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*Technical Report*

## 3rd Generation Partnership Project;
## Technical Specification Group Radio Access Network;
## Radio Link Timing Adjustment
## (Release 5)

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Postal address

3GPP support office address

650 Route des Lucioles - Sophia Antipolis
Valbonne - FRANCE
Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Internet

http://www.3gpp.org

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# Foreword

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

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Version x.y.z

where:

x the first digit:

1 presented to TSG for information;

2 presented to TSG for approval;

3 or greater indicates TSG approved document under change control.

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

z the third digit is incremented when editorial only changes have been incorporated in the document.

# 1 Scope

The purpose of the present document is to help the TSG RAN WG3 group to specify the changes to existing specifications, needed for the introduction of the Radio Link Timing Adjustment worktask., as proposed in [1].

The document describes the agreed requirements related to the worktask, the different areas that were studied, the agreements that were made, and it identifies the affected specifications with related Change Requests. It also describes the schedule of the worktask.

The present document is a 'living' document, i.e. it is permanently updated and presented to all TSG-RAN meetings.

# 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 and/or edition number or version number) 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] RP-010261: "Radio Link Timing Adjustment; Work Item Description", submitted at TSG RAN#11 (http://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_11/Docs/PDFs/).

[2] R1-010135: "RL timing adjustment by UTRAN; Answer to LS R3-00-2726 (R1-00-1334)" (http://www.3gpp.org/ftp/TSG_RAN/WG3_Iu/TSGR3_18/Docs/).

[3] 3GPP TS 25.133: "Requirements for support of radio resource management (FDD)".

[4] 3GPP TS 25.214: "Physical layer procedures (FDD)".

[5] 3GPP TS 25.215: "Physical layer; Measurements (FDD)".

[6] 3GPP TS 25.331: "Radio Ressource Control (RRC) protocol specification".

[7] 3GPP TS 25.423: "UTRAN Iur Interface RNSAP Signalling".

[8] 3GPP TS 25.433: "UTRAN Iub Interface NBAP Signalling".

# 3 Definitions, symbols and abbreviations

## 3.1 Definitions

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

## 3.2 Symbols

None.

## 3.3 Abbreviations

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

| | |
|---|---|
| AM | Acknowledged Mode |
| DCCH | Dedicated Control Channel |
| DL | Downlink |
| DPCCH | Dedicated Physical Control Channel |
| DPCH | Dedicated Physical Channel |
| DPDCH | Dedicated Physical Data Channel |
| L1 | Layer 1 |
| NBAP | Node B Application Part |
| P-CCPCH | Primary Common Control Physical Channel |
| RL | Radio Link |
| RLC | Radio Link Control |
| RLS | Radio Link Set |
| RNC | Radio Network Controller |
| RRC | Radio Resource Control |
| SAP | Service Access Point |
| SRNC | Serving Radio Network Controller |
| UE | User Equipment |
| UL | Uplink |
| UM | Unacknowledged Mode |
| UMTS | Universal Mobile Telecommunications System |
| UTRAN | Universal Terrestrial Radio Access Network |

# 4 Introduction

WG1 expressed (outgoing liaison R1-010135) that in the event of RL adjustment being required, the Rel99/Rel4 process of deleting and re-establishing a RL temporarily causes additional DL interference in one or more cells due to loss of macro-diversity gain. In addition it slightly increases the risk of dropped calls. Therefore RAN WG1 asked RAN WG3 to consider implementing a RL adjustment procedure for a future release.

The present document investigates the possibility to execute a timing adjustment of one individual RL, typically one of several RLs in the active set.

# 5 Requirements

The following requirements are identified:

1) It shall be possible for the SRNC to execute a timing adjustment of one individual radio link by means of reconfiguring it.

# 6 RAN3 Study areas

## 6.1 General

This subclause of the technical report presents the investigation made by TSG RAN3 on relevant issues brought forward by the Radio Link Timing Adjustment work item and describes thoroughly possible solutions that are considered feasible by the working group.

## 6.2 Introduction to Radio Link Timing Adjustment: background and discussion

### 6.2.1 WG1 specification (TS 25.214 and TS 25.215)

In WG1 specification TS 25.214 V3.6.0/V4.0.0, the possibility of adjusting the transmission timing is described as follows:

**TS 25.214 V3.6.0/V4.0.0:**

2002.2.1.X Transmission timing adjustments

During a connection the UE may adjust its DPDCH/DPCCH transmission time instant.

If the receive timing for any downlink DPCCH/DPDCH in the current active set has drifted, so the time between reception of the downlink DPCCH/DPDCH in question and transmission of uplink DPCCH/DPDCH lies outside the valid range, L1 shall inform higher layers of this, so that the network can be informed of this and downlink timing can be adjusted by the network.

Therefore, it is expected that Node B can adjust the downlink transmission time of DPCH.

For this purpose, the following UE measurement is defined in TS 25.215 V3.6.0/V4.0.0:

**TS 25.215 V3.6.0/V4.0.0**

2002.2.1.X UE Rx-Tx time difference

| | |
|---|---|
| **Definition** | The difference in time between the UE uplink DPCCH/DPDCH frame transmission and the first detected path (in time), of the downlink DPCH frame from the measured radio link. Type 1 and Type 2 are defined. For Type 1, the reference Rx path shall be the first detected path (in time) amongst the paths (from the measured radio link) used in the demodulation process. For Type 2, the reference Rx path shall be the first detected path (in time) amongst all paths (from the measured radio link) detected by the UE. The reference path used for the measurement may therefore be different for Type 1 and Type 2. The reference point for the UE Rx-Tx time difference shall be the antenna connector of the UE. Measurement shall be made for each cell included in the active set. |
| **Applicable for** | Connected Intra |

It can be understood that the type 1 is defined for timing adjustment and the type 2 is defined for UE positioning. Therefore the UE measures the "UE Rx-Tx time difference" and reports it to the SRNC in order that the SRNC can check the timing and can determine the timing adjustment.

### 6.2.2 WG2 specification (TS 25.331)

The UE can perform the previously described measurement (UE Rx-Tx time difference) and report it to the SRNC as described in TS 25.331:

**TS 25.331 V3.6.0/V4.0.0**

2002.2.1.X Reporting event 6F: The UE Rx-Tx time difference for a RL included in the active set becomes larger than an absolute threshold.

