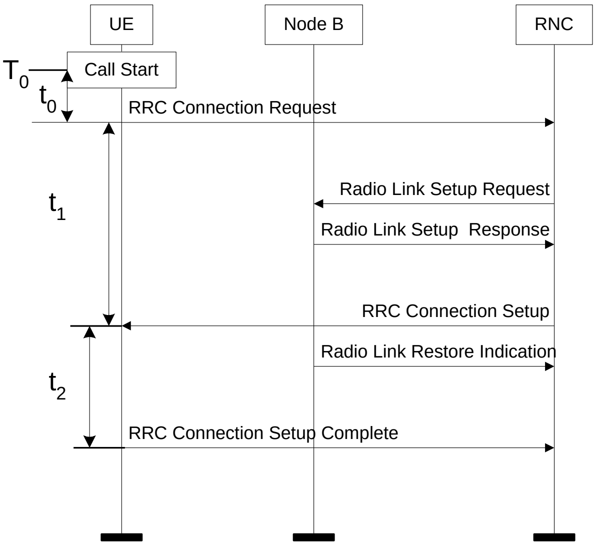

Figure 6.1.1-1: RRC Connection Setup (Idle to CELL_DCH state)

In Figure 6.1.1-1 a typical RRC connection setup procedure from Idle mode to CELL_DCH is described. As this procedure is part of several of the upcoming procedures and therefore is treated here in more detail.

Table 6-1 presents the RRC connection establishment delay from Idle to CELL_DCH using DCH.

Table 6-1: RRC connection establishment in CELL_DCH state using DCH

Message/procedure	Sender/receiver	Delay	Cumulative Delay	Comments	Reference time point in Figure 6.1.1-1
SIB7 reading time	NA	70 ms	70 ms	Highly depending on UTRAN SIB7 scheduling	t_0
RRC connection request	UE/RNC	40 ms	110 ms		
RRC connection setup	RNC/UE	200 ms	310 ms	Includes network RL setup delays, no predefined/default configuration	t_1
RRC connection completed	UE/RNC	300 ms	610 ms	Includes synchronisation delay, reduced in Rel6	t_2
RRC Connection setup in Total			610 ms		T_0-t_2

From Table 6-1 it can be seen that the total setup time of the RRC connection is roughly 600 ms, of which SIB 7 reading time is about 11 %. Even though the SIB 7 reading time is highly depending on the UTRAN SIB 7 scheduling frequency, frequent reading of SIB 7 introduces a considerably large part of overall delay. This delay will have larger portion of total delay in Rel-5 networks, as these results are based on R'99 specifications, and thus no predefined/default configurations are used in RRC Connection Setup message. The reason for frequent SIB 7 reading is the UE requirement to obtain the current uplink interference level, so that the uplink RACH transmission power can be set to correct level for RACH transmission of RRC Connection Request message.

Table 6-2 presents the RRC connection establishment delay from Idle to CELL_ DCH using HS-DSCH and E-DCH.

Table 6-2: RRC connection establishment in CELL_DCH state using HS-DSCH and E-DCH

Message/procedure	Sender/ receiver	Delay (ms)	Cumulative Delay (ms)	Comments	Reference time point in Figure 6.1.1-1 and 6.1.3-1
Reading time of SIB 7	NA	70 ms	70	Highly depending on UTRAN SIB7 scheduling.	t_0
RRC connection request	UE/RNC	40 ms	110		
RRC connection setup	RNC/UE	200 ms	310	Includes network RL setup delays, no default HSPA configuration assumed	t_1
RRC connection setup complete	UE/RNC	150 ms	460	Synchronisation delay reduction taken into account	t_2
RRC connection setup sub-total:			460 ms		T_0-t_2

From Table 6-2 it can be seen the total setup time of the RRC connection is approximately 450ms, which is 150ms shorter than the DCH case due faster Rel-6 synchronisation and UL signalling (E-DCH).

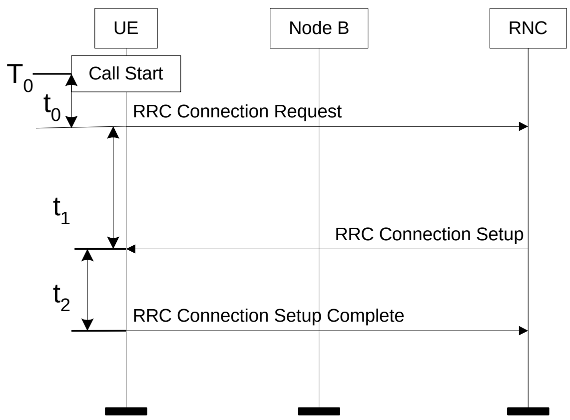

Figure 6.1.1-2: RRC Connection Setup (Idle to CELL_FACH state)

In Figure 6.1.1-2 a typical RRC connection setup procedure from Idle mode to CELL_FACH is described. As this procedure is part of several of the upcoming procedures and therefore is treated here in more detail.

Table 6-3 presents the delay analysis of the RRC connection establishment in CELL_FACH state. The setup delays are around 270 ms compared to 600 ms when establishment is done in CELL_DCH state. This time reduction is due to following reasons: No RL link setup are done towards Node B(s), RRC connection setup message is shorter as no RL configuration needs to be transmitted and UE is able to respond to the setup message immediately without performing RL synchronisation procedure.

Table 6-3: RRC connection establishment in CELL_FACH state

Message/procedure	Sender/receiver	Delay	Cumulative Delay	Comments	Reference time point in Figure 6.1.1-2
SIB7 reading time	NA	70 ms	70 ms	Highly depending on UTRAN SIB7 scheduling	t_0
RRC connection request	UE/RNC	40 ms	110 ms		
RRC connection setup	RNC/UE	60 ms	170 ms	no predefined/default configuration	t_1
RRC connection completed	UE/RNC	100 ms	270 ms		t_2
RRC Connection setup in Total			270 ms		T_0-t_2

6.1.2 CS Call Setup

6.1.2.1 Mobile Originated AMR call setup

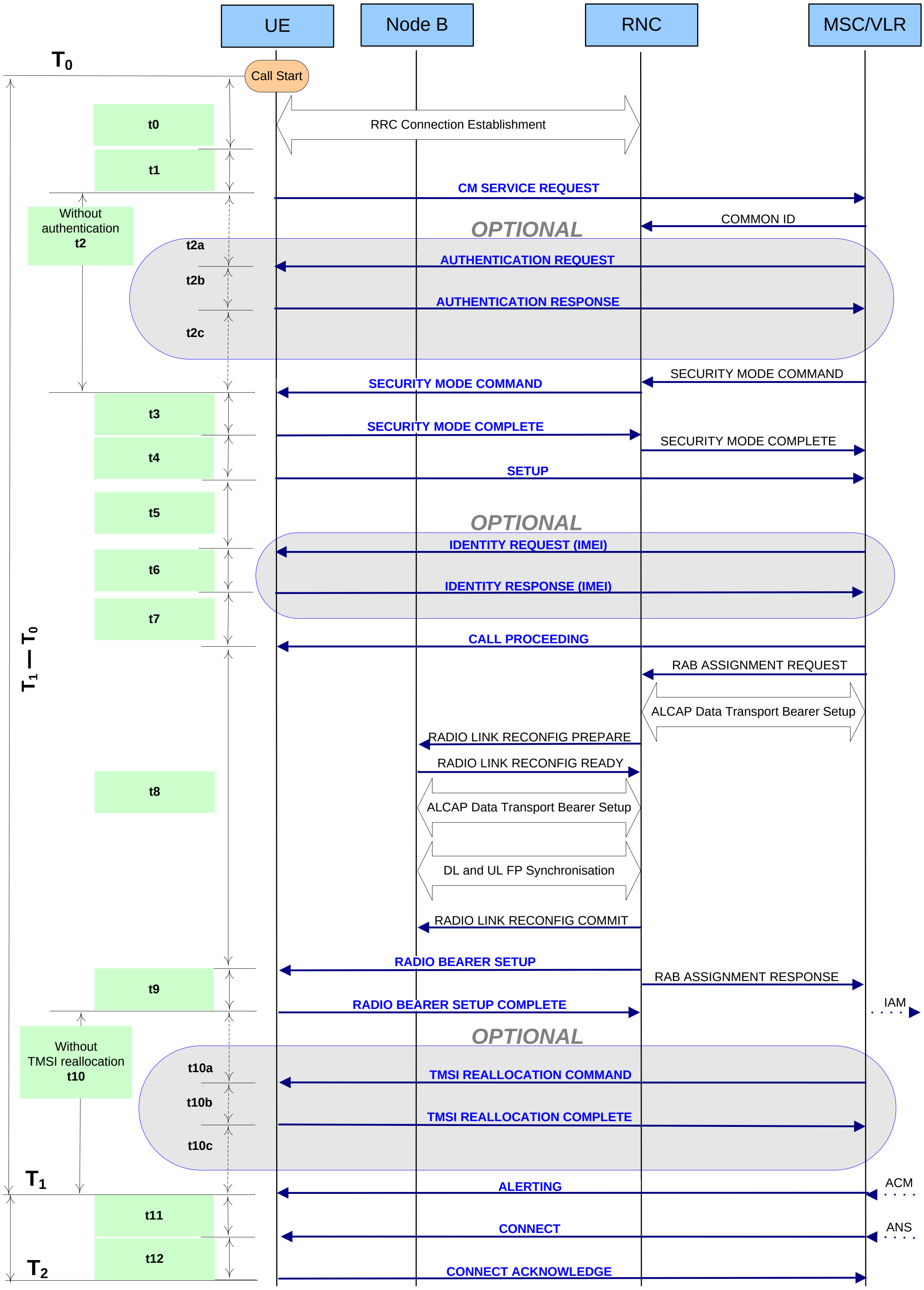

Figure 6.1.2-1: Mobile Originated CS Voice Call

The Figure 6.1.2-1 presents the reference case for Mobile Originated voice call setup procedure. $\mathbf{T_0}$ marks the instant in time when the user pushes the "send" button on the terminal. $\mathbf{T_1}$ is the reception of the NAS ALERTING message, when the user can hear if the call did go through, and $\mathbf{T_2}$ marks the time when the conversation can start.

The reference case(s) for RRC connection setup phase and delay contributed of it (time duration t0+t1) are analysed in subclause 6.1.1.

Table 6-4 presents the CS voice call setup delay from the moment the UE has already established the RRC connection, but security and Iu connection do not exist. As mentioned above the UTRAN has configured a 3.4 kbps DCH with 40 ms TTI for the SRBs in RRC Connection Setup.

The UTRAN utilises the synchronous reconfiguration procedure in RB setup to modify existing RL, which is the most delay introducing individual UTRAN procedure based on this analysis. The reason for this delay is that the UE needs to receive the reconfiguration message before expiration of the activation time, and possible RLC retransmissions introduce variations to the signalling delays of RB reconfiguration message. Typically, this is solved in UTRAN by selecting quite long values for the activation time.

Known methods to reduce the needed activation time value are optimisation in RLC polling mechanism in UTRAN, use higher bit rate for SRBs (13.6 kbps, 27.2 kbps, or utilisation of HS-DSCH for SRBs) or reduce block error targets of the DCH, to reduce RLC retransmissions. The optimisation of RLC polling might not be that straightforward and utilisation of higher bit rate SRBs, or lower BLER does not come for free without effects to the network capacity.

Table 6-4: CS Voice call setup, UE in CELL_DCH state (3.4kbps for SRBs)

Message/procedure	Sender/receiver	Delay	Cumulative Delay	Comments	Reference time point in Figure 6.2.1-1
CM service request	UE/CS CN	200 ms	200 ms	Includes authentication delays	t_2
Security mode command	RNC/UE	100 ms	300 ms		t_3
Security mode Command Completed	UE/RNC	200 ms	500 ms		t_3
Setup	UE/CS CN	150 ms	650 ms		t_4
Call proceeding	CS CN/UE	100 ms	750 ms		t_7
Radio bearer setup	RNC/UE	200 ms	950 ms	UTRAN resource reservation and, RL reconfiguration delays	t_8
Radio bearer setup completed	UE/RNC	400 ms	1350 ms	Synchronous reconfiguration	t_9
Alerting	CS CN/UE	250 ms	1600 ms		t_{10}
CS voice Call setup delay			1600 ms		T_1-t_2
Total from Idle			2210 ms		T_1-T_0

Call setup time analysis when CELL_DCH state is used, can be summarised with following notes:

- SIB 7 reading time is quite significant
- Utilisation of default configuration will significantly reduce transmission delay of the RRC connection setup message
- SRB bit rate does not effect to the delay of RRC connection setup part, but shorter TTI than 40ms will definitely have effects to the actual service set up phase (presented in Table 6-4)
- Synchronised RB reconfiguration is the most delay introducing single UTRAN procedure

Table 6-5 presents the delays associated to CS voice call setup when the UE is in CELL_FACH state after RRC connection setup. The downlink utilises 10 ms TTI on FACH and 20 ms TTI on RACH. In addition the UTRAN can perform unsynchronised RB setup procedure to establish RBs for CS voice RAB.

