3GPP TSG-RAN WG2#26 *R2-020088*
Sophia Antipolis, France, January 7 – 11, 2002

Agenda Item: 9.2.2

Source: Ericsson

Title: **Mobility examples when the UE has an HS-PDSCH assignment**

Document for: Discussion and decision

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1 Introduction

In [1], a categorisation of mobility related concepts and procedures have been proposed. This contribution illustrates a selection of these procedures as signalling message sequence examples. The message sequences are very similar to the sequences presently given in TS 25.303 and TS 25.931 for ordinary DCH handover cases.

One objective of this contribution is the identification of necessary modifications in the existing mobility procedures, which are implied by the incorporation of HS-DSCH in the CELL_DCH state.

Section 2 includes a discussion of some important mobility aspects. In Section 3 of this contribution, we consider the following examples:

- Intra-Node B synchronised serving HS-DSCH cell change:
  The serving HS-DSCH cell is changed without change of the active set. The same Node B controls source and target HS-DSCH cells.
- Inter-Node B synchronised serving HS-DSCH cell change during hard handover
  The serving HS-DSCH cell is changed in combination with, e.g., an inter-frequency hard handover, at a given activation time. Source and target HS-DSCH cell are controlled by different Node Bs.
- Inter-Node B synchronised serving HS-DSCH cell change after active set update (radio link addition)
  The serving HS-DSCH cell is changed subsequently after the addition of a new radio link to the active set. Source and target HS-DSCH cell are controlled by different Node Bs.

If agreement on the basic handover principles employed here can be achieved, it is straightforward to derive signalling message sequences for other conditions. The examples presented in the contribution are considered as a starting point to achieve a common understanding of the basic principles.

2 Discussion of mobility procedures

2.1 General aspects

Due to the similarity of DSCH and HS-DSCH it is straightforward to design the respective handover procedures alike.

In Release 99 and Release 4 support for the following DSCH handover scenarios is provided:

- Change of serving DSCH cell within the given active set;
- Hard handover comprised of following steps: DCH and DSCH resources are released in the source cell, a DCH is established in the target cell, DSCH is assigned in the new cell.

HS-DSCH handovers could be performed basically in the same way requiring only minor changes of the existing RRC connection mobility procedures in CELL_DCH state (i.e. Physical channel reconfiguration, Transport channel reconfiguration) as well as the respective NBAP/RNSAP procedures.

Due to existence of additional transmission queues in Node B MAC-hs, the question arises how to handle data contained in the buffers at handover. This issue is discussed further below.

2.2 Synchronized versus unsynchronised handover

The tx/rx timing of synchronized and unsynchronised handover is illustrated Figure 1. With regard to HS-DSCH transmission and reception, the following notation is assumed:

t_0: time instant where the handover decision in the network is made;

t_1: time instant where HS-DSCH service to a UE in the source cell (controlled by Node B 1) stops;

t_2: time instant where UE 1 stops listening to its assigned shared control channel and if necessary to its assigned HS-DSCH(s);

t_3: time instant where the UE starts listing in the target cell to HS-DSCH and associated control channels;

t_4: time instant where the target Node B is prepared to transmit to the UE on HS-DSCH;

ΔT_{sync}: time interval needed in the UE to synchronize to the target cell.

With regard to ΔT_{sync} three cases should be distinguished:

1) Radio links exist in both the source and the target cell for dedicated physical channels. In this case the necessary synchronization time can be minimized, i.e. possibly $\Delta T_{sync} = 0$ can be achieved.

2) The radio link of the target HS-DSCH cell is added to the active set. In this case a synchronization time ΔT_{sync} as required for ordinary radio link addition procedure results.

3) The radio link(s) of the target cell is established on a new frequency. In this case the synchronization time ΔT_{sync} amounts to what is required for performing an ordinary hard handover.

Synchronised serving HS-DSCH cell change shall be defined as a handover where $t_1 = t_2 = t_4$, as outlined in Figure 2.

For unsynchronised serving HS-DSCH cell change no such timing relation between UE and UTRAN can be guaranteed. Stop and start of transmission/reception in the source and target cells are performed as early as possible after reception of the respective reconfiguration commands.

Synchronization between the UE and the network is currently achieved with activation timers. The activation timer settings are selected by RRC in SRNC and communicated to the involved UE and Node B(s). Due to unknown delays on the Iur/Iub interfaces, processing and protocol delays, however, a suitable margin may need to be taken into account in the choice of timer setting. This may result in longer handover delay than can be achieved with unsynchronised procedures.