When this event is ordered by UTRAN in a MEASUREMENT CONTROL message, the UE shall send a MEASUREMENT REPORT message when the UE Rx-Tx time difference becomes larger than the threshold defined by the IE "UE Rx-Tx time difference threshold".

2002.2.1.X Reporting event 6G: The UE Rx-Tx time difference for a RL included in the active set becomes less than an absolute threshold.

When this event is ordered by UTRAN in a MEASUREMENT CONTROL message, the UE shall send a MEASUREMENT REPORT when the UE Rx-Tx time difference becomes less than the threshold defined by the IE "UE Rx-Tx time difference threshold".

If the SRNC determines the DL timing adjustment, then the SRNC can signal this DL timing adjustment using Reconfiguration messages including the *DPCH frame offset* IE.

**TS 25.331 v3.6.0/v4.0.0**

2002.2.1.X PHYSICAL CHANNEL RECONFIGURATION

This message is used by UTRAN to assign, replace or release a set of physical channels used by a UE:

- RLC-SAP: AM or UM.
- Logical channel: DCCH.
- Direction: UTRAN → UE.

| | | | | |
|---|---|---|---|---|
| Downlink information per radio link list | OP | 1 to <maxRL> | | Send downlink information for each radio link |
| >Downlink information for each radio link | MP | | Downlink information for each radio link 10.3.6.27 | |

2002.2.1.X Downlink information for each radio link

| | | | | |
|---|---|---|---|---|
| Downlink DPCH info for each RL | OP | | Downlink DPCH info for each RL 10.3.6.21 | |

2002.2.1.X Downlink DPCH info for each RL

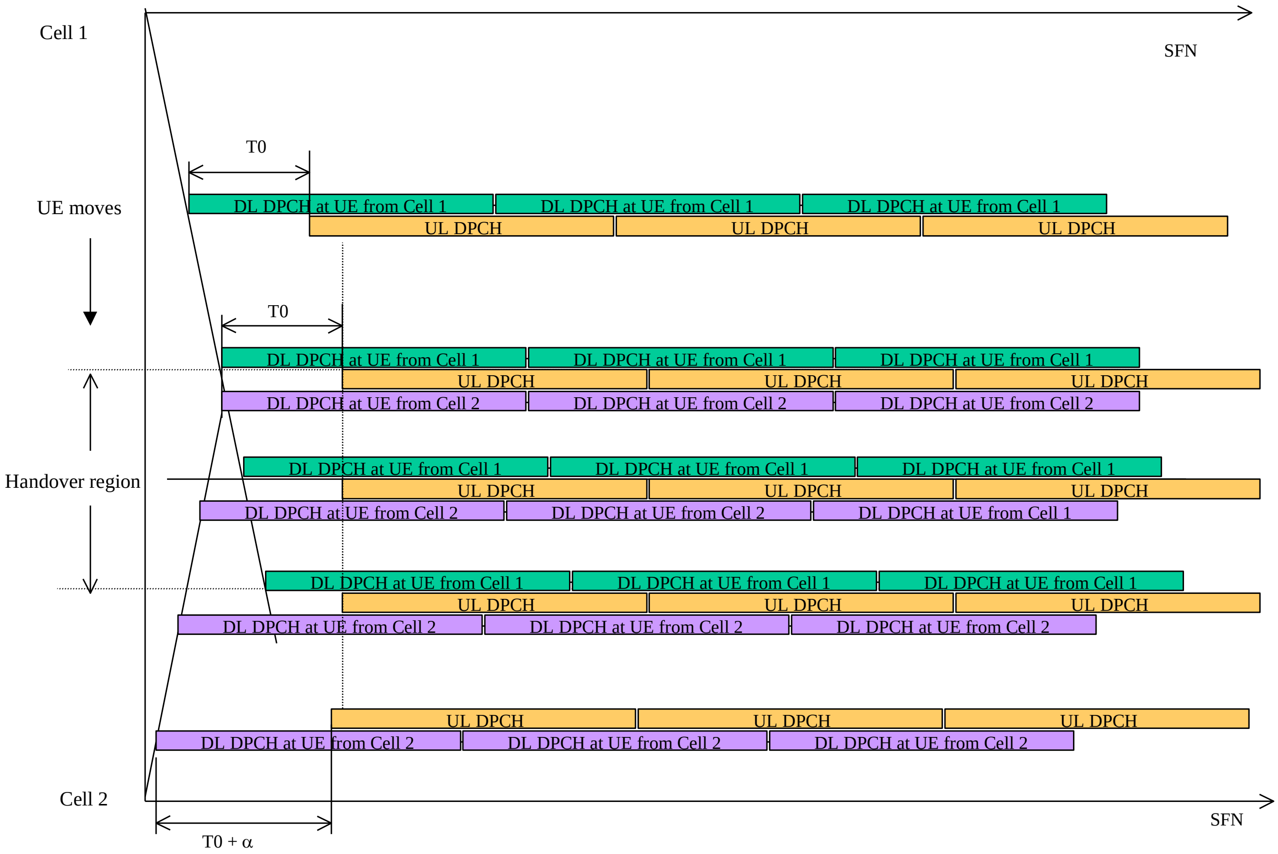
| | | | | |
|---|---|---|---|---|
| >>DPCH frame offset | MP | | Integer(0..38144 by step of 256) | Offset (in number of chips) between the beginning of the P-CCPCH frame and the beginning of the DPCH frame<br>This is called $\tau_{DPCH,n}$ in [26] |

### 6.2.3 WG3 specification (TS 25.423 and TS 25.433)

Currently, there is no RNSAP/NBAP message which contains any information about DL timing adjustment and therefore it is not possible for the SRNC to adjust the DL timing of a DPCH. It can be concluded that RNSAP/NBAP should support the DL DPCH timing adjustment based on the measurement "UE Rx-Tx time difference" for consistency with the WG1 and WG2 specifications.

## 6.3 Description of timing mechanisms

Figure 1 shows the timing relationship between DL DPCH and UL DPCH at UE side when UE moves from Cell 1 area to Cell 2 through the handover region. As it is shown in figure 1, it can be assumed that the time difference between DL DPCH and UL DPCH is T0 (1 024 chips). When the UE moves from Cell 1 area to the handover region, the time when DL DPCH arrives at UE is delayed as shown in figure 1. UE may adjust the UL DPCH transmission time to keep the T0 time offset but the requirement described in [3] should be fulfilled.