Table 6-5: CS Voice call setup, UE in CELL_FACH state

Message/procedure	Sender/receiver	Delay	Cumulative Delay	Comments	Reference time point in Figure 6.2.1-1
CM service request	UE/CS CN	200 ms	200 ms	Includes authentication delays	t2
Security mode command	RNC/UE	100 ms	300 ms		t3
Security mode Command Completed	UE/RNC	200 ms	500 ms		t3
Setup	UE/CS CN	150 ms	650 ms		t4
Call proceeding	CS CN/UE	100 ms	750 ms		t7
Radio bearer setup	RNC/UE	200 ms	950 ms	UTRAN resource reservation and, RL reconfiguration delays	t8
Radio bearer setup completed	UE/RNC	300 ms	1250 ms	asynchronous reconfiguration	t9
Alerting	CS CN/UE	250 ms	1500 ms		t10
CS voice Call setup delay			1500 ms		T_1-t_2
Total from Idle			1770 ms		T_1-T_0

Call setup time analysis when CELL_FACH state is used, can be summarised with following notes:

- SIB 7 reading time is again quite significant as in previous case
- Utilisation of default configuration will significantly reduce transmission delay of the RRC connection setup message
- SRBs mapped on FACH can utilise 10 ms TTI which reduces the setup times compared to case when the SRBs are using 3.4 kbps DCH (~ 400ms / 18%)
- Possibility to utilise unsynchronised RB reconfiguration gives gains compared to CELL_DCH case
- Node B resource consumption can be reduced by increasing the common channel load, allowing load balancing between dedicated and common channels

In addition, interactions between the CELL_FACH state mobility and call setup procedures require special considerations. These considerations are presented in subclause 6.3.1.

6.1.2.2 Mobile Originated Video Telephony Call Setup

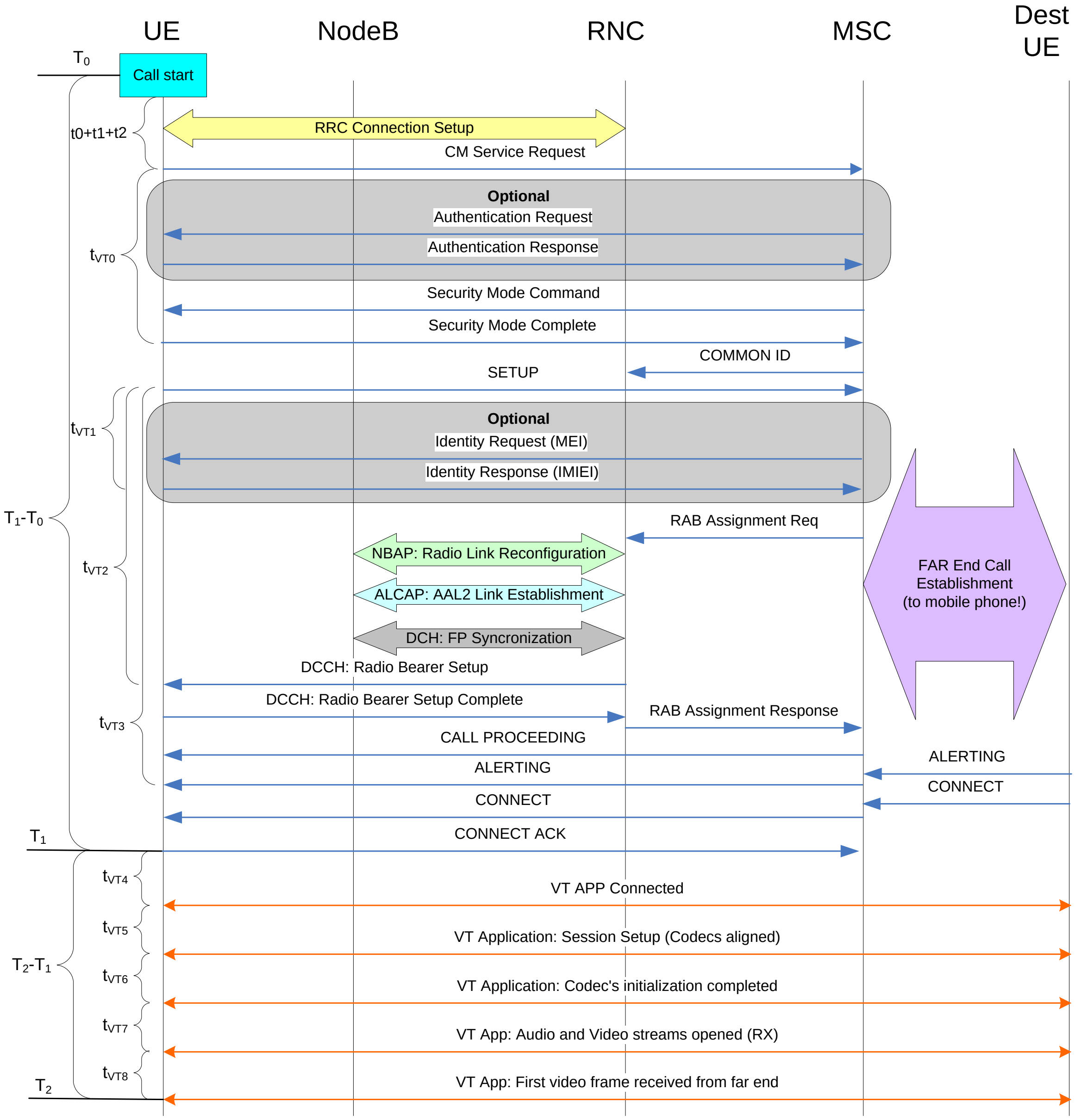

Figure 6.1.2-2: Mobile Originated CS Video Telephony Call (mobile to mobile)

The CONNECT ACK (**T_1**) indicates the completion of the radio bearer establishment. After this, the videophone applications exchange capabilities, agree on coded formats, initialize the necessary elements, create the stream endpoints before the actual audio and video information can flow.

Since the VT call is always a mobile to mobile call it is affected by the length of the paging procedure of the called mobile.

The reference case(s) for RRC connection setup phase and delay contributed of it (time duration t0+t1) are analysed in subclause 6.1.1.

6.1.3 PS Call Setup

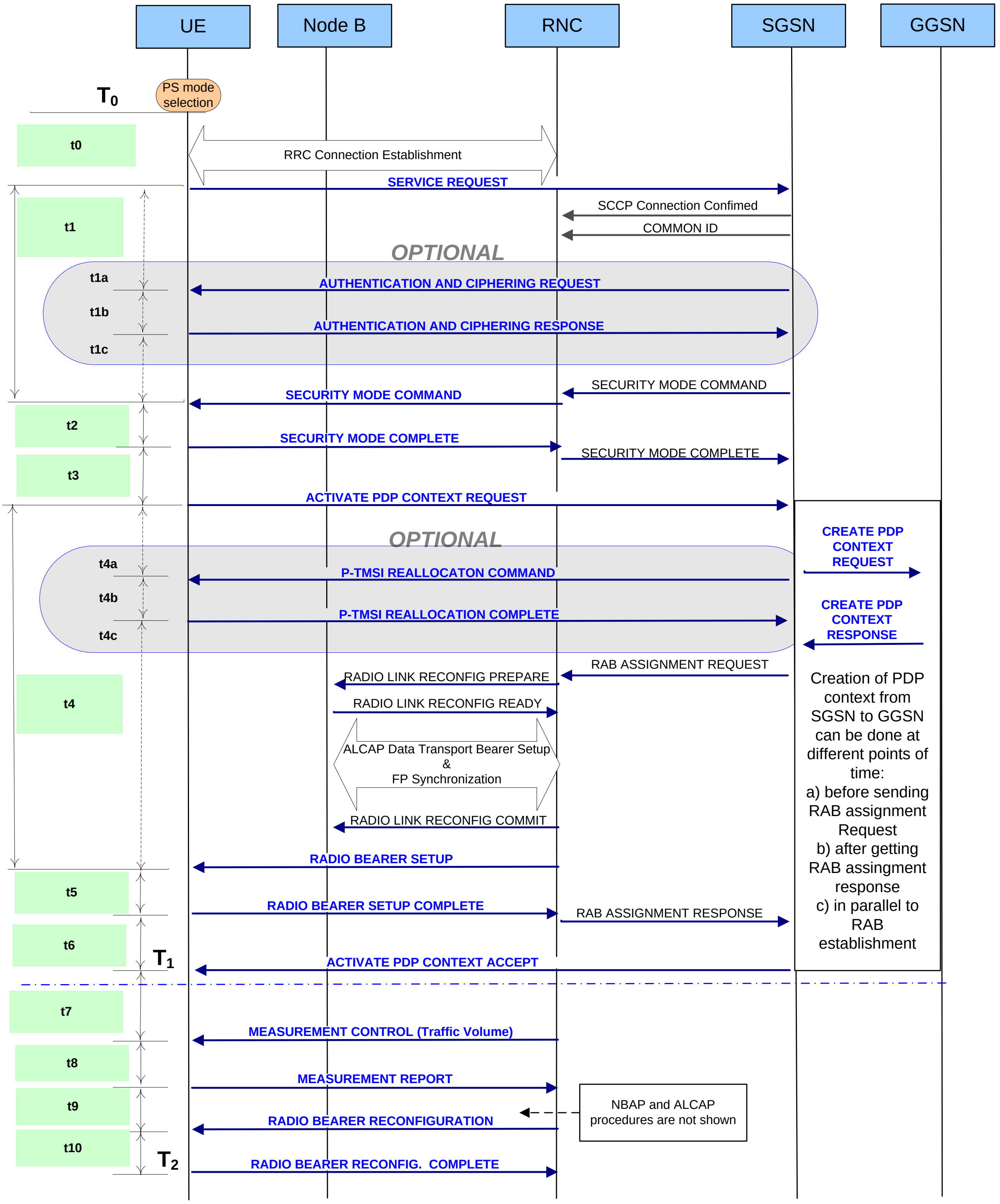

Figure 6.1.3-1: Mobile Originated Packet Connection Setup

The Figure 6.1.3-1 presents the reference case for the Mobile Originated packet connection setup procedure. $\mathbf{T_0}$ marks the instant in time when the user activates the packet service. $\mathbf{T_1}$ is the reception of the NAS ACTIVATE PDP CONTEXT message. Thus for PS call setup time analysis, the time instant $\mathbf{T_1}$ is considered as point when higher layer data can be conveyed through the UTRA. $\mathbf{T_2}$ marks the time when the physical channel is reconfigured to optimally handle the packet service in UTRAN and the analyses of this procedure is presented in subclause 6.1.5.

The reference case(s) for RRC connection setup phase and delay contributed of it (time duration t0+t1) are analysed in subclause 6.1.1.

Table 6-6 shows the delays involved in Mobile Originated packet connection setup. It is assumed that SRBs are mapped on HS-DSCH/E-DCH directly in RRC connection setup, and this is reflected in the grand total delay of 820ms.

The analysis considers usage of 10ms E-DCH TTI and both HS-DSCH and E-DCH can carry one SRB message in a single frame. In addition, it assumes good radio conditions with no retransmissions at L2.

NOTE: E-DCH 2ms TTI would also provide the same delay reduction if the HARQ operation point would have to be set to same level. However, 2ms has coverage limitations especially in macro-cells and is therefore not considered as basis for the analysis.

Table 6-6: Rel-6 RRC connection and RB setup on HSPA channels delay budget.

Component	Sender/ receiver	Delay (ms)	Cumulative Delay (ms)	Comments	Reference time point in Figure 6.1.3-1
Service request	UE/PS CN	10 ms	10	UE starts sending the service request immediately after RRC connection complete	t_1
Security mode command	RNC/UE	30 ms	40	Authentication assumed to be done in GPRS attach procedure beforehand	t_2
Security mode complete	UE/RNC	40 ms	80		t_3
PDP context activation request	UE/PS CN	10 ms	90		t_4
Radio Bearer setup	RNC/UE	120 ms	210	Includes the PDP context activation delay in SGSN and GGSN RAB assignment request procedure	t_5
Radio Bearer setup complete	UE/RNC	80 ms	290	Setup of new Radio bearer and MAC-d flow, with activation time "now"	t_5
PDP context activation accept	PS CN/UE	70 ms	360	Includes the RAB assignment response delay	t_6
PDP context activation sub-total:			360 ms		
Total from Idle:			820 ms		T_0-T_1

6.1.4 CELL_FACH to CELL_DCH State Transition

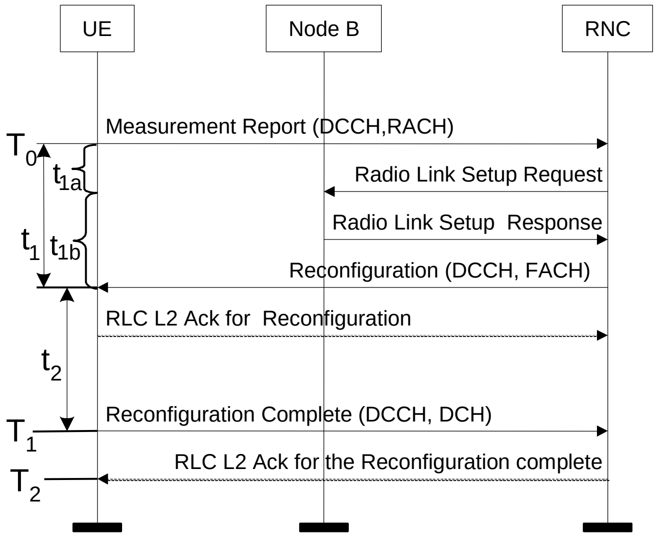

Figure 6.1.4-1: CELL_FACH to CELL_DCH State Transition

In the Figure 6.1.4-1 the CELL_FACH to CELL_DCH transition is analyzed. This procedure allows the resumption of a packet data call that is temporary in "dormant" or low activity state. UTRAN decides to perform the state transition based on UE measurement reporting and/or UTRAN internally determined causes:

1) State transition based on UE measurement report:
   $\mathbf{T_0}$ marks the instant in time when the measurement report including the Traffic Volume Measurement is sent over the radio interface.