Handover delay, ΔT_{HO}, could be defined as the time interval starting at t_0, where the handover decision is made, until the UE receiver is ready to receive *and* the Node B is ready to transmit, i.e. $\Delta T_{HO} = \max(t_3, t_4) - t_0$.

Figure 2 illustrates that transmissions in the hatched time interval ΔT_{sync}, would not be received by the UE. However, to optimise performance, the scheduler could delay data transmissions in order to give the UE suitable time to obtain synchronization.

Unsynchronized handover minimizes the handover delay ΔT_{HO} but it is generally more difficult to obtain knowledge about the exact time instant when both UE and the network are ready for transmission and reception, and thus being able to avoid transmissions before the receiver is ready.

Therefore unsynchronized handover is mostly suitable for instance for active set update with radio link addition where communication is ensured on the old radio links while a new link is set up.

Concerning HS-DSCH handover it is obviously most appropriate to employ a synchronized scheme. This ensures that transmissions in the source cell can be accomplished until the required resources in the target Node B are prepared. The synchronized switching in UE and Node B ensures optimal performance. Requirements regarding the UE synchronization time ΔT_{sync} are to be defined however (this requires involvement of RAN1 and RAN4). Signalling sequences for synchronized serving HS-DSCH cell change within the active set is outlined in Section 3.1.

When a radio link is added to the active set it can be regarded as unlikely that the added cell immediately also becomes the one best suited for HS-DSCH service. Therefore, a setup of a new radio link combined with a direct change of the serving HS-DSCH cell to this new link is probably not needed. In Section 3.3 an example of a two-step handover procedure is outlined, which is comprised of a radio link addition in the first step, and synchronized serving HS-DSCH cell change in the second step.

An alternative direct setup of HS-DSCH at active set update could be added if justified by performance gains.

The question arises whether this principle of using a two-step procedure is also adequate in case of a hard handover (e.g. interfrequency handover). As a third example given in Section 3.2, we have outlined an example of hard handover for a UE with HS-DSCH assignment. In this case it suffices to apply a two-step procedure in the transport network signalling only, where in the first step the new radio link is setup the target Node B and in the second step the synchronized serving HS-DSCH cell change is prepared. This example is applicable with the existing NBAP/RNSAP procedures. Optimization of the NBAP/RNSAP signalling will be possible and shall be considered by RAN3.

On the radio interface, however, the hard handover can be handled with only a single reconfiguration message. This example should be applicable in Release 99 already when hard handover is performed for a UE with DSCH assignment.