**Figire 1: DL DPCH and UL DPCH timing relationship of a UE**

When UE is in a handover region, UE may not be able to keep the T0 offset since there are more than one DL DPCH and the DL DPCHs have different delay as shown in figure1. Therefore it can be assumed that UE does not change the UL DPCH transmission time. When UE moves out of the handover region, the time difference between DL DPCH and UL DPCH is T0+α where α can be larger than 128chip. When α is larger than some threshold, UE reports it to SRNC and then SRNC may determine the DL DPCH transmission timing adjustment.

# 6.4 Overview of possible solutions

- The previous subclauses describe the mechanisms on which timing is based in 3GPP specifications and higlights both the fact that it is already stated in other working groups specifications that the network shall support the adjustment of the downlink DPCH timing and the fact that currently RAN3 specifications don't allow such adjustment.

## 6.4.1 Timing adjustment by means of combined DL and UL timing corrections

UE not in Soft Handover.

NOTE 1: The Non Soft Handover scenario is only described in the present document for the sake of simplicity when illustrating the adjustment mechanisms, as in normal operation, when only one radio link is present there is no need to adjust the timing. This could possibly only apply to USTS-capable Ues while in USTS mode.

CASE 1 (decrease UL/DL diff):

This is the case when the UE Rx-Tx time difference becomes larger than an absolute threshold, T0+ Δ (≡128chip) defined by the IE "UE Rx-Tx time difference threshold".

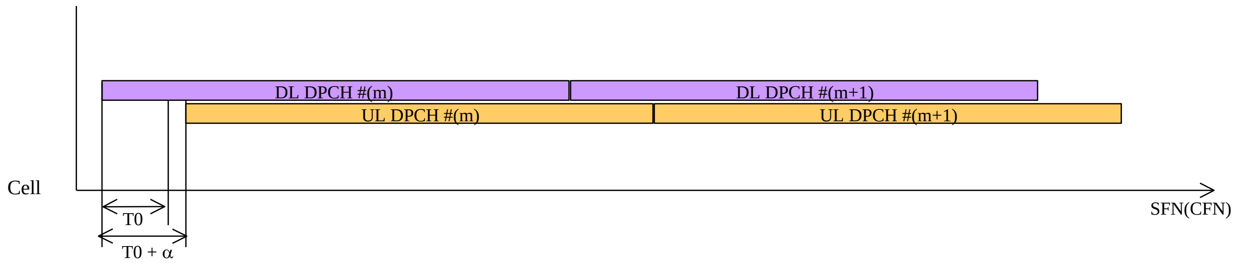



**Figure 2: DL DPCH and UL DPCH timing relationship at a UE side (T0< T0 + α)**

The case in which the time difference between DL DPCH and UL DPCH, T0+ α where α is larger than predefined threshold, 128 chip is shown in figure 2. When α is larger than 128 chip, UE reports it to SRNC and then SRNC may determine the DL DPCH transmission time adjustment.

SRNC may calculate and determine the Node B control factor, $\kappa$ from 1,2 with step size of 256 chip to put the adjusted time difference within the valid range. The determined Node B control factor shall be delivered to the Node B and the UE using RNSAP/NBAP and RRC messages such as RADIO LINK RECONFIGURATION PREPARE message and PHYSICAL CHANNEL RECONFIGURATION message, respectively. After receiving the control factor $\kappa$ through RADIO LINK RECONFIGURATION PREPARE message, Node B shall delay DL DPCH transmission time by amount of $256 \times \kappa$ chip.

As a result, the transmission time adjusted DL DPCH frame and its corresponding UL DPCH frame at UE transmission time aspects is shown in figure 3. Its dotted vertical line and solid vertical line are the starting point of $m^{th}$ DL DPCH before and after timing adjustment procedure, respectively, and their time difference on UE SFN(CFN) axis amounts to $256 \times \kappa$ chip. After timing adjustment, the time difference between DL DPCH and UL DPCH equals to $T0 + \alpha - 256 \times \kappa$ chip and satisfies the requirements for valid DPCH timing adjustment.

- $T0 - \Delta < T0 + \alpha - 256 \times \kappa < T0 + \Delta$.

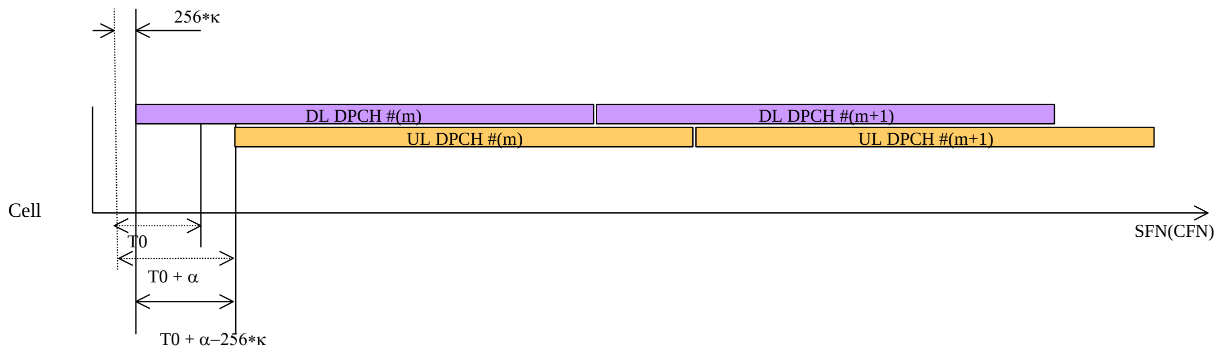



**Figure 3: DPCH timing adjustment by delaying DL DPCH at a Node B side**

CASE 2 (increase UL/DL diff):

This is the case when the UE Rx-Tx time difference becomes less than an absolute threshold, $T0 - \Delta$ ($\equiv$128 chip) defined by the IE "UE Rx-Tx time difference threshold".