2) State transition based on UTRAN internal reason:
   In this case the t_{1a} is zero and T_0 marks the instant in time when the Radio Link Setup Request is sent to the Node B.

$\mathbf{T_1}$ is the transmission of the RRC CHANNEL RECONFIGURATION COMPLETE message, when the user data can start to flow. The signaling flow in Figure 6.1.4-1is based on the assumption of acknowledge mode transfer of the RRC: RECONFIGURATION message, and thus $\mathbf{T_2}$ marks the time when the procedure is completed at the reception of the L2 Ack for the RRC CHANNEL RECONFIGURATION COMPLETE message.

6.1.5 Reconfiguration of the DCH

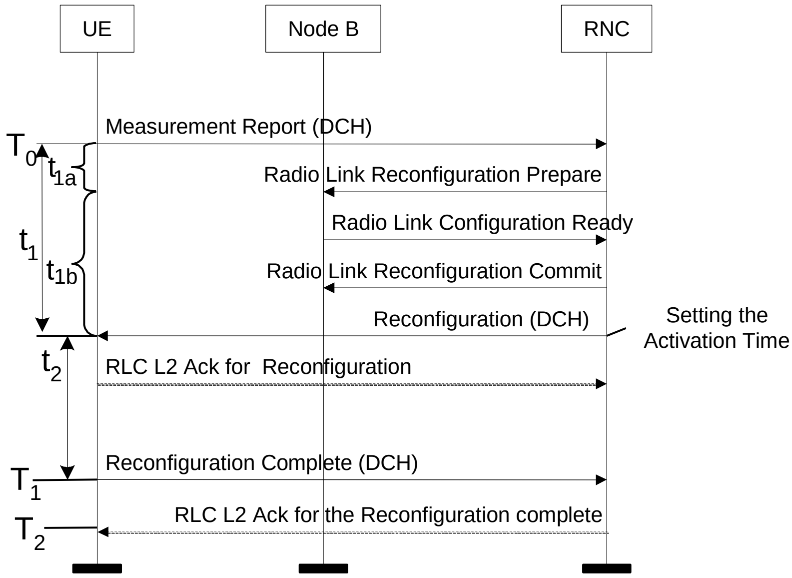

Figure 6.1.5-1: The Reconfiguration of the DCH

In the Figure 6.1.5-1 the reconfiguration procedure of DCH in CELL_DCH state due to UE reasons is analyzed. UTRAN decides to perform the state transition based on UE measurement reporting and/or UTRAN internally determined causes:

1) State transition based on UE measurement report:
   $\mathbf{T_0}$ marks the instant in time when the measurement report including e.g. the Traffic Volume Measurement is sent over the radio interface.

2) State Transition based on UTRAN internal reason:
   In this case the t_{1a} is zero and T_0 marks the instant in time when the Radio Link Setup Request is sent to the Node B.

$\mathbf{T_1}$ is the transmission of the RRC CHANNEL RECONFIGURATION COMPLETE message, when the user data can start to flow at the new configuration, The signaling flow in Figure 6.1.5-1is based on the assumption of acknowledge mode transfer of the RRC: RECONFIGURATION message and thus $\mathbf{T_2}$ marks the time when the procedure is completed at the reception of the L2 Ack for the RRC CHANNEL RECONFIGURATION COMPLETE message.

6.2. Void

6.3 Effects of the Mobility

6.3.1 CELL_FACH State Mobility

The usage of CELL_DCH state in voice/video/PS data call setups benefits from the SHO and HHO, which can be performed between any of the setup procedures analysed in subclause 6.1.2. Naturally active set update during call setup will introduce some extra delay, as measurement reports and active set update message need to be transmitted, but RLC PDUs are not lost due to UE mobility.

Since the CELL_FACH state mobility is based on UE performing Cell Reselection, any reselection during the downlink transmission will introduce PDU loss until the UTRAN receives the Cell update message from the UE. In normal situation, the AM RLC will retransmit those PDUs after Cell update confirm procedure, and last PDUs of the message are received by the UE enabling the procedure to continue.

However, the Security Mode command needs special handling even though it takes roughly 17% of total setup times as shown in previous section. This is due to the fact that without special handling from UTRAN, in some scenarios the security is not started at all or the security is only started in UTRAN or in UE causing ciphering failure and call drop. Scenarios with intra RNC mobility and Security Mode Command procedure are present with possible UTRAN solution in subclauses 6.3.1.1-6.3.1.4.

In addition, the following problems of CELL_FACH state mobility have been identified:

- inter-RAT cell reselection to GERAN during connection setup and call setup phase
- inter RNC cell reselection during the security mode command procedure

6.3.1.1 Cell Update started before SMC received by UE

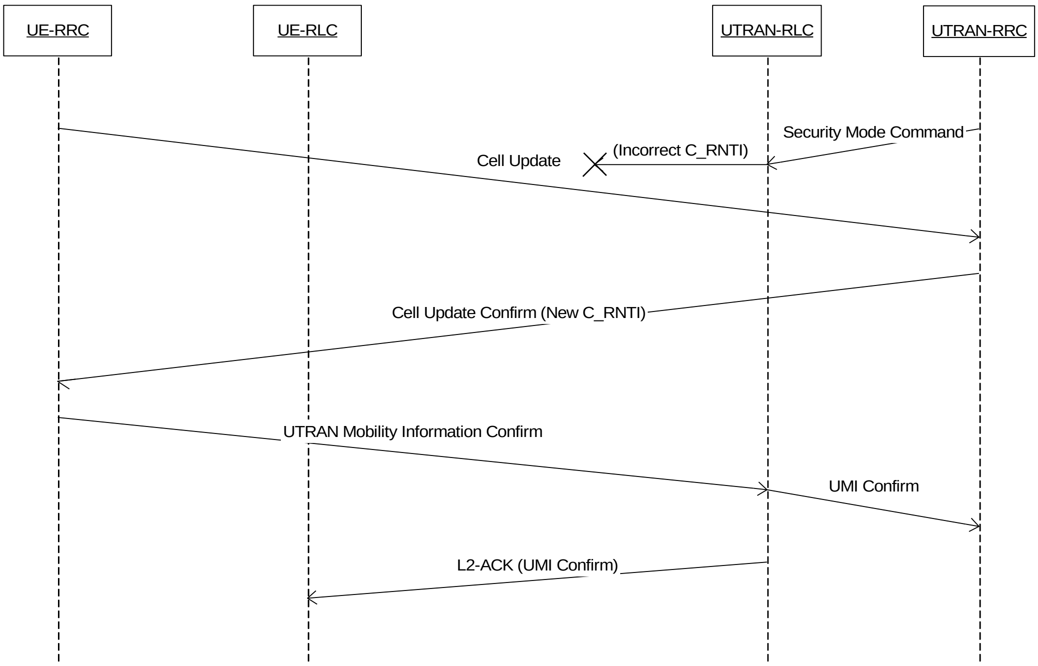

Figure 6.3.1-1: Scenario 1

Details of the Scenario:

- Security Mode Command is delivered to UE after Cell update confirm
- UE will not abort SMC, as it was not received during CU.
- UTRAN will abort SMC, as CU happened during SMC as far as NW is concerned.

Hence, the scenario is causing de-synchronisation between UE and UTRAN.

Solution:

- To avoid this UTRAN should re-establish bearers including SRB2 by re-establishment indicators in Cell update confirm and re-initiate the SMC after UTRAN Mobility Information Confirm.

6.3.1.2 Cell Update started after SMC received by UE, but L2 ACK for SMC not received by UTRAN

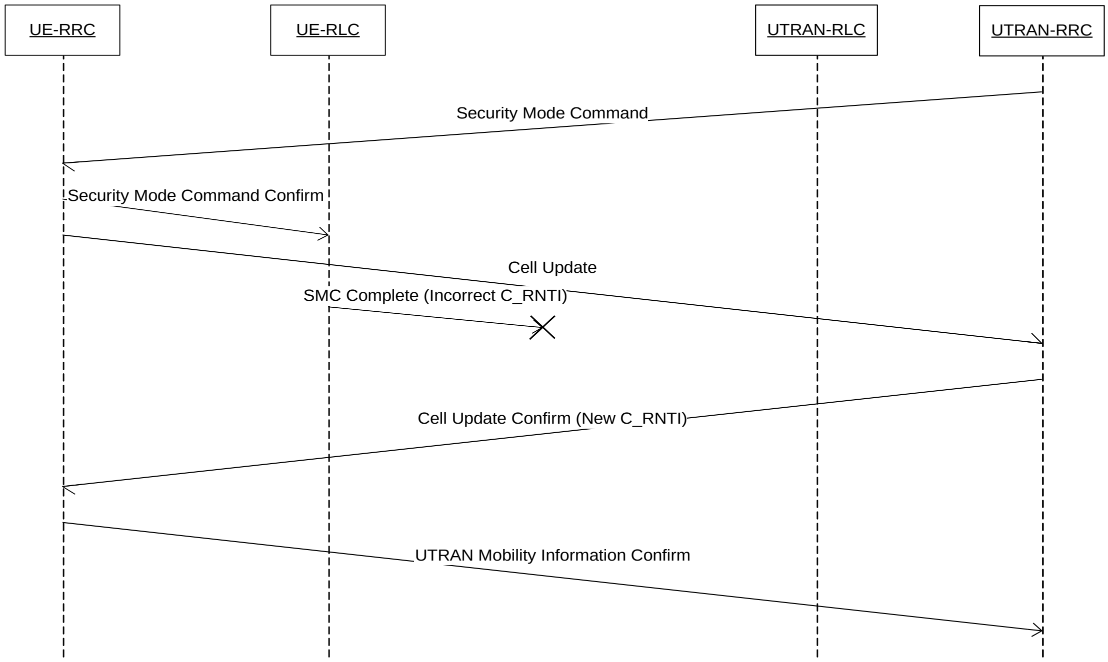

Figure 6.3.1-2: Scenario 2

Details of the Scenario:

- Security Mode Command is delivered to UE
- Cell Update is started before RLC ACK is delivered to NW.
- UE will abort SMC as Cell update occurred after reception.
- NW will abort SMC as CU happened during SMC

Solution**:**

- UTRAN will also re-establish bearers in cell update confirm message and re-initiate the SMC after UTRAN Mobility Information Confirm as in solution to scenario 1.

6.3.1.3 Cell Update started after SMC received by UE and L2 ACK for SMC received by UTRAN

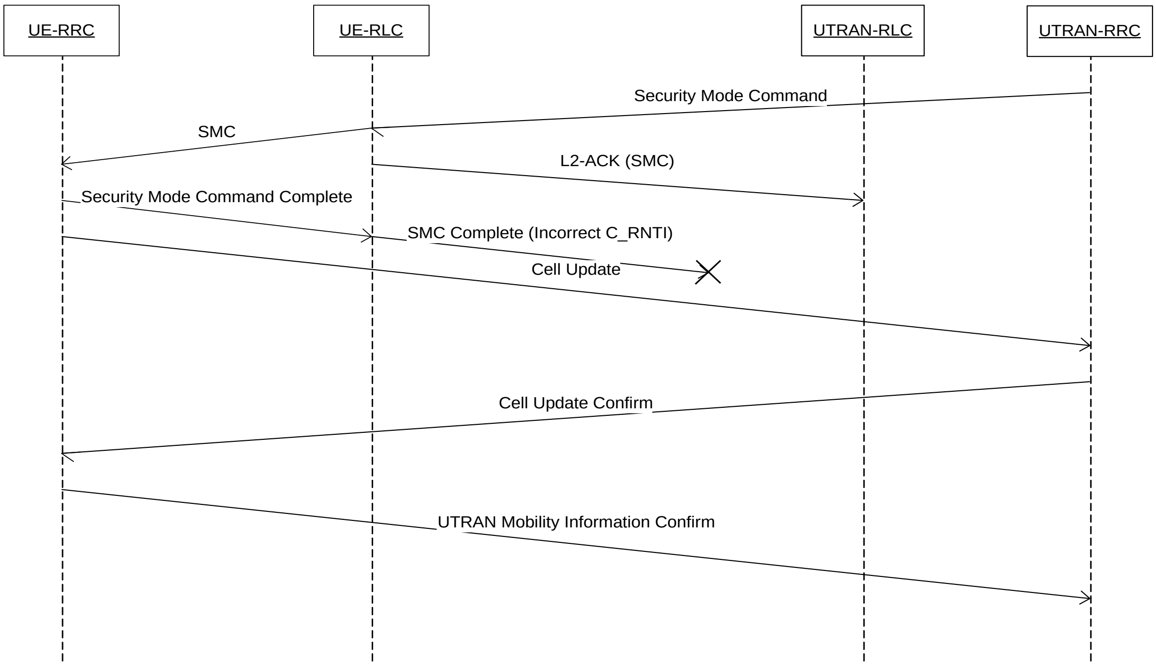

Figure 6.3.1-3: Scenario 3

Details of the Scenario**:**

- Security Mode Command is delivered to UE
- RLC ACK is delivered to UTRAN.
- Cell update is started
- UE will abort Security Mode Command as Cell update occurred after reception. SMC but before sending the Security mode command Completed
- UTRAN will abort SMC as CU happened during SMC

Solution:

- UTRAN does not need to re-establish bearers this time as in solution to scenario 1. If UTRAN does not re-establish, then it will have to ignore any potential SMCC from the UE delivered after Cell update confirm.