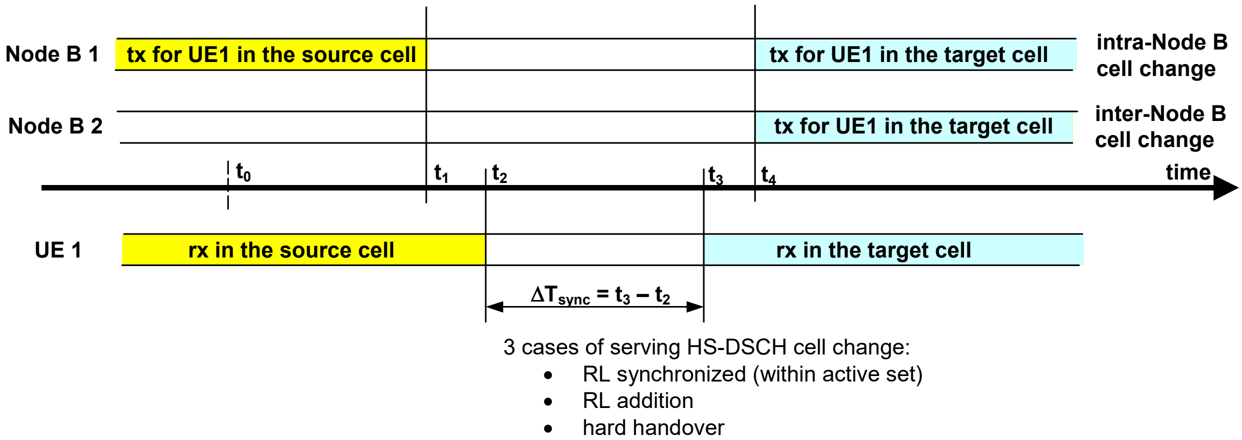

Figure 1: Illustration of timing relationships at serving HS-DSCH cell change

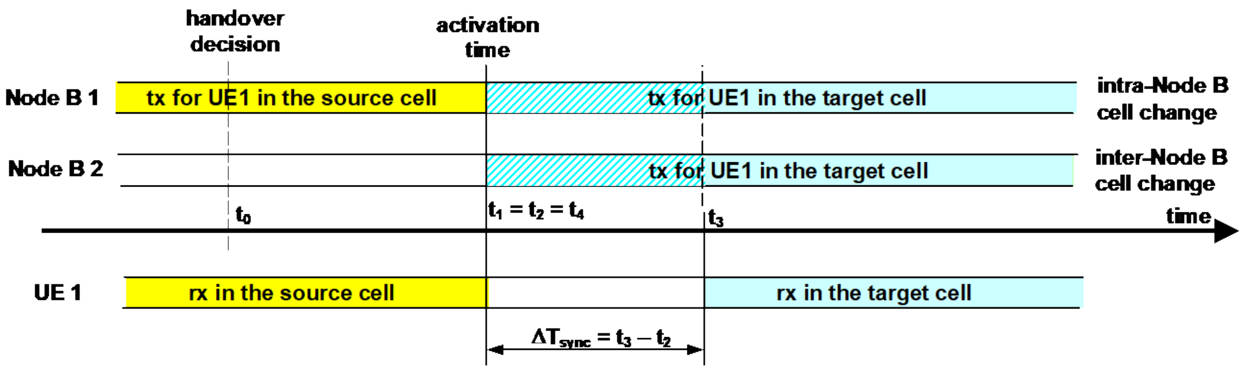

Figure 2: Timings at synchronized serving HS-DSCH cell change

2.3 HARQ buffer management issues

In certain handover scenarios provision of information on HARQ transmit buffer status by the source Node B to the RLC entity in SRNC may be useful to avoid unnecessary double transmissions or to minimize the round trip delay. Such issues were addressed in [3].

At the previous meeting it has been agreed, that in case of AM RLC mode, the polling function should be utilized to obtain the status of the data transmission to the UE on RLC level.

A complete reset of MAC-sh entities in both the UE and the Node B can be regarded as the simplest means of buffer management. Advanced HARQ buffer management would be required only in case of inter-Node B serving HS-DSCH cell changes. In the intra-Node B case, the MAC-hs entity normally does not need to be re-initialised (both in Node B and the UE).

The issue of HARQ buffer management can be seen as one part of a more generalized “MAC-hs relocation” function, which addresses the exchange of MAC-hs status information between between UE and the UTRAN and between different Node Bs.

We suggest that as the first step of HS-DSCH mobility we shall focus on design of simple handover schemes, which do not rely on advanced buffer management. Such schemes can be introduced at a later stage if justified by clear performance gains.

3 Examples of mobility procedures

3.1 Intra-Node B synchronised serving HS-DSCH cell change

Figure 3 illustrates an intra-Node B serving HS-DSCH cell change while keeping the dedicated physical channel configuration and the active set, using the Physical channel reconfiguration procedure. The transition from source to target HS-DSCH cell is performed synchronised, i.e. at a given activation time.

In this example, the UE transmits a MEASUREMENT REPORT message containing intra-frequency measurement results, here assumed to be triggered by the event 1D “change of best cell”. When the SRNC has performed the handover decision, the Node B is prepared for the serving HS-DSCH cell change at an activation time indicated with CPHY-RL-Commit-REQ primitive. The SRNC then sends a PHYSICAL CHANNEL RECONFIGURATION message, which indicates the target HS-DSCH cell and the activation time to the UE. Since the same Node B controls both the source and target HS-DSCH cells we assume there is no need to reset the MAC-hs entities. When the UE has completed the serving HS-DSCH cell change it transmits a PHYSICAL CHANNEL RECONFIGURATION COMPLETE message to the network.

In this example it is assumed that HS-DSCH transport channel and radio bearer parameters do not change. If transport channel or radio bearer parameters shall be changed, the serving HS-DSCH cell change would need to be executed by a Transport channel reconfiguration procedure or a Radio bearer reconfiguration procedure, respectively.