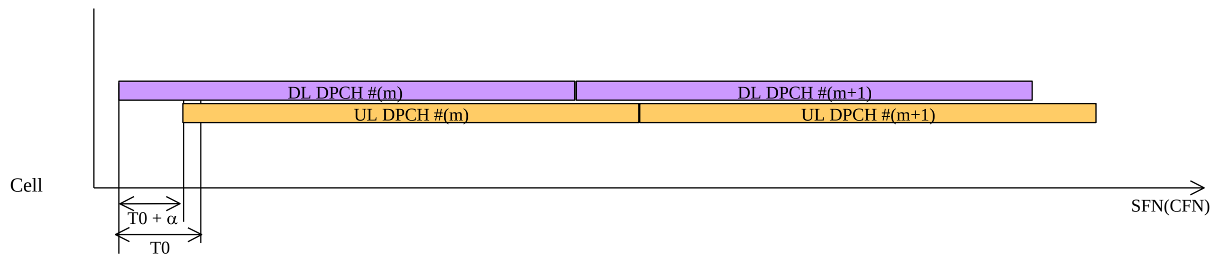



**Figure 4: DL DPCH and UL DPCH timing relationship at a UE side (T0> T0 + α)**

Figure 4 shows the case in which the time difference between DL/UL DPCHs, T0+α where α is less than predefined absolute threshold, 128 chip. When α is less than –128 chip, UE reports it to SRNC and then SRNC may determine the DL DPCH transmission timing adjustment.

SRNC may calculate UE control factor, $\upsilon$ with 'step_size' of 1, 4, 16, …, 256 chip, based on the measurements from UE to sustain valid time difference between DPCHs. The UE control factor by SRNC shall be delivered to the UE and the Node B using modified or new RRC and RNSAP/NBAP messages such as PHYSICAL CHANNEL RECONFIGURATION message and RADIO LINK RECONFIGURATION PREPARE message, respectively.

After receiving the control factor $\upsilon$ through PHYSICAL CHANNEL RECONFIGURATION message, the UE shall delay UL DPCH transmission time by the amount of 'step_size' × $\upsilon$ chip.

NOTE 2: The above parameters shall fullfil the constraint '$\upsilon$ × stepsize <= 256 chips'.

Figure 5 shows the DL DPCH frame and its corresponding and transmission time adjusted UL DPCH frame at UE transmission time aspects. Also, its dotted vertical line and solid vertical line are the starting point of $m^{th}$ UL DPCH before and after timing adjustment procedure, respectively. After timing adjustment, the time difference between DL DPCH and UL DPCH equals to T0 + α + 'step_size' × $\upsilon$ chip which satisfies the requirements for valid DPCH timing adjustment.

- $T0 - \Delta < T0 + \alpha + \text{'step\_size'} \times \upsilon < T0 + \Delta$.

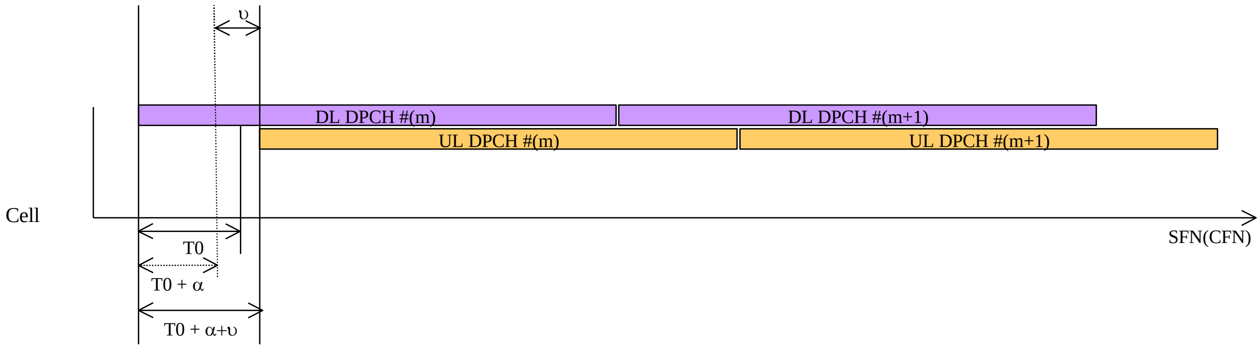



**Figure 5: DPCH timing adjustment by delaying UL DPCH at UE side**

UE in Soft Handover:

It is assumed that a UE has 2 paths, in a way of one path per a cell, from 2 cells as shown in figure 6 and their time differences satisfy following relations.

- $T0 + \alpha1 < T0$;
- $T0 < T0 + \alpha2$.

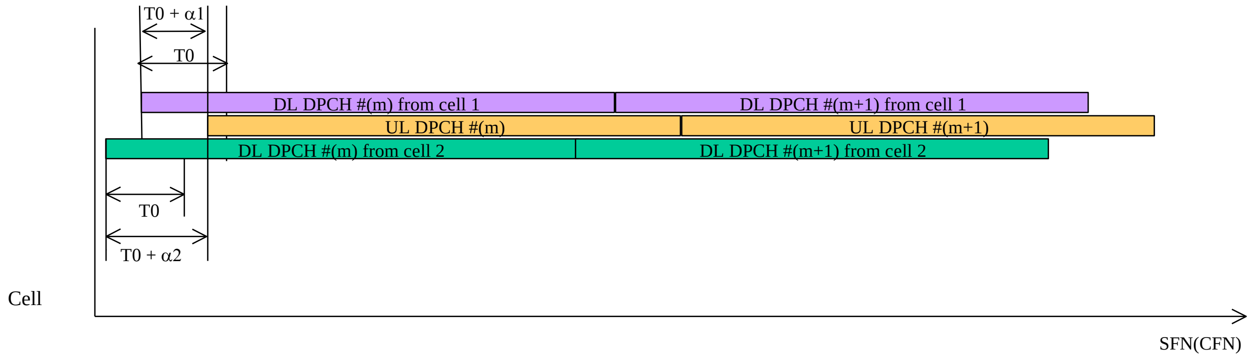



**Figure 6: DL DPCH and UL DPCH timing relationship at a UE side (T0 + $\alpha1$ < T0 < T0 + $\alpha2$ )**

Under the given condition, T0 + $\alpha1$ < T0, the advanced transmission for DL DPCH frame at Node B side, which may cause a loss in transferring data, shall be replaced by the delayed transmission for UL DPCH frame at UE side.

The delayed transmission for UL DPCH frame affects the time difference of DPCH between the UE and the other Node B. Hence, SRNC shall calculate new Node B control factor in consideration of the change in time difference by the previous timing adjustment for cell 1. And SRNC delivers newly calculated Node B control factor, $\kappa'$ to the Node B and the UE using modified RNSAP/NBAP and RRC messages such as RADIO LINK RECONFIGURATION PREPARE message and PHYSICAL CHANNEL RECONFIGURATION message, respectively. After receiving control factor $\kappa'$, Node B shall delay DL DPCH transmission time by amount of 256 × $\kappa'$ chip.