6.3.1.4 Cell Update after SMCC, before L2 ack for SMCC delivered to UE.

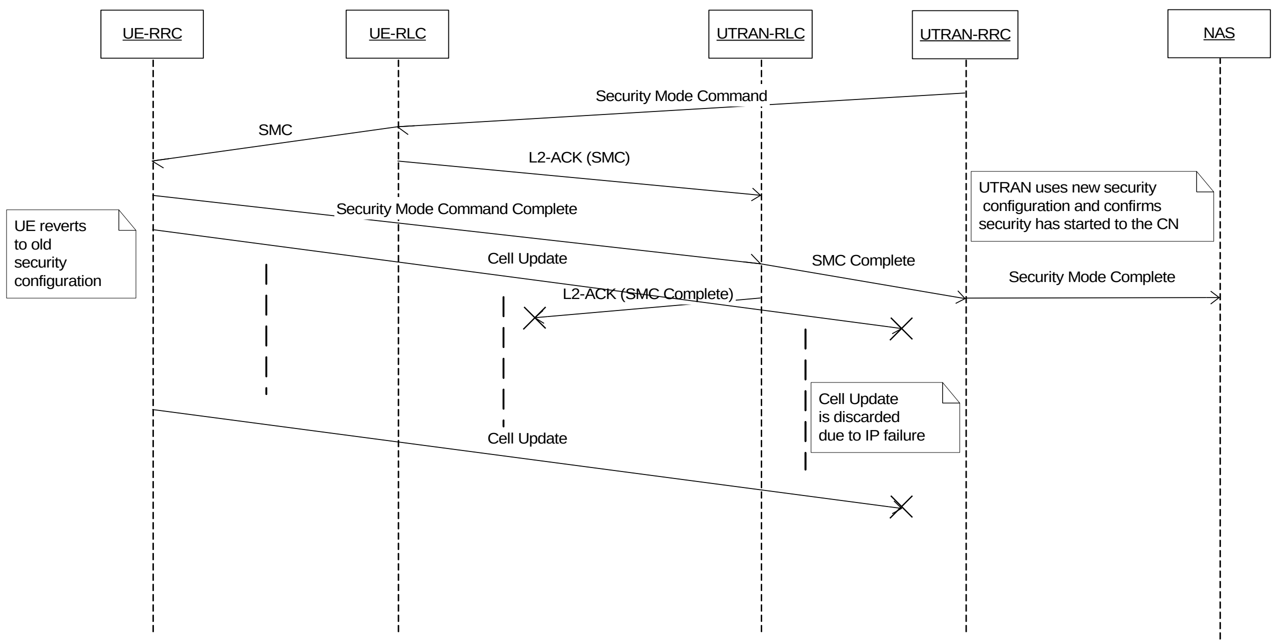

Figure 6.3.1-4: Scenario 4

Details of the Scenario:

- Security Mode Command is delivered to UE
- RLC ACK is delivered to UTRAN.
- Security Mode Command Completed is sent by UE, and received by UTRAN, UTRAN starts to use new Configuration.
- Cell update is started, before L2 ACK for Security mode command completed is delivered to UE.
- UE will abort SMC as Cell update occurred before L2 ACK for SMCC.

In case of initial call setup, NW can know about UE's abortion due to lack of integrity protection in Cell Update message.

For Multi RAB call setup, NW can know about UE's abortion as CU integrity protection will fail on UTRAN side.

Solution:

UTRAN could use this failure information to abort the SMC. The NW then uses old keys to attempt to accept CU (or T302 retry from UE), and send CUC.

NOTE: The "Integrity check info" IE is optional in the Cell Update message, but there is nothing in the specification stating the UE shall omit it (although it seems logical to do so).

However, if the RNC has sent the Security Mode Complete message to the CN, the UTRAN cannot abort the Security Mode Command anymore. Currently, there is no solution for this scenario in current standards.

7 Overview of Proposed Improvements

This subclause presents proposed improvements. The conclusion for each proposal is captured in clause 8.

7.1 Default Configurations

The Rel-5 default configuration concept is specified for cases in which the UE enters CELL_DCH without having any CELL_DCH configuration previously allocated i.e. it is used upon handover from GSM/ GERAN Iu and upon RRC connection establishment. The current default configurations include combinations of signalling radio bearers (SRB1-3) with a single CS RAB.

The get full advantage of default configurations also in other situation, a new set of default configurations is required to be introduced together with the signalling support of the default configurations in the Radio Bearer Setup message. The signalling support of the default configurations in the Radio Bearer Setup message is agreed in R2-052284 CR2676 to 25.331. The signalling support in the Radio Bearer Reconfiguration message is not supported.

The other requirement of utilising default configurations is that the existing PS RABs will not be released when using default configurations to set up another RB.

The Rel-6 will introduce new set of default configurations, as listed in subclause 8.1.

7.2 Stored Configurations

7.2.1 General Principle

The main principle of the stored configuration is that the UE stores some RB configuration for later use. The general assumptions for these stored configurations are:

1) The scope of stored configurations is limited to either a PLMN or equivalent PLMN. It is FFS if co-ordination of the same stored configuration identity (SCI) and or stored configuration set identity (SCSI) among PLMNs is feasible.

2) Each stored configuration is uniquely identifiable within the PLMN.

3) Stored configurations are synchronised between UE and UTRAN

The UTRAN may utilise the stored configuration in RB setup or reconfiguration when the UE has indicated that it has stored RB configurations, by only indicating the SCI in the setup/reconfiguration message. The UE indicates the status of the stored configurations in RRC Connection Setup Complete message. The need of stored configuration status messages in other messages is FFS.

Two separate methods to store, and synchronise RB configurations in UE has been envisaged:

1) Storing the configuration during RB setup when the full configuration is send to the UE, achieving the synchronisation by utilising system information broadcast by the UTRAN, as defined in subclause 7.2.2.

2) Introduce explicit signalling that UTRAN utilises for storing and synchronising the configuration in the UE as defined in subclause 7.2.3.

7.2.2 Signalling of Stored Configurations at RB Setup

The method for storing configurations at RB setup consists primarily of the addition of an SCI field to the RADIO BEARER SETUP message. UTRAN can utilise this field in two ways:

1) When accompanied by a full configuration, UTRAN indicates to the UE that it shall associate the SCI value with the configuration.

2) By itself, UTRAN has knowledge that the UE is already storing a configuration with that SCI, and indicates that the radio bearer to be set up shall use that stored configuration.

7.2.2.1 Establishment of a Stored Configuration

The procedure to associate an SCI value with a configuration is shown in Figure 7.2.2-1.

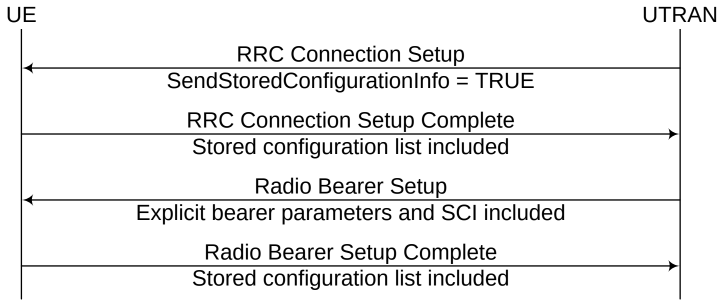

Figure 7.2.2-1: RB setup establishing a stored configuration

The UTRAN indicates to the UE in the RRC CONNECTION SETUP message that the UE should send its stored configuration list in RRC CONNECTION SETUP COMPLETE message to the UTRAN. This gives knowledge to the UTRAN, which configurations are available for use. In the case that UTRAN wishes to set up a bearer using a configuration that is not in the UE's list, it sends an explicit description of the bearer in the RADIO BEARER SETUP message, together with an SCI. The UE acts on received IEs and stores the IEs together with SCI value.

If for some reason the UE's list of stored configurations changes while the RRC connection is in place, it will need to send an UE CAPABILITY INFORMATION message to update the UTRAN

7.2.2.2 Use of a Previously Stored Configuration

The procedure to utilise a stored configuration, is shown in Figure 7.2.2-2.

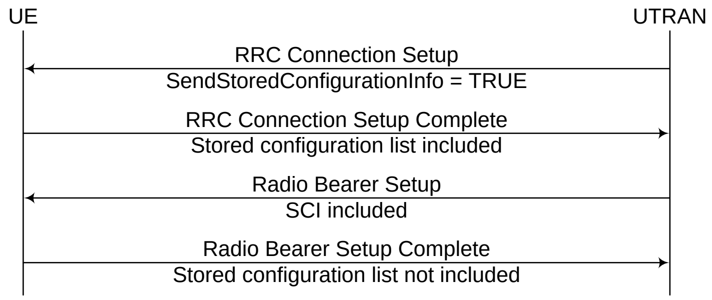

Figure 7.2.2-2: RB setup using a configuration previously stored

In this case the desired configuration was available in the list reported by the UE in the RRC CONNECTION SETUP COMPLETE message, and the UTRAN sends only the corresponding SCI in the RADIO BEARER SETUP message. The UE's list of stored configurations is not affected in this procedure, as the RADIO BEARER SETUP COMPLETE message does not contain IEs to be stored by the UE.

7.2.2.3 Other Affected Messages

In addition to the RADIO BEARER SETUP message, other RRC messages that may include a radio bearer configuration (reconfiguration messages and the CELL UPDATE message) would be able to include the SCI field with the same semantics.

The RRC CONNECTION SETUP message is an exception, as when the UTRAN is sending this message, it does not yet have the UE's list of stored configurations.

7.2.2.4 Management of Stored Configurations

To manage and synchronise the SCI values between UTRAN and UE, the broadcast system information should contain the list of currently used SCIs. The UTRAN should continuously transmit used SCIs in one of the System Information Blocks. The UTRAN would "activate" an SCI by adding its value to the broadcast list, and "deactivate" it by deleting it. When the UE determines from the SIB contents that an SCI has been deactivated, the UE shall delete the corresponding configuration from its stored configurations.

To avoid situation that, an UE has gone out of service when the SCI value was not yet invalidated, and return after the UTRAN has used same SCI again, giving no means to the UE to determine that the configuration associated with that SCI had changed. The UTRAN should wait long enough between invalidation and reuse of a given SCI that any problematic "lost" UEs will have discarded their system information (including the SCI validity information) due to the existing 6-hour timer.

To reduce BCCH bandwidth, it would be beneficial for the UTRAN to send an interval of SCIs in use, rather than a complete list. This requires that the UTRAN will sometimes have to perform active management used SCI values to keep the SCIs contiguous (e.g., in the situation where the interval [1,4] is in use and then SCI 2 is invalidated).

To support this management, it is desirable for the UTRAN to have a method to signal a "reassignment" of a new SCI to an existing configuration; in the example above, the UTRAN could make the valid identifiers (1, 3, and 4) contiguous by assigning SCI 5 to the same configuration as SCI 1, then invalidating SCI 1.

A "shorthand" notation telling the UE to perform this reassignment has advantages in terms of signalling and procedural complexity over explicitly duplicating the original SCI assignment. The signalling to support reassignment consists of a single IE containing two SCI values; this IE would be included in the RADIO BEARER SETUP message, but could be considered for inclusion in other messages as well, to allow the UTRAN to reassign the SCI for UEs for which no RB setup is needed.

The valid SCI interval could be signalled in appropriate SIB due to fact that changes should not be very frequent, as the lifetime of a given configuration in the network can be expected to be very long, so the SIB need not be one of those intended for frequent rereading.

Figure 7.2.2-3 illustrates the sequence of events in the management of SCIs between the UTRAN and an UE. The UTRAN begins with four stored configurations A, B, C, and D, with SCIs 0, 1, 2, and 3 respectively. The UE has already stored configurations A, B, and D from this list.