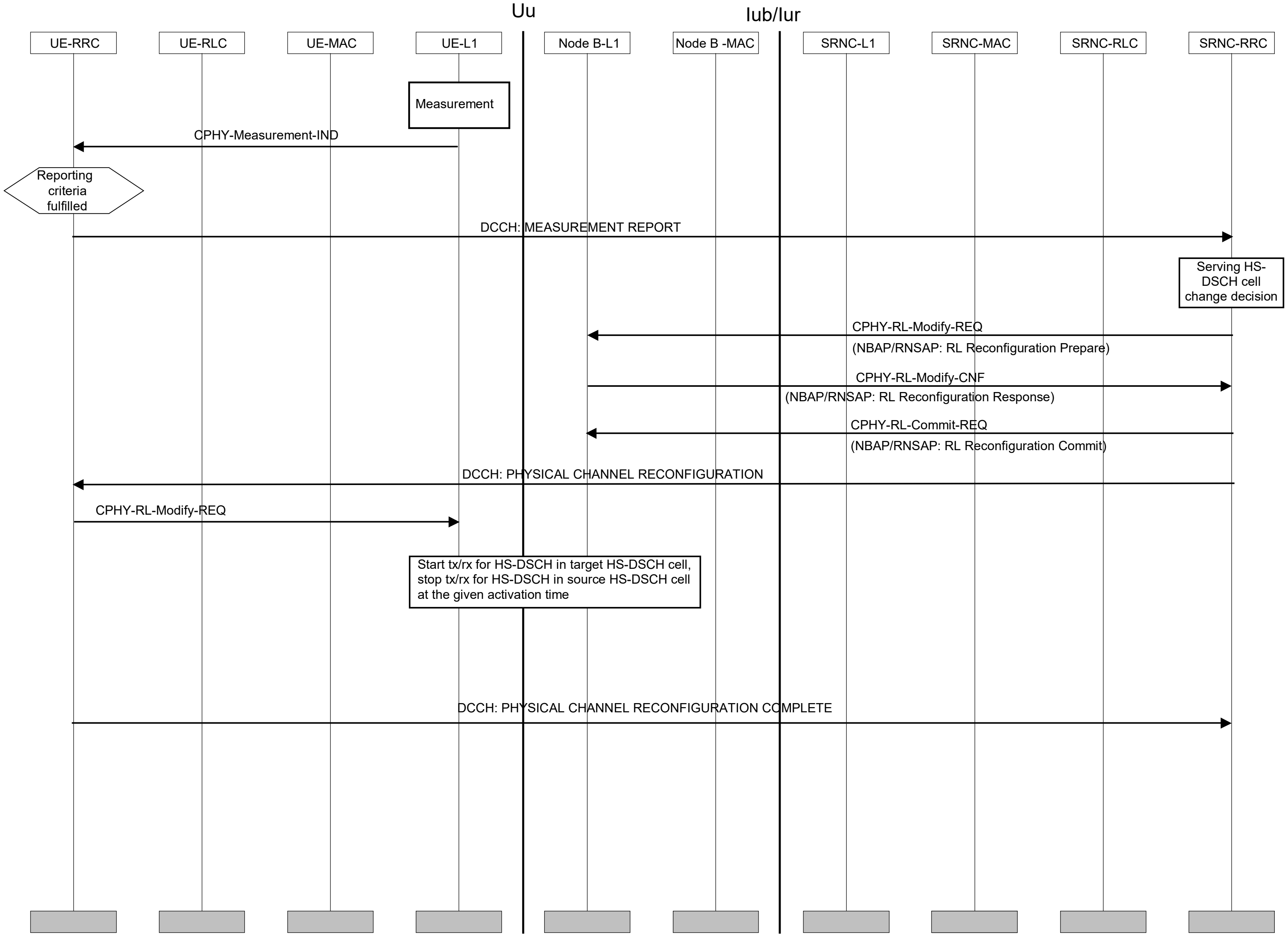

Figure 3: Intra-Node B synchronised serving HS-DSCH cell change

3.2 Inter-Node B synchronised serving HS-DSCH cell change during hard handover

Figures 4 illustrates a synchronized inter-Node B serving HS-DSCH cell change in combination with hard handover. The reconfiguration is performed in two steps within UTRAN. On the radio interface only a single RRC procedure is used.

Here we assume the UE transmits a MEASUREMENT REPORT message containing intra-frequency measurement results, triggered by the event 1D “change of best cell”. The SRNC determines the need for hard handover based on received measurement reports and/or load control algorithms (measurements may be performed in compressed mode for FDD).

In the first step, the SRNC establishes a new radio link in the target Node B. In the second step this newly created radio link is prepared for