The transmission timing adjusted DL/UL DPCH frames at UE transmission time aspects are shown in figure 7 where dash-dotted vertical line and dotted vertical line are the starting point of $m^{th}$ UL DPCH frame and $m^{th}$ DL DPCH frame from cell 2, respectively, before timing adjustment procedure. After timing adjustment, the time difference between $m^{th}$ DL DPCH frame from cell 1 and $m^{th}$ UL DPCH frame equals to T0+ $\alpha1$ +'step_size' × $\upsilon$ chip between (T0 - $\Delta$ ) and (T0 + $\Delta$ ). Also, the time difference between $m^{th}$ DL DPCH frame from cell 2 and $m^{th}$ UL DPCH frame equals to T0 + $\alpha2$ - 256× $\kappa'$ chip which satisfies the requirements for valid DPCH timing adjustment like below.

- $T0 - \Delta < ( T0 + \alpha2 - 256 \times \kappa' ) = ( T0 + \alpha2 - 256 * \kappa + 'step\_size' \times \upsilon ) < T0 + \Delta$ .

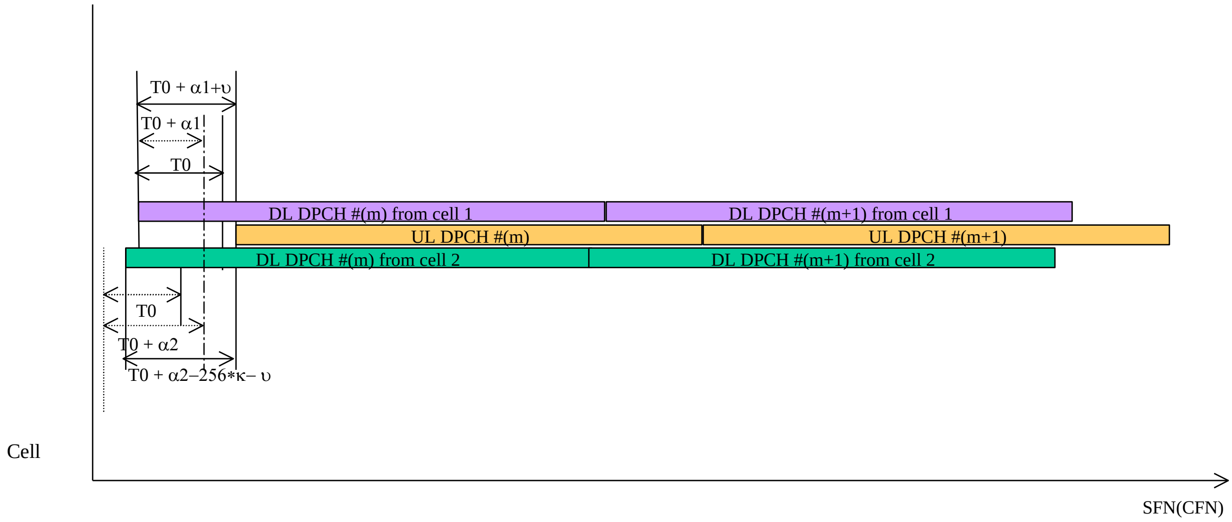



**Figure 7: DPCH timing adjustment by delaying UL/DL DPCH**

When the UE Rx-Tx time difference becomes less than T0 - $\Delta$ , SRNC calculates the UE control factor $\upsilon$ based on the decision rule and then makes the UL DPCH frame of a UE be delayed by 'step_size' × $\upsilon$ chip using modified PHYSICAL CHANNEL RECONFIGURATION message. This method can avoid the data loss effect which will be invoked by the advance of DL DPCH frame of a Node B.

## 6.4.2 Timing adjustment by means of DL timing corrections only.

This solution affects only the radio link whose timing needs to be adjusted and consists in always correcting the DL timing.

Direction of the timing adjustments.

Being this shifting a result of stocastic processes which are to be considered unpredictable, there is the same probability for a radio link to shift out from the receiving window in either direction. Therefore both positive and negative adjustments are needed.

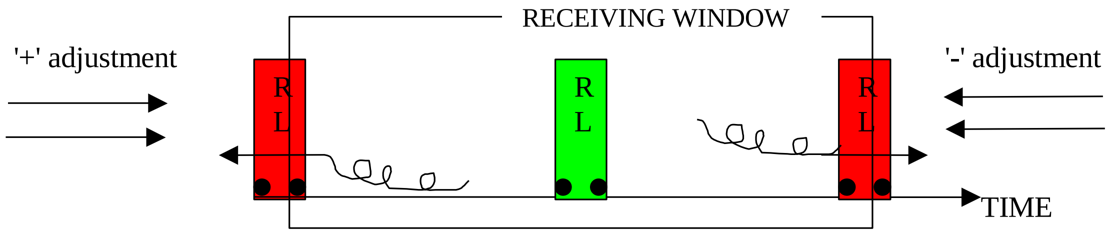



**Figure 8: Direction of the timing adjustments**

2002.2.1.X Range of the timing adjustments.

When the purpose of the timing adjustment is to bring a radio link back into the UE receiving window when it is shifting out from it, then an adjustment of ±256 chips is the one to adopt. The UE receiving window consists of 256 chips plus two 20-chip margin side bands. Therefore in order to adjust the timing of an individual RL to avoid it shifting out from the receiving window at the UE, 256 chips adjustments should be enough.

2002.2.1.X Preferable adjustment mechanism.

When discussing the adjustment mechanisms, it should be taken into consideration what elementary procedures currenly present in the specifications could support the feature (or if new procedures are needed) and by means of which information elements (new or already specified) this feature shall be realised.

It appears reasonable to enhance the Synchronised Radio Link Reconfiguration Preparation procedure in both NBAP and RNSAP. There is no need to specify new procedures nor to impact more procedures than these.