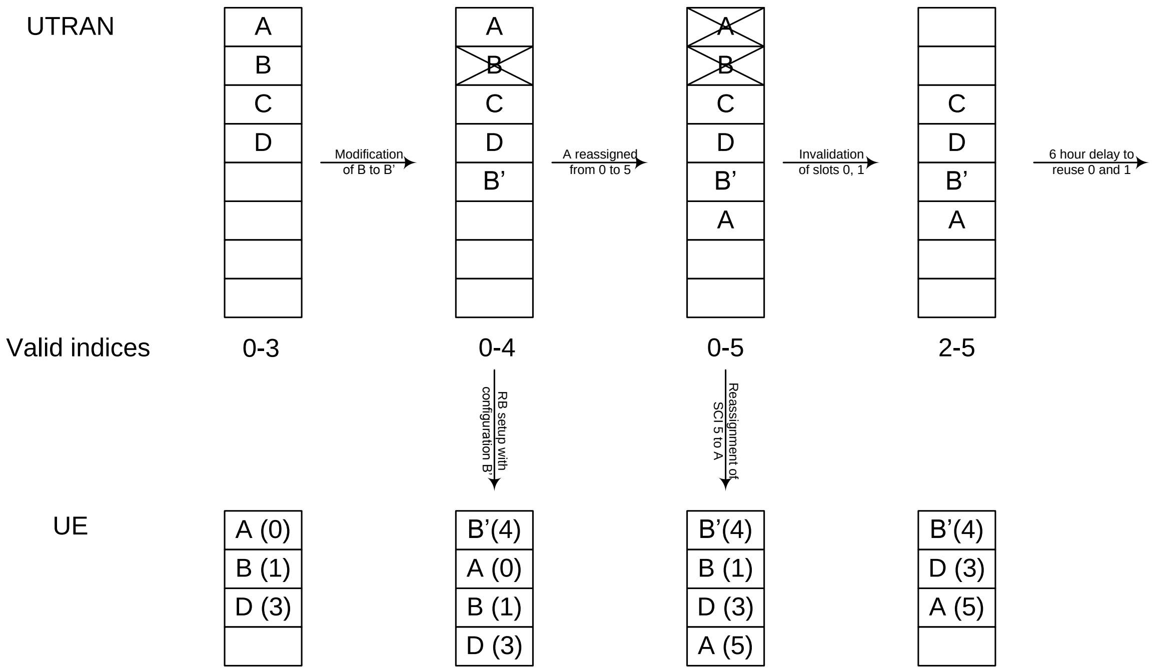

Figure 7.2.2-3: Management of SCIs as configurations change

Between the first and second columns of the Figure 7.2.2-3, the UTRAN decides to replace configuration B with a new configuration called B'. It adds B' to its list (with SCI 4), signals the new interval in the system information, and sets up a bearer using configuration B' with the UE. At this point the UTRAN stops using configuration B (the X through the configuration in the figure) but cannot yet signal it as invalid, because the SCIs for the remaining valid configurations (SCI values of 0, 2, 3, 4) are not contiguous. As the SCI 1 (configuration B) is not yet actually signalled as invalid in the system information, the example UE is storing both configurations B and B'.

To make the SCIs contiguous, the UTRAN reassigns configuration A from SCI 0 to 5. UEs receiving the reassignment will not store two copies of configuration A with different SCIs. At this point the UTRAN is signalling a valid interval of 0-5, but not actually using values 0 and 1; it can maintain this state until it determines that a sufficient number of UEs have received the reassignment. (UEs that do not receive the reassignment will "forget" configuration A when SCI 0 is no longer signalled as valid, so they may later need an explicit assignment of SCI 5 to the same configuration.)

When it determines that enough UEs have been updated, the UTRAN can actually expire SCIs 0 and 1, by signalling a valid SCI interval of 2-5. The UE in the Figure 7.2.2-1, seeing this change in the system information, deletes its stored configuration B (SCI 1).

At this point the only UEs still storing configurations 0 and 1 are out of service. Such UEs could return to service at any time in the next 6 hours with their system information still stored, so the UTRAN needs to wait at least that long before it can reassign SCIs 0 and 1 to new configurations.

7.2.3 Stored Configurations Management by Explicit Signalling

Configurations are transmitted to the UE explicitly by using a new signalling procedure on the DCCH. The UE stores the configuration for later use.

7.2.3.1 Identifying Stored Configurations

1) Stored Configuration Set Identity (SCSI) is used to identify the set of configurations stored in the UE.

2) Stored Configuration Identity identifies a "stored configuration", which is one element of a "stored configuration set".

7.2.3.2 Stored Configuration Transfer Procedure

The RNC can update the stored configurations any time the UE is RRC Connected. The RRC sends a list of configurations in a message called RRC: STORED CONFIGURATION UPDATE. It should be possible to remove, add, or update individual configurations stored in the UE to increase the efficiency of the predefined configuration set update.

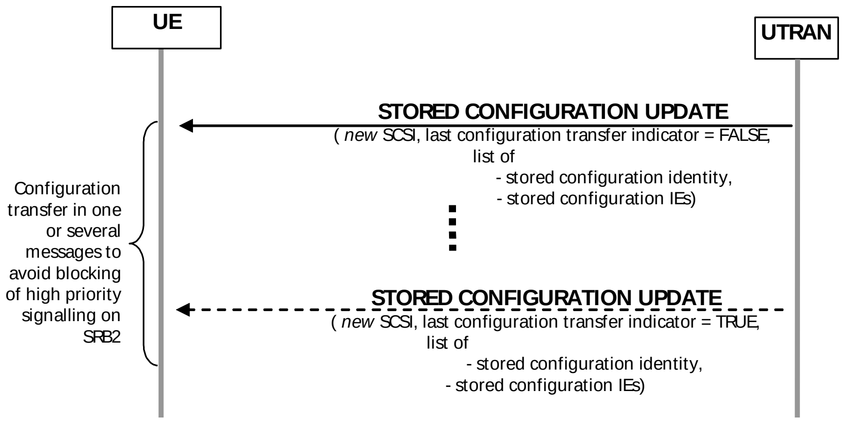

Figure 7.2.3-1: Stored Configuration Update procedure

To avoid large message sizes a segmented configuration transfer shall be possible: The RNC may transmit with one STORED CONFIGURATION UPDATE message one, several, or all configurations to be stored in the UE. Indicators within the message are used to inform the UE whether it has to expect additional STORED CONFIGURATION UPDATE messages with configurations to be stored while it is RRC Connected. It should be left to the RNC implementation how many configurations are transmitted in one STORED CONFIGURATION UPDATE message. If the UE moves into the Idle mode while it has not received all configurations stored for later use then it shall erase all stored configurations.

When an UE stored configuration set is updated, it must be associated with a new SCSI.

7.2.3.3 Notifying Stored Configurations

UTRAN has to be informed about the UE stored configurations before it can command the UE to apply a stored configuration in an RRC message. This can be obtained by a notification in the RRC Connection setup or after explicit request by the UTRAN.

In case of notification in RRC Connection setup, the UE informs UTRAN about its stored configurations by sending the associated SCSI in the RRC CONNECTION SETUP COMPLETE message, synchronising the stored configurations between the UE and the UTRAN as presented in Figure 7.2.2-2.

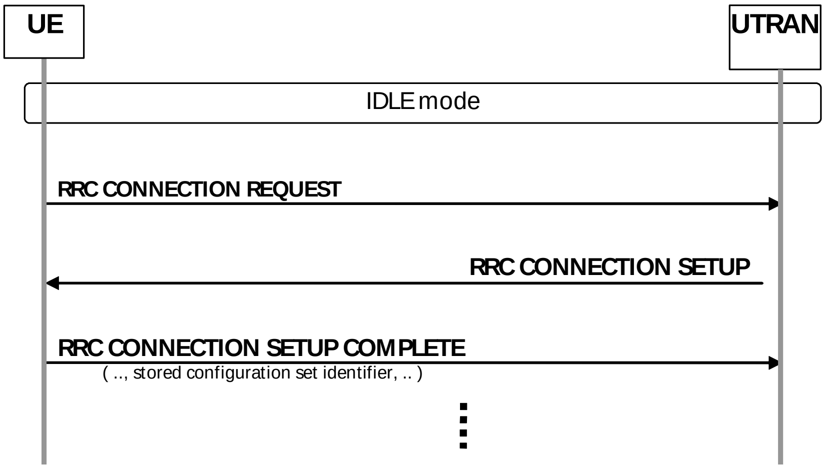

Figure 7.2.3-2: Notifying Stored Configurations in RRC Connection Setup

If the UTRAN does not hold information about the UE stored configurations, UE can explicitly request this information by sending the RRC: STORED CONFIGURATIONS STATUS REQUEST message to the UE. The UE responses with RRC: STORED CONFIGURATION STATUS RESPONSE message, which contains the SCSI associated with the UE stored configurations synchronising the stored configurations between the UE and the UTRAN as presented in Figure 7.2.2-3.

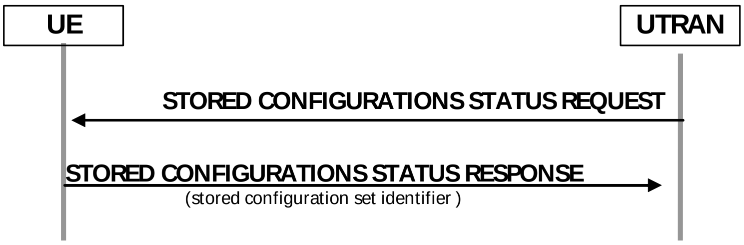

Figure 7.2.3-3: Notifying Stored Configurations by Stored Configuration Status Procedure

The Stored Configuration Procedure is only necessary if the UTRAN holds no valid information about the stored configurations, stored by the UE. This may happen for instance after a SRNC relocation, where the target RNC supports the "stored configuration feature" while the source RNC does not support it.

7.2.3.4 Lifetime of Stored Configurations in the UE

When a UE stores configurations for later use then a mechanism has to be included to allow the UE to determine when the stored configurations are outdated which then results in deleting the stored configurations from the UE memory.

This can be achieved by a combination of

1) information about the validity broadcasted on the BCCH, such as a "stored configuration support identity" or "supported SCSI(s)". The details are FFS.

2) A UE timer which is started when the UE camps no longer in a cell which supports its stored configuration set. It should be possible to set the timer to several hundred deci-hours so that the UE keeps a stored configuration set even if it is for a longer timer out of coverage. Timers that run several hundred deci-hours are supported nowadays by the UE, see e.g. T3212 (periodic location update timer). The details are FFS.

7.3 Configurations for RB and SRB

7.3.1 Void

7.3.2 New Reference Configurations

Following configurations are to be introduced in [5] for Rel-6.

1) UL/DL 13.6kbps SRB on DCH inclusion with PS RB(s), the reuse of configuration 3) subclause 6.10.2.4.1.3 of [6] is FFS.

2) UL/DL 27 kbps standalone SRB on DCH, agreed in R2-052602 CR0052.

3) Interactive or background / UL:16 DL: 16 kbps / PS RAB + UL:27.2 DL:27.2 kbps SRBs for DCCH, agreed in R2-052602 CR0052.

7.4. Enhancements to System Information Broadcast

7.4.1 Reducing the SIB7 reading time

To avoid deterioration of DRX and power savings UEs are not reading the SIB7 always when the validity of SIB7 expires, rather only when RACH access is needed. Reading the SIB7 during the RACH access introduces delay which is directly dependent on the scheduling period of the SIB7. Avoiding or reducing the SIB7 reading time, enhancements for MOC, MTC, CELL_PCH/URA_PCH to CELL_FACH/DCH state transitions are expected.

Following list summaries different solutions identified to reduce SIB7 reading time:

1) Faster SIB7 scheduling; current standard allows scheduling period to be 4 frames in minimum, but typically such short value is not used in UTRAN.

2) Allow the UE to use the last stored values of SIB7 only when a specific value of the Expiration Time Factor IE is signalled (one of the current values is modified). The expiration time would still be the same as signalled, therefore the UE is still required to read SIB7 during the RACH access, to update UL interference value and minimise the time when using incorrect UL interference level.[R2-052988].

3a) One bit indicator on SIB5/6 is introduced to allow the UEs to use the last stored SIB7 values of the cell where it is camped, when starting the access procedure from Idle mode, or from CELL_PCH and URA_PCH state. The purpose of indicator in SIB5/6 is to allow UTRAN control the range of UL interference values stored by the UEs.
In case that UTRAN needs to modify stored SIB7 values in the UEs, due to update, or setting them to invalid, the UTRAN is required to page all UEs in the cell due to SIB5/6 update.
UEs in the CELL_FACH state are acting as specified in Rel-5, although and indication could be introduced, to allow the usage of the stored SIB7 values. [R2-052831].

3b) UL interference value (and optionally dynamic persistence values) in SIB5/6 is introduced. If included in SIB5/6 the UE uses these values when starting the access procedure from Idle mode, CELL_PCH and URA_PCH allowing the UTRAN to control the exact values stored by the UEs.
In case that UTRAN wants to change the UE stored UL interference value (and optionally dynamic persistence values) due to update or switch back to SIB7 reading, UTRAN is required to page a SIB5/6 update to all UEs.
UEs in the CELL_FACH state act as specified in Rel-5, although an indication could be introduced to allow them using their stored SIB5/6 values. [R2-052831].

4) Define UE behaviour from point 2 and also introduce one bit flag to SIB5/6 as in point 3 or introduce the flag to the MIB. [R2-052987].

5) Introduce SIB7 IEs in Paging Type 1 message, allowing the UE use that interference level in MTC. To get these benefits in MOC, or in state transitions the UE would be required to receive PCH for decoding updated UL interference level from any Paging Type 1 message being send in PCH when accessing RACH. [R2-052389].

7.4.2 Reducing the SIB11 reading time in CELL_DCH to CELL_FACH

When assuming a typical interactive web browsing session the RNC moves the UE from CELL_DCH to CELL_FACH sate after RNC defined inactivity time is expired. When UE receives the Physical Channel Reconfiguration message to move UE to CELL_FACH state, the UE shall perform a cell selection.

If UE selects different cell than indicated in Primary CPICH and Frequency Info IEs in Physical Channel Reconfiguration message or those IEs were not included in the message the UE performs the CELL UPDATE procedure before transmitting the Physical Channel Reconfiguration Complete message.