It seems appropriate, being the only needed adjustments 256 chips wide, to introduce a new information element that represents a relative shift of 256 chips in positive or negative direction. The figures below illustrate a possible outline of the solution.

| | | | | | | |
|---|---|---|---|---|---|---|
| **RL Information** | | *0..<max noofRLs >* | | | EACH | reject |
| >RL ID | M | | 9.2.1.53 | | – | |
| >DL Code Information | O | | FDD DL Code Information 9.2.2.14A | | – | |
| >Maximum DL Power | O | | DL Power 9.2.1.21 | Maximum allowed power on DPCH | – | |
| >Minimum DL Power | O | | DL Power 9.2.1.21 | Minimum allowed power on DPCH | – | |
| >SSDT Indication | O | | 9.2.2.47 | | – | |
| >SSDT Cell Identity | C–SSDTIndON | | 9.2.2.44 | | – | |
| >Transmit Diversity Indicator | C – Diversity mode | | 9.2.2.53 | | – | |
| >DL DPCH Timing Adjustment | O | | 9.2.1.x | Required RL Timing Adjustment | YES | reject |
| Transmission Gap Pattern Sequence Information | O | | 9.2.2.53A | | YES | reject |

The new Information Element could be defined as follows.

9.2.1.X DL DPCH Timing Adjustment.

This IE indicates the direction, positive or negative (with regards to the SFN timing), of the required Radio Link timing adjustment, which has always a size of 256 chips.

| IE/Group Name | Presence | Range | IE type and reference | Semantics description |
|---|---|---|---|---|
| DL DPCH Timing Adjustment | | | ENUMERATED (positive, negative) | The size of the timing adjustment is 256 chips. |

Based on the above discussion, it appears reasonable that the adjustments of the radio link timing shall be both positive and negative, as the concerned radio link could shift outside the receiver's window in either direction.

More over, it appears that the timing shall be corrected by 256 chips in order to move a radio link back into the UE reception window.

The preferred mechanism to perform the adjustment of the radio links timing shall then be, according to the arguments outlined above, to enhance the Synchronised Radio Link Reconfiguration Preparation in both NBAP and RNSAP by introducing a new information element indicating, by its presence, that a timing adjustment is required and, by its value, the direction of such correction (positive, negative).

### 6.4.3 Analysis of the described solutions

In the previous subclauses different solution for the problem of the radio link timing adjustment are described. This subclause aims to summarize the characteristics of the two solutions, their advantages and their possible drawbacks in order to ease the choice of the most beneficial option.

Throughout this subclause, the solution described in subclause 6.4.1 will be named 'Solution A' while the other one will be 'Solution B'.

| | SOLUTION 'B' | SOLUTION 'A' |
|---|---|---|
| decrease UL/DL diff | DL Tx change | DL Tx change |
| increase UL/DL diff | DL Tx change | UL Tx change |
| increase UL/DL diff | 1 RL affected | more RLs might be affected (one for UL, the others DL) |
| loss of data | some | none |
| delay of execution | lower | higher |

## 6.5 Open issues

None.

# 7 RAN2 Study areas

## 7.1 General

The R99 release of the RRC protocol includes signalling support for adjusting the downlink timing of radio links; all reconfiguration messages may include the IE "DPCH frame offset" for each of the radio links to be modified.

The R99 specification does not specify the UE behaviour upon DL RL timing adjustment. Although to a large extend this behaviour seems obvious, some clarification is needed as indicated in the following subclauses.

## 7.2 Changes required to TS 25.331

The "Default DPCH offset value" and the "DPCH frame offset" for the first RL concern the same timing information. Hence RRC specifies that the value of these IEs should have corresponding values. If this is not the case, the UE shall consider the requested configuration to be invalid.

This consistency check shall not only be performed when both parameters are included in the same message. The UE is required to store the "Default DPCH offset value" in a variable (DOFF) for later use. The only case in which the DOFF variable is re- used is the timing re- initialised hard handover; in case UTRAN does not signal the value the UE shall apply the stored value. If UTRAN does not provide a value and the UE does not have a DOFF value is stored, it shall apply value 0. In all these three cases (UE receives new value, UE applies stored value, UE applies 0) the UE shall perform the consistency check between DOFF and DPCH frame offset.

Currently it is not explicitly stated that the DOFF variable shall be updated to remain consistent with the actual DPCH frame offset for the 1st RL. E.g. in the (likely) case that DPCH frame offset of the 1st RL is changed upon a timing maintained hard handover (to compensate for differences in propagation delays), the UE is not require to update the DOFF variable. Considering that, the DOFF variable merely seems to be a number not directly related to the actual radio interface timing. This would suggest that the DOFF also need not be updated when the DPCH frame offset of the 1st RL is changed using another procedure, e.g. one that best meets the demands of the Release 5 work item on radio link timing adjustment.

NOTE: It should be noted that if the DOFF is in steps of 512 chips while the DPCH frame offset is in steps of 256 chips. The DL timing adjustments should be done in steps of 256 chips due to the UE window of ±148 chips. This means that the DOFF and the DPCH frame offset of the 1st RL anyhow can not remain exactly consistent.

There is a related ambiguity in R99, for which the preferred solution is to remove the DOFF variable. As stated in the previous, the proposal is that the procedure specification is updated to cover the (somewhat obvious) UE behaviour upon DL RL timing adjustment. Considering the previous, the proposal is not to specify that the UE shall update the DOFF variable. Rapporteur's note: the related R99 change can be found in RRC CR1286.

### 7.2.1 Action across border of value range

Some clarification is needed concerning the UE action when the "DPCH frame offset" value reaches the border of the value range. This is specified by means of an example provided in the following table. It shows the subsequent "DPCH frame offset" values for a certain RL as signalled by UTRAN. The proposed UE behaviour that is indicated in column "UE action" is based on the fact that only steps of 256 chips are valid.

| # | Value | UE action |
|---|---|---|
| 1 | 37888 | |
| 2 | 38144 | Adjust timing +256 chips |
| 3 | 0 | Adjust timing +256 chips |
| 4 | 38144 | Adjust timing -256 chips |

Since the UE action depends on a previously received IE value, a new variable may be needed to facilitate the procedure specification.

## 7.3 Conclusion and possible solution

The R99 release of the RRC protocol already provides signalling support for adjusting the downlink timing of radio links. However, the procedure specification needs to be updated to cover the UE behaviour upon RL timing adjustment and especially the UE action when the "DPCH frame offset" value reaches/ crosses the border of the value range.

Finally, as regards to the support of radio link timing adjustment by R99 UEs it should be noted that although the R99 signalling supports RL timing adjustment, the UE behaviour was not specified. Hence, one can not assume that the RL timing adjustment will work with R99 UEs.

### 7.3.1 Detailed changes to the RRC protocol

Subclause 8.2.2.3 of TS 25.331 needs to be modified as follows (needed additional text is highlighted in yellow):

8.2.2.3 Reception of RADIO BEARER SETUP or RADIO BEARER RECONFIGURATION or RADIO BEARER RELEASE or TRANSPORT CHANNEL RECONFIGURATION or PHYSICAL CHANNEL RECONFIGURATION message by the UE

The UE shall be able to receive any of the following messages:

- RADIO BEARER SETUP message; or
- RADIO BEARER RECONFIGURATION message; or
- RADIO BEARER RELEASE message; or
- TRANSPORT CHANNEL RECONFIGURATION message; or
- PHYSICAL CHANNEL RECONFIGURATION message;

and perform a hard handover, even if no prior UE measurements have been performed on the target cell and/or frequency.

If the UE receives:

- a RADIO BEARER SETUP message; or
- a RADIO BEARER RECONFIGURATION message; or
- a RADIO BEARER RELEASE message; or
- a TRANSPORT CHANNEL RECONFIGURATION message; or
- a PHYSICAL CHANNEL RECONFIGURATION message;

it shall:

- set the variable ORDERED_RECONFIGURATION to TRUE;
- perform the physical layer synchronisation procedure as specified in [29];
- act upon all received information elements as specified in subclause 8.6, unless specified in the following and perform the actions below.

The UE may first release the physical channel configuration used at reception of the reconfiguration message. The UE shall then:

- in FDD, if the IE "PDSCH code mapping" is included but the IE "PDSCH with SHO DCH Info" is not included and if the DCH has only one link in its active set:
  - act upon the IE "PDSCH code mapping" as specified in subclause 8.6; and
  - infer that the PDSCH will be transmitted from the cell from which the downlink DPCH is transmitted.
- enter a state according to subclause 8.6.3.3.

In case the UE receives a RADIO BEARER RECONFIGURATION message including the IE "RB information to reconfigure" that only includes the IE "RB identity", the UE shall:

- handle the message as if IE "RB information to reconfigure" was absent.

NOTE: The RADIO BEARER RECONFIGURATION message always includes the IE "RB information to reconfigure". UTRAN has to include it even if it does not require the reconfiguration of any RB.

If after state transition the UE enters CELL_DCH state, the UE shall, after the state transition:

- remove any C-RNTI from MAC;
- clear the variable C_RNTI.

If the UE was in CELL_DCH state upon reception of the reconfiguration message and remains in CELL_DCH state, the UE shall:

- if the IE "Uplink DPCH Info" is absent, not change its current UL Physical channel configuration;
- if the IE "Downlink information for each radio link" is absent, not change its current DL Physical channel configuration.
- if "DPCH frame offset" is included for one or more RLs in the active set, the UE shall
  - use its value to determine the beginning of the DPCH frame in accordance with the following:
    - if the received IE "DPCH frame offset" is across the value range border compared to the DPCH frame offset currently used by the UE, the UE shall consider it to be a request to adjust the timing with 256 chips across the frame border e.g. if the UE receives value 0 while the value currently used is 38144, the UE shall consider this as a request to adjust the timing with +256 chips
    - if after taking into account value range borders, the received IE "DPCH frame offset" corresponds with a request to adjust the timing with a step exceeding 256 chips:
      - set the variable INVALID_CONFIGURATION to FALSE;
      - and the procedure ends.
  - adjust the radio link timing accordingly.

If after state transition the UE enters CELL_FACH state, the UE shall, after the state transition:

- if the IE "Frequency info" is included in the received reconfiguration message:
  - select a suitable UTRA cell according to [4] on that frequency.
- if the IE "Frequency info" is not included in the received reconfiguration message:
  - select a suitable UTRA cell according to [4].
- if the received reconfiguration message included the IE "Primary CPICH info" (for FDD) or "Primary CCPCH info" (for TDD), and the UE selects another cell than indicated by this IE or the received reconfiguration message did not include the IE "Primary CPICH info" (for FDD) or "Primary CCPCH info" (for TDD):
  - initiate a cell update procedure according to subclause 8.3.1 using the cause "Cell reselection";
  - when the cell update procedure completed successfully:
    - if the UE is in CELL_PCH or URA_PCH state:
      - initiate a cell update procedure according to subclause 8.3.1 using the cause "Uplink data transmission";
      - proceed as below.
- start timer T305 using its initial value if timer T305 is not running and if periodical update has been configured by T305 in the IE "UE Timers and constants in connected mode" set to any other value than "infinity" in system information block type 1;
- select PRACH according to subclause 8.5.17;
- select Secondary CCPCH according to subclause 8.5.19;
- use the transport format set given in system information;

- if the IE "UTRAN DRX cycle length coefficient" is included in the same message:
  - ignore that IE and stop using DRX.
- if the contents of the variable C_RNTI is empty:
  - perform a cell update procedure according to subclause 8.3.1 using the cause "Cell reselection";
  - when the cell update procedure completed successfully:
    - if the UE is in CELL_PCH or URA_PCH state:
      - initiate a cell update procedure according to subclause 8.3.1 using the cause "Uplink data transmission";
      - proceed as below.

If the UE was in CELL_FACH state upon reception of the reconfiguration message and remains in CELL_FACH state, the UE shall:

- if the IE "Frequency info" is included in the received reconfiguration message:
  - select a suitable UTRA cell according to [4] on that frequency;
  - if the received reconfiguration message included the IE "Primary CPICH info" (for FDD) or "Primary CCPCH info" (for TDD), and the UE selected another cell than indicated by this IE or the received reconfiguration message did not include the IE "Primary CPICH info" (for FDD) or "Primary CCPCH info" (for TDD):
    - initiate a cell update procedure according to subclause 8.3.1 using the cause "cell reselection";
    - when the cell update procedure completed successfully:
      - proceed as below.