In addition to above requirements, the UE is also required to read the entire SIB11 (SIB12 if applicable) before sending the Cell Update from selected cell or Physical Channel Reconfiguration Complete message. This requirement of reading SIB11, introduce CELL_DCH to CELL_FACH state transition delay which is directly depending on length of the SIB11 and scheduling frequency.

As in above scenario, the Cell Update and Cell Update Confirm is done during ordered reconfiguration procedure, the UTRAN cannot move the UE back to CELL_DCH in the Cell Update Confirm message before receiving the Physical Channel Reconfiguration complete. Therefore, the measurement configuration received from SIB11 or the measurement results in Cell Update are not critical during this first Cell Update procedure, and UE behaviour could be relaxed by allowing the UE to send Cell Update or Reconfiguration Complete message before reading SIB11.

7.5 Avoiding Activation Time in Reconfiguration

The idea to reduce the delay due to the activation time that is used in the Radio bearer Setup / Radio Bearer reconfiguration message, which is the main contributor in t9 of subclause 6.1.2.1, t_{VT2}-t_{VT3} in 6.1.2.2, t5 in 6.1.3 and t2 in subclause 6.1.5 and which is estimated to be 400 msec in Table 6-4, but is depending on the UTRAN setting.

As shown in subclauses 6.1.2.1, 6.1.2.2, 6.1.3 and 6.1.5 the radio bearer setup or the reconfiguration of the data rate is done using a synchronized reconfiguration which means that in the "Radio Bearer Reconfiguration Commit" message sent on the Iur/Iub interface and the "Radio Bearer Setup" / "Radio Bearer Reconfiguration" message an activation time (CFN) in the future is included which indicates a time instant at which the new configuration shall be taken into account.

The setting of the activation time is UTRAN implementation depending, but typically some margins are reserved for RLC retransmission of the PDU carrying Reconfiguration messages.

The subclause 7.5.1 describes, how the activation time avoided (allow using activation time value "now") in a way that is compatible with R’99 network specifications (except the case where NodeBs are not controlled by the SRNC). In subclause 7.5.2 possible standard enhancements on the network side are described that would allow to address the limitations of the method defined in subclause 7.5.1. The enhancements described in 7.5.2 are currently under investigation of RAN1 and RAN3 in order to analyse the impacts and the feasibility of these changes.

The subclause 7.5.3 discuss possibilities to setup physical and transport channel resources already in RRC Connection Setup procedure for end user services so that activation time is avoided in Radio Bearer Setup procedure and thus subclauses 7.5.1, 7.5.2 and 7.5.3 are considered as alternative options for enhancements.

7.5.1 Utilising Hard Handover

In order to decrease the time wasted due to the activation time one optimisation which is already possible with the R'99 UE / network specifications is to use a non-synchronized reconfiguration, i.e. perform a hard handover on the same frequency from network perspective and reconfiguration from the UE perspective. This scenario is shown in Figure 7.5.1-1.

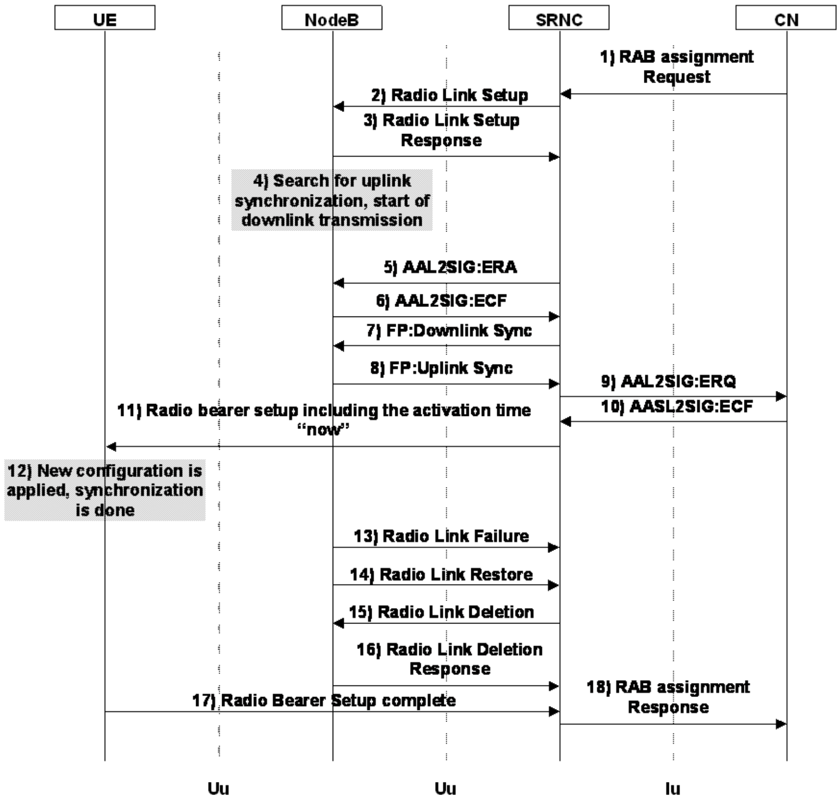

Figure 7.5.1-1: Avoiding Activation Time by Utilising Hard Handover

In step 1 to 10 the RNC establish on the involved Node Bs a new independent configuration, with new transport resources for all transport channels. The Node B tries to obtain synchronization to the UE by transmitting on the downlink with a fixed power that has been received form the RNC.

In step 11 the UE receives the message to change the configuration used for the uplink and the downlink. This message ideally indicates that the uplink scrambling code is changed, so that the old Node B context can detect a RL failure when the UE applies the new configuration. In step 12 the UE tries to receive the downlink that is newly established and eventually starts to transmit in the uplink (depending whether the synchronization procedure A is used or not).

The Node B will detect that the synchronization of the old RL is lost, and that the synchronization with the new RL is gained, and report this to the RNC with the messages RL Link Failure for the old RL and RL Restore for the new Radio Links (step 13, 14). The RNC can then delete the old Radio Links (step 15, 16).

The UE will indicate the successful Radio Bearer Setup Complete message (step 17), and the RNC can acknowledge the successful RAB setup to the CN (step 18).

The drawback of this scenario is that during the reconfiguration the resources for the old and the new configuration are used, i.e. the Node B starts the transmission in the downlink as soon as the Radio Link setup procedure is completed, and stops transmitting on the old Radio Link Set only when the old Radio Links are deleted by the RNC. This wastes capacity on the air interface (two sets of DL spreading codes are reserved, and transmitted), and HW processing capacity in the Node B as the Node B needs to decode two different UE configurations. In addition, as there are two RL configurations simultaneously configured this scenario wastes resources from the transport network and from the RNC. Furthermore, it is not possible to use a spreading factor from the same branch before and after the reconfiguration.

However, as scenario allows reducing the connection setup delay introduced by activation time it is a trade-off between the decreased connection setup delay and the increased usage of resources.

This scenario is not feasible in 25.433 in the case where Node Bs in a drift RNC are involved, and therefore an impact on RAN3 specifications would be foreseen in order to make this mechanism generally usable.

7.5.2 Utilising Synchronization via Change of Uplink Scrambling Code

One possibility to overcome the shortcomings of 7.5.1 is would detect the change of the configuration from the change of the used uplink scrambling code as illustrated in Figure 7.5.2.-1. However, this would require some enhancements in the RAN3 specifications.

The modifications shown in Figure 7.5.2-1 are defining one possible option to introduce necessary changes, and currently RAN1 and RAN3 are evaluating the feasibility and possible impacts to the specifications of the scenario. [R2-052613] [R2-052580].

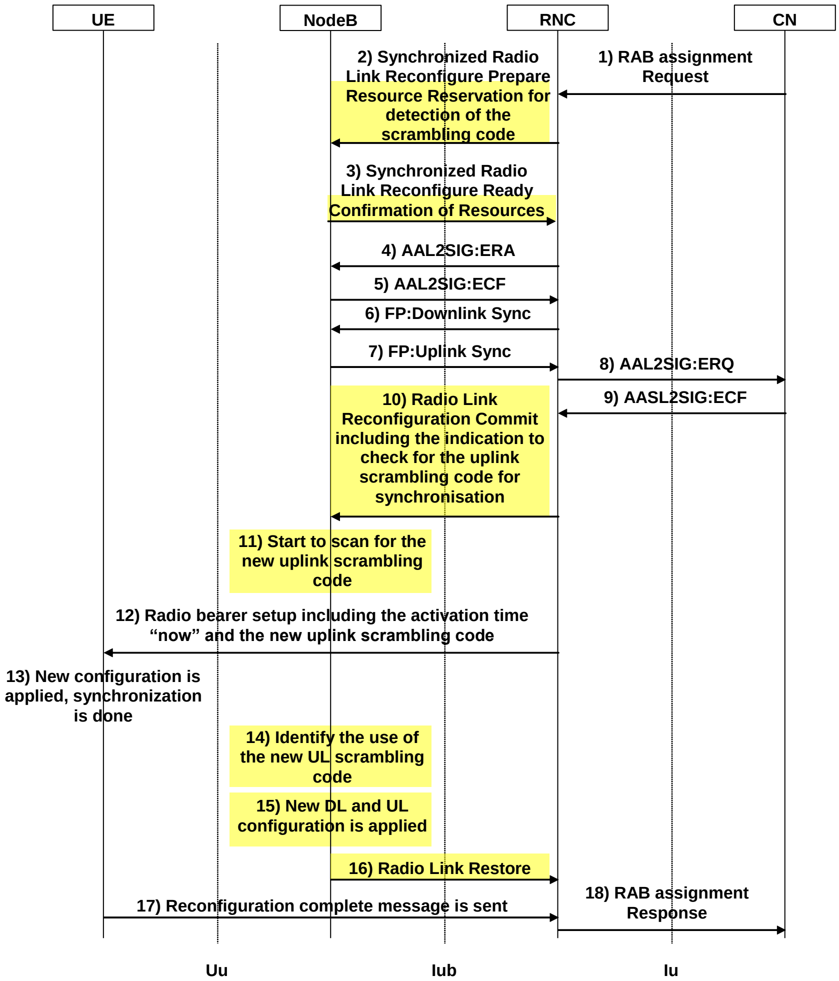

Figure 7.5.2-1: Utilising Enhanced quasi-synchronized reconfiguration

In step 1 to 9 the RNC allocates the resources for the reconfigured radio link / the new radio bearer to be setup, including the change in the uplink scrambling code. In order to ensure backwards compatibility, and also for managing the resources in the Node B the Radio Link Reconfiguration Preparation procedure on Iub/Iur would need to include in step 2 the indication that the Node B is required to scan for the new uplink scrambling code of the UE in order to synchronize when the UE takes into account the new uplink scrambling code.

In the case that the resources are not available in the Node B, and / or the Node B does not support the synchronization via the change of the uplink scrambling code the Node B could indicate this to the RNC in step 3 (e.g. by not confirming the special request received in step 2). This allows the RNC to switch to the legacy procedure.

In step 10 the RNC indicates to the Node B that the new configuration should be taken into account when the uplink scrambling code of the new configuration is used by the UE. In the case the slot format of the new configuration is different and a specific indication would be introduced in the Radio Link Configuration Commit message the Node B would then start to scan in order to detect the new uplink scrambling code from the UE. The RNC transmits the new configuration to the UE in step 12.

In step 13 the UE would then immediately apply the new configuration. Upon detection of the new uplink scrambling code in step 14 the Node B would then stop to transmit the old configuration, apply entirely the new configuration and consider that the reconfiguration is successful. The Node B and the UE would indicate to the RNC in step 16 and 17 the successful reconfiguration.

In order to perform the procedure as described above mainly the specifications 25.433 and 25.423 would be impacted. There is a need to extend the Radio Link Reconfiguration Preparation procedure in order to reserve resources for the scanning of the uplink scrambling code. Furthermore it would be necessary to extend the messages "Synchronised Radio Link Reconfiguration Commit" on the Iub and the Iur interface with a critical extension in order to indicate that the Node B should only apply the new configuration at detection of the new uplink scrambling code and to ignore the activation time. The "Radio Link Restore" message might be needed to be affected in order to indicate to the RNC that the new configuration has been taken into account in all involved Node Bs.

Procedural text would be needed in order to specify the behaviour in steps 11, 14 and 15. Detailed description of the behaviour in RAN1 would not be necessary due to the fact that the implementations of the Node B algorithms are mainly unspecified.

7.5.3 Extending the Utilisation of RRC Connection Setup Message

The alternative method for avoiding Activation Time for RB Setup message for CS services (CS Video or CS Voice) compared to scenarios presented in subclauses 7.5.1.and 7.5.2 is to setup necessary transport and physical channel resources for CS service immediately in RRC Connection Setup message. Thus the Radio Bearer Setup procedure performed after receiving RAB Assignment fro CS CN would only setup the Radio Bearer and provide valid mapping to transport channels but would not modify transport or physical channel configuration, and could therefore be performed unsynchronised.

However, as the RNC is not totally aware of which service UE is going to setup when receiving RRC Connection Request message (cannot separate CS Video and CS Voice, nor AMR codec) following cases can be identified:

1) Existing R99/ REL-4

   Upon receiving an RRC Connection Request with the cause value set to ‘conversational originating/ terminating call’, UTRAN assumes the UE wishes to establish a CS speech call.

   In this case, UTRAN pre-configures the transport and physical channel configuration for the CS speech call during RRC Connection Setup. Since the transport and physical channels are pre-configured, an asynchronous RB establishment procedure can be used upon RAB assignment to configure the remaining RB information (i.e. RB mapping and RLC configuration).

   If during RAB assignment it turns out that UTRAN made an incorrect assumption, UTRAN needs to perform a synchronous RB reconfiguration procedure, in which case the same call setup delay applies as for the case pre-configuration is not used.

2) Existing REL-5

   UTRAN may use the same approach as for R99/ REL-4 UEs. In addition, UTRAN may use pre-defined configurations when pre-configuring the transport and physical channel configuration for the CS RAB.

3) REL-6

   To solve limitations of R'99/Rel-4/Rel-5 following enhancements are identified:

   3.1) The RRC Connection Request message is extended by an IE ‘CS conversational call type’ by which the UE can explicitly indicate the call it wishes to establish e.g. CS speech, CS 64 kbps video. The Cell Update message is also extended with the same IE to provide similar enhancements to UEs in CELL_PCH and URA_PCH.

   3.2) Clarification is added to the RRC connection establishment procedure that, upon receiving the RRC connection setup message including a default configuration, the UE ignores the RB information corresponding with RABs (but considers the transport and physical channel information).

Note: As mentioned before, the above behaviour is already defined for pre-defined configurations since REL-5

These changes not only allow to cover CS calls other than speech but also enable UTRAN to use default configurations when pre-configuring the transport and physical channel configuration for the CS speech call during RRC connection setup. The Figure 7.5.3.-1 illustrates the required changes.

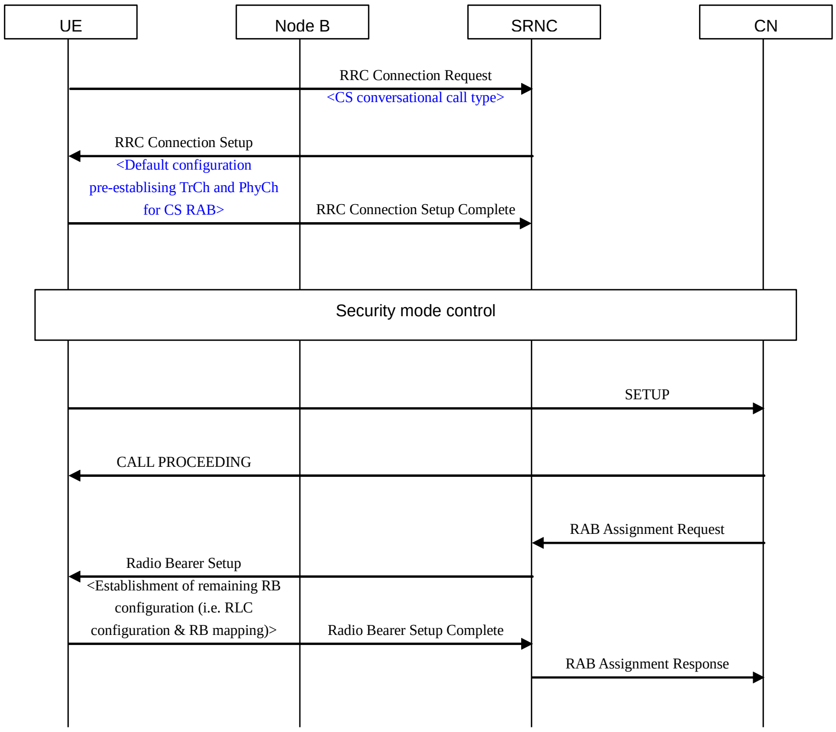

Figure 7.5.3-1: Signalling flow illustrating enhancements for REL-6

7.6 Enhancements on RACH

7.6.1 Optimization of RACH Transmission Control procedure

This subclause addresses the delay introduced by the RACH access procedure as specified in 25.321. This is part of the delay as shown in 6.1.1 in t0 for both scenarios when going from idle to CELL_DCH or from idle to CELL_FACH, although the RACH procedure is not shown in this graph.

Described changes impact only the UE implementation, and there is no impact at all on the network. This means that this change could be implemented by R'99 UEs without any backwards compatibility problems. The actual gain in terms of average delay introduced at call setup depends heavily on the network setting as shown in Table 7-1, where the setting proposed in 34.108 is highlighted in yellow:

Table 7-1: Average delay at call setup due to the persistence test in msec

		Persistence value (SIB 7)						
		1,00	2,00	3,00	4,00	5,00	6,00	7,00
Persistence scaling factor (SIB 5/6)	0,10	100	200	800	6400	102400	3276800	209715200
	0,20	50	100	400	3200	51200	1638400	104857600
	0,30	33	67	267	2133	34133	1092267	69905067
	0,40	25	50	200	1600	25600	819200	52428800
	0,50	20	40	160	1280	20480	655360	41943040
	0,60	17	33	133	1067	17067	546133	34952533
	0,70	14	29	114	914	14629	468114	29959314
	0,80	13	25	100	800	12800	409600	26214400

	0,90	11	22	89	711	11378	364089	23301689

In the model of MAC specification the physical layer is controlled according to the following scheme which is an extract of 25.321:

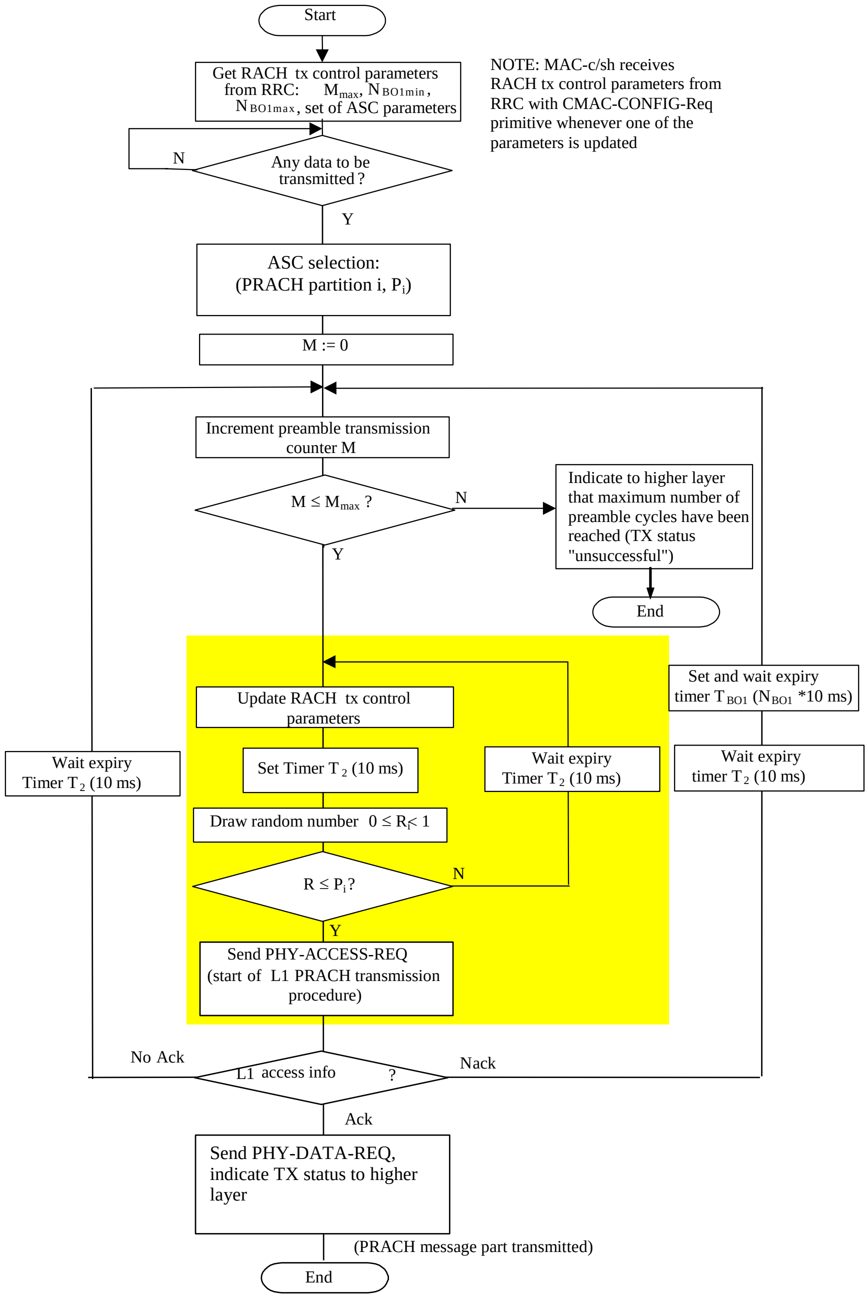

Figure 7.6.1-1: Current RACH transmission control procedure

The Figure 7.6.1-1 shows that before each L1 procedure (i.e. ramping in order to be allowed to receive an AICH indicator allowing to send the message part) a delay according to the persistency value P1 is introduced (yellow part).

The persistence depends on the "Persistence scaling factors" according to the access class / the logical channel priority and the "Dynamic persistency value" as broadcast in SIB7 and is updated before each test. This delay is important in order to distribute the timing of the access to the random access channel, e.g. when many UEs perform a LA/RA update when entering to a new LA/RA.

Then all UEs will wait for the reception of SIB7, and then after reception immediately initiate the access to the network. In order to avoid that all UEs will do the first ramping simultaneously the delay due to the persistency test allows to spread the UEs.

However in the case that the trigger for the RACH procedure is independent for a restricted number of UEs, e.g. at call establishment of an individual user, or when a user has uplink data to be transmitted there does not seem to be any advantage of delaying the actual start of the L1 procedure.

It is therefore considered the possibility to remove the persistence test in the MAC procedure in order to allow the UE to start the transmission of the preamble immediately for a call setup.

This is shown in the Figure 7.6.1-2 where a parameter "PT" has been introduced which is received by MAC from RRC / RLC, such that at transmission on RACH of certain PDUs received from RLC the persistence test as highlighted by the yellow box is not done, e.g. the first test when M = 1 is not done in the case PT is set to "False".

The persistence test should not be performed before the start of the first L1 transmission (i.e. PT should be "FALSE") in the case that the "RRC Connection Request" / "Cell Update" message is sent with any of the following Establishment causes:

- Originating Conversational Call,
- Originating Streaming Call,
- Originating Interactive Call,
- Originating Background Call,
- Originating Subscribed traffic Call,
- Terminating Conversational Call,
- Terminating Streaming Call,
- Terminating Interactive Call,
- Terminating Background Call,
- Call re-establishment

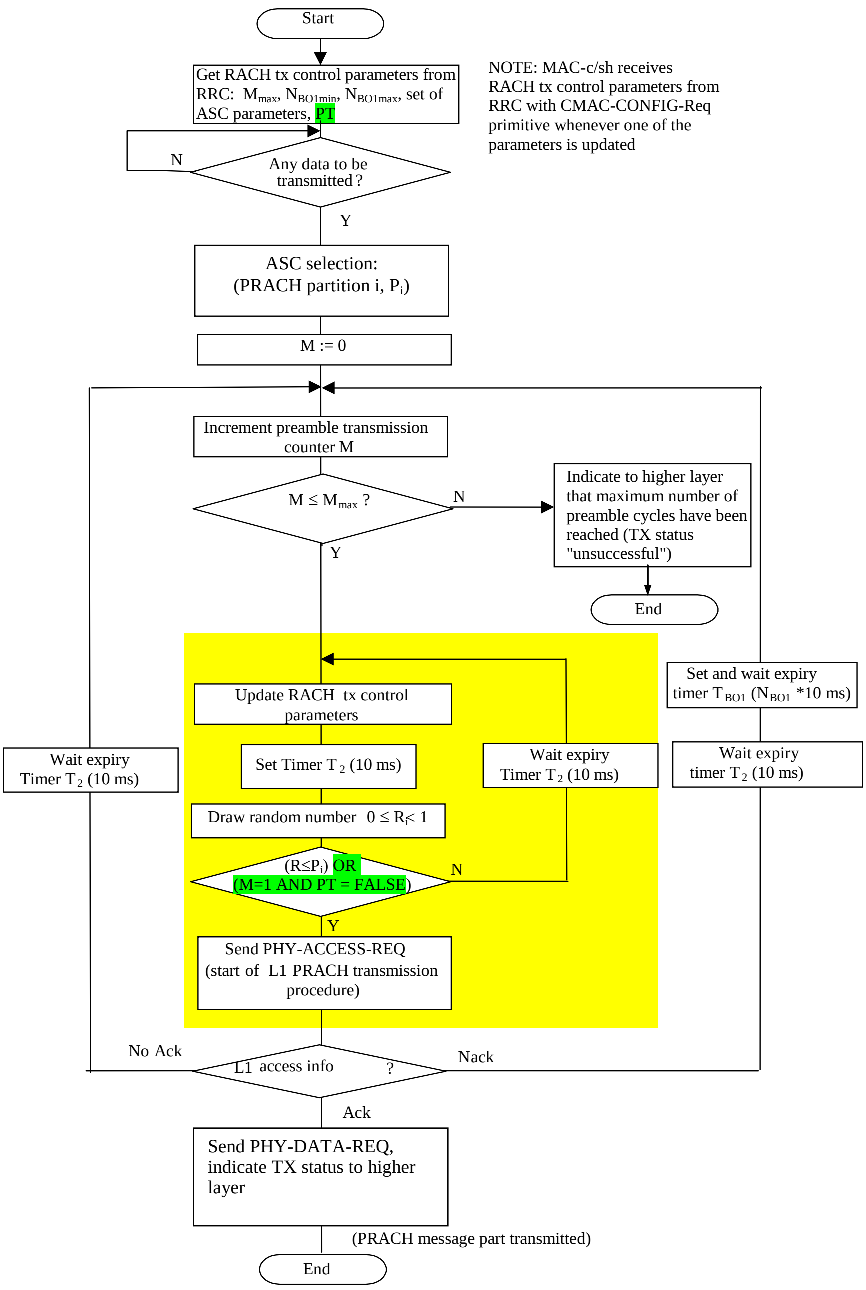

Figure 7.6.1-2: Proposed RACH transmission control procedure

And it should be set to "TRUE" for the remaining cases (for information):

- Emergency Call,

Note: The persistence value used for Emergency Call is always 1, thus persistence test will always succeed and therefore no changes are required for Emergency Call.