The UE shall transmit a response message as specified in subclause 8.2.2.4, setting the information elements as specified below. The UE shall:

- if the received reconfiguration message included the IE "Downlink counter synchronisation info":
  - re-establish RB2;
  - set the new uplink and downlink HFN of RB2 to MAX(uplink HFN of RB2 | downlink HFN of RB2) + 1;
  - increment by one the downlink and uplink HFN values for RB2;
  - calculate the START value according to subclause 8.5.9;
  - include the calculated START values for each CN domain in the IE "START list" in the IE "Uplink counter synchronisation info".
- if the received reconfiguration message did not include the IE "Downlink counter synchronisation info":
  - if the variable START_VALUE_TO_TRANSMIT is set:
    - include and set the IE "START" to the value of that variable.
  - if the variable START_VALUE_TO_TRANSMIT is not set and the IE "New U-RNTI" is included:
    - calculate the START value according to subclause 8.5.9;
    - include the calculated START values for each CN domain in the IE "START list" in the IE "Uplink counter synchronisation info".
- if the received reconfiguration message contained the IE "Ciphering mode info":
  - include and set the IE "Radio bearer uplink ciphering activation time info" to the value of the variable RB_UPLINK_CIPHERING_ACTIVATION_TIME_INFO.

- if the received reconfiguration message contained the IE "Integrity protection mode info" with the IE "Integrity protection mode command" set to "Modify":
  - include and set the IE "Uplink integrity protection activation info" to the value of the variable INTEGRITY_PROTECTION_ACTIVATION_INFO.
- if the received reconfiguration message did not contain the IE "Ciphering activation time for DPCH" in IE "Ciphering mode info":
  - if prior to this procedure there exist no transparent mode RLC radio bearers:
    - if, at the conclusion of this procedure, the UE will be in CELL_DCH state; and
    - if, at the conclusion of this procedure, at least one transparent mode RLC radio bearer exists:
      - include the IE "COUNT-C activation time" and specify a CFN value for this IE.
  - if prior to this procedure there exists at least one transparent mode RLC radio bearer:
    - if, at the conclusion of this procedure, no transparent mode RLC radio bearers exist:
      - include the IE "COUNT-C activation time" and specify a CFN value for this IE.
- set the IE "RRC transaction identifier" to the value of "RRC transaction identifier" in the entry for the received message in the table "Accepted transactions" in the variable TRANSACTIONS; and
- clear that entry;
- if the variable PDCP_SN_INFO is not empty:
  - include the IE "RB with PDCP information list" and set it to the value of the variable PDCP_SN_INFO.
- in TDD, if the procedure is used to perform a handover to a cell where timing advance is enabled, and the UE can calculate the timing advance value in the new cell (i.e. in a synchronous TDD network):
  - set the IE "Uplink Timing Advance" according to subclause 8.6.6.26.
- if the IE "Integrity protection mode info" was present in the received reconfiguration message:
  - start applying the new integrity protection configuration in the uplink for signalling radio bearer RB2 from and including the transmitted response message.

If after state transition the UE enters CELL_PCH or URA_PCH state, the UE shall, after the state transition and transmission of the response message:

- if the IE "Frequency info" is included in the received reconfiguration message:
  - select a suitable UTRA cell according to [4] on that frequency.
- if the IE "Frequency info" is not included in the received reconfiguration message:
  - select a suitable UTRA cell according to [4].
- prohibit periodical status transmission in RLC;
- remove any C-RNTI from MAC;
- clear the variable C_RNTI;
- start timer T305 using its initial value if timer T305 is not running and if periodical update has been configured by T305 in the IE "UE Timers and constants in connected mode" set to any other value than "infinity" in system information block type 1;
- select Secondary CCPCH according to subclause 8.5.19;

- if the IE "UTRAN DRX cycle length coefficient" is included in the same message:
  - use the value in the IE "UTRAN DRX Cycle length coefficient" for calculating Paging occasion and PICH Monitoring Occasion as specified in subclause 8.6.3.2.
- if the IE "UTRAN DRX cycle length coefficient" is not included in the same message:
  - set the variable INVALID_CONFIGURATION to TRUE.
- if the UE enters CELL_PCH state from CELL_DCH state, and the received reconfiguration message included the IE "Primary CPICH info" (for FDD) or "Primary CCPCH info" (for TDD), and the UE selected another cell than indicated by this IE or the received reconfiguration message did not include the IE "Primary CPICH info" (for FDD) or "Primary CCPCH info" (for TDD):
  - initiate a cell update procedure according to subclause 8.3.1 using the cause "cell reselection";
  - when the cell update procedure completed successfully:
    - the procedure ends.
- if the UE enters CELL_PCH state from CELL_FACH state, and the received reconfiguration message included the IE "Primary CPICH info" (for FDD) or "Primary CCPCH info" (for TDD), and the UE selected another cell than indicated by this IE:
  - initiate a cell update procedure according to subclause 8.3.1 using the cause "cell reselection";
  - when the cell update procedure is successfully completed:
    - the procedure ends.
- if the UE enters URA_PCH state, and after cell selection the criteria for URA update caused by "URA reselection" according to subclause 8.3.1 is fulfilled:
  - initiate a URA update procedure according to subclause 8.3.1 using the cause "URA reselection";
  - when the URA update procedure is successfully completed:
    - the procedure ends.

## 7.4 Open issues

None.

# 8 Agreements

The following conclusions were agreed:

1. The solution described in subclause 6.4.2 is considered the most feasible under RAN3 point of view and the one that best fulfils the requirements of this work item, therefore it is agreed that this solution will be adopted and specified in RAN3 TSs.

2. The solution described in clause 7 is considered feasible and appropriate by TSG RAN2 and it is agreed that it will be adopted and specified in RAN2 TSs.

# 9 Specification Impact and associated Change Requests

This clause lists places where Change request need to be given in order to enhance Release 4 specification to Release 5 specification for this work task.

**Table 1: Place where Change request is given in order to refer the new procedure**

| 3GPP TS | CR | Title | Remarks |
|---|---|---|---|
| 25.433 | 603 | Introduction of RL Timing Adjustment support | This CR was agreed at RAN3#27 |
| 25.423 | 564 | Introduction of RL Timing Adjustment support | This CR was agreed at RAN3#27 |
| 25.331 | 1291R1 | Radio link timing | This CR was agreed at RAN2 #27 |

# Annex A: Change History

| Change history | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Date** | **TSG #** | **TSG Doc.** | **CR** | **Rev** | **Subject/Comment** | **Old** | **New** |
| 03/2002 | 15 | - | - | | Approved at TSG RAN #15 and placed under Change Control | - | 5.0.0 |
| 06/2002 | 16 | RP-0204 | 001 | 1 | Correction of reference to a RAN4 specification | 5.0.0 | 5.1.0 |