- Inter-RAT cell re-selection,
- Inter-RAT cell change order,
- Registration, Detach,
- Originating High Priority Signalling,
- Originating Low Priority Signalling,

- Terminating High Priority Signalling,
- Terminating Low Priority Signalling,
- Terminating – cause unknown, MBMS reception, MBMS ptp RB request

Also it could be useful to not be perform the persistence test (i.e. "PT = FALSE) before the start of the first L1 transmission (i.e. PT should be "FALSE") in the case user plane data or other RRC messages are transmitted, because the trigger for the RACH procedure in different UEs should be relatively independent.

7.7 Enhancements to RRC Connection Establishment Procedure

This subclause addresses possible delay optimizations to the RRC connection establishment as specified in TS 25.331. This delay is part of the delay as described in subclause 6.1.1

7.7.1 Enhanced measurement procedure during RRC connection establishment

In case of fast changing channel conditions during the RRC connection establishment (e.g. due to a high UE velocity or "street corner effects" or limited coverage of the frequency) UEs might not receive the RRC connection setup message from UTRAN, either because the RRC connection request did not reach the UTRAN or the RRC connection setup did not reach the UE.

During the RRC connection establishment period, it could be beneficial for the UE to perform inter-frequency or inter-RAT measurements in order to be prepared for a potential inter-frequency or inter-RAT cell reselection upon T300/T318 expiry, especially in case the channel conditions on the current frequency do not allow to successful finalization the RRC connection establishment.

Further, it could be beneficial to perform measurements during this period and send a measurement report to UTRAN immediately after the RRC connection setup complete, based on UTRAN configuration. This would give UTRAN some knowledge about the latest channel conditions for a potential handover right after the RRC connection establishment.

In Rel-6 specification, as long as timer T300/T318 is running, a single receiver UE is bound to continuously monitor the S-CCPCH/FACH and is therefore not capable of performing any inter-frequency or inter-RAT measurements.

Mechanisms should be studied which enable the UE and UTRAN to calculate frames during which UE is allowed to stop monitoring FACH and perform configured inter-frequency or inter-RAT measurements, prior to the reception of the RRC connection setup message.

It should be investigated what delay such a mechanism might add in case of full coverage, i.e. good channel conditions, as the UTRAN would not be able to send the RRC connection Setup message of every FACH frame, but only on those, which are not used by the UE for the measurements. Details for the required signaling between UE and UTRAN should be studied.

7.7.2 Early Sending of Initial direct transfer

In Rel-6, the UE starts to send Initial Direct Transfer on SRB#3 after receiving the RRC Connection Setup message and submitting the RRC Connection Complete to the lower layers.

To avoid delay introduced by RTT of the RRC Connection Request and RRC Connection Setup message, the Initial Direct Transfer could potentially be sent as concatenated to RRC Connection Request [R2-060366] or allow the UE to start sending Initial Direct Transfer message on CCCH immediately after sending RRC Connection Request message in separate CCCH transmission [R2-060580] [R2-061317].

Before both enhancements can be further assessed following issues has been identified to require further study:

1) Message size constrains in CCCH in RACH

2) RACH load and Uplink coverage

3) Error scenarios in call establishment flow

7.7.2.1 Error scenarios for early sending the IDT in separate CCCH transmission

1) Unsuccessful Early Transmission of IDT

The confirmation in the RRC Connection Setup message is also used to handle unsuccessful transmission of this early IDT on CCCH and to transmit the normal IDT on DCCH. If the UTRAN does not receive the IDT on CCCH before sending RRC CONNECTION SETUP, it indicates to the UE that the IDT on CCCH was not correctly received so that the UE sends the conventional IDT on DCCH after the RRC CONNECTION SETUP COMPLETE message. The UE does not transmit an early IDT after reception of the RRC CONNETION SETUP message. In this procedure, since the early IDT failed, call setup delay cannot be reduced by the early IDT.

2) Transmission of Early IDT after Unsuccessful Transmission of RRC CONNECTION REQUEST

If RRC CONNECTION REQUEST is unsuccessfully transmitted and Early IDT is successfully transmitted, the UE will send RRC CONNECTION REQUEST again after T300 expiry. In this case, it is proposed that the UE shall send RRC CONNECTION REQUEST and the early IDT again regardless of successful transfer of the previous early IDT. Thus, UTRAN should ignore the early IDT received before successfully receiving RRC CONNECTION REQUEST.

If UE performs cell re-selection after sending RRC CONNECTION REQUEST, the UE sends RRC CONNECTION REQUEST and the early IDT again.

3) Handling of Duplicated Early IDT messages

If the IDT is early transmitted before completion of the RRC connection establishment, whenever an RRC CONNECTION REQUEST message is transmitted due to cell re-selection or timer expiry i.e. the MAC layer indicates successful transmission of an RRC CONNECTION REQUEST message, an early IDT will be transmitted again. In this case, CN may receive duplicated NAS messages e.g. SERVICE REQUEST message. This duplication is avoided by UTRAN waiting until being ready to send the RRC CONNECTION SETUP message before routing the early IDT to CN. This causes re-imposes some delay on the transmission of the contents of the Initial Direct Transfer on the Iu interface.

4) Physical failures and invalid messages

After the RRC CONNECTION SETUP message is transmitted, a physical channel failure could occur. Also, a UE could receive an invalid RRC CONNECTION SETUP or RRC CONNECTION REJECT message. In this case, the UE will re-try to request a RRC connection. Thus, an early IDT message will be transmitted again and so the NAS message in the early IDT may be routed to the CN. The CN may be able to found out duplication of the NAS message.

5) Rejection of RRC Connection Request

The UTRAN can reject the RRC Connection Request from the UE. In this case, the UTRAN does not to route the early IDT to CN.

6) Handling of Early IDT in legacy RNC

The use of the new initial direct transfer message on CCCH on RACH is ignored by any legacy RNC and the conventional Initial Direct transfer message is sent after the transmission of the RRC CONNECTION SETUP COMPLETE message.

The transmission of the conventional Initial direct transfer message will be suppressed by a corresponding indication from the RNC in the RRC Connection Setup message that confirms the correct reception of the Early Initial direct transfer message on the CCCH

8 Conclusions

8.1 Default Configurations

It was agreed in TSG RAN WG2 #51 to intro following default configurations:

1) Default configuration for the SRBs on HSDPA and HSUPA R2-060712 CR#2749,

2) Two default configurations for PS connections to speed up PS connection setup.

8.2 Stored Configurations

It was concluded in TSG RAN WG2 #51 not to adopt stored configurations functionality as described in subclause 7.2.

8.3 Configurations for RB and SRB

Introduced new reference configurations are defined in subclause 7.3.2.

8.4 Enhancements to System Information Broadcast

8.4.1 Reducing the SIB7 reading time

It was concluded in TSG RAN WG2 #51 not to adopt any of the solutions described in subclause 7.4.1 to reduce SIB7 reading.

8.4.2 Reducing the SIB11 reading time in CELL_DCH to CELL_FACH

It was concluded in TSG RAN WG2 #54 to allow relaxation to SIB11 reading as described in 7.4.2 and R2-062312 and consider default RACH reporting as described in R2-062358 for Rel-7. The stage-3 CR is defined in TEI7.

8.5 Avoiding Activation time in Reconfiguration

8.5.1 Utilising Hard Handover

It was concluded in TSG RAN WG2 #54 not to adopt solution described in 7.5.1 to avoid activation time by using hard handover.

8.5.2 Utilising Synchronization via Change of Uplink Scrambling Code

It was concluded in TSG RAN WG2 #54 to adopt the solution described in 7.5.2 to avoid activation time in reconfiguration and introduce necessary CRs to NBAP, RNSAP specifications for Rel-7.

8.5.3 Extending the Utilisation of RRC Connection Setup Message

It was concluded to add new call type indications: CS speech , CS 64kbps video and CN domain indicator to 25.331 in Rel-6, with additional clarification added to the RRC connection establishment procedure that, upon receiving the RRC connection setup message including a default configuration, the UE ignores the RB information corresponding with RABs (but considers the transport and physical channel information).

The same call type indication was added to the Cell Update message in Rel-7.

8.6 Enhancements on RACH

8.6.1 Optimization of RACH Transmission Control procedure

It was concluded in TSG RAN WG2 #53 not to adopt the solution described in 7.6.1 for the RACH transmission procedure.

8.7 Enhancements to RRC Connection Establishment Procedure

7.7.1 Enhanced measurement procedure during RRC connection establishment

It was concluded in TSG RAN WG2 #54 to assess the possibilities to introduce inter frequency and inter RAT measurement gaps for the case when UE is waiting RRC Connection Setup message, in the potential separate work item which address improvements to DL reception in CELL_FACH state.

8.7.2 Early Sending of Initial direct transfer

It was concluded in TSG RAN WG2 #54 not to adopt any solution described in 7.7.2 to introduce early sending of Initial Direct Transfer message.

9. Recommendations

9.1 Reducing the SIB7 reading time

To avoid extensive SIB7 reading times in call establishment phase, it is recommended that 160ms is the longest SIB7 scheduling period used by UTRAN.

Additionally it is recommended that UTRAN uses long expiration time for the SIB7.

Annex A: Change history

Document history		
Date	**Version**	**Comment**
2005-04	V 0.0.0	First skeleton proposed for RAN2 #46bis
2005-05	V 0.1.0	Scope of the document updated based comments in RAN2 46bis. Not controversial cases to be analysed included in clause 6. The general definitions for default configuration and stored configurations are included in clause 7 Subclause for Configurations for RB and SRBs is created.
2005-05	V 0.2.0	The mechanism for Stored Configuration updated. Scenarios for delay analyse updated
2005-05	V 0.2.1	Corrections based on comments to the version V0.2.0 after email review on RAN2 reflector.

Document history		
Date	**Version**	**Comment**
2005-09	V 0.3.0	The delay analysis of RRC connection setup and Mobile originated CS AMR call utilising both CELL_DCH and CELL_FACH state for setup signalling introduced based on R2-051916. Update in Ch. 7.1: CR on introducing default configurations to RB Setup was agreed (R2-052284 CR 2676).
2005-10	V 0.3.1	The reference time point for PS call setup is clarified The list of new reference configuration introduced in 25.993 is updated
2005-11	V 0.4.0	Possible enhancements to reduce SIB7 and SIB11 reading time included Possible enhancements to avoid activation time in call establishment included Possible optimisation for RACH transmission control procedure included
2005-11	V 0.4.2	Subclause 7.4.1 updated based comments received on RAN2 reflector. To be presented in TSG-RAN #30 for information.
2006-02	V 0.5.2	Subclause 7.7 added to capture Enhancements to RRC Connection Establishment Procedure Subclauses 8.1-8.5 added to capture conclusions proposed enhancements included in 8.1-8.5 Subclause 9.1. added to capture recommendation on Reducing the SIB7 reading time
2006-05	V 0.6.0	Clause 5 added timing requirements for state transitions and call establishment. Subclause 6.1 added analysis for RRC Connection establishment and PS Call setup using HS-DSCH and E-DCH. Subclauses 7.5.3 and 8.5.3 documented addition of CS call type to Cell Update message. Subclause 7.2.2 added further analysis of error cases on Early IDT transmission (separate RRC connection request and IDT method). Subclause 8.6.1 added conclusion on RACH transmission procedure from 7.6.1.
2006-05	V 0.6.1	Delay analyses in 6.1.3 clarified.

Document history		
Date	**Version**	**Comment**
2006-08	V 0.7.0	Conclusion added on: 1) Relaxing SIB11 reading time 2) Utilisation of HHO, and scrambling code for avoiding activation time in reconfiguration 3) Enhanced measurement procedure during RRC connection establishment procedure 4) Early sending of Initial Direct Transfer message. To be presented in TSG-RAN #33 for approval.
2006-08	V 0.7.1	After the review of RAN WG2 #54 and approved for presentation for approval.
2006-09	V 2.0.0	Table numbering corrected. Identical clean version from 0.7.1

Change history							
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**Old**	**New**
09/2006	RP-33	RP-060605			Approved at TSG-RAN #33 and placed under Change Control	2.0.0	7.0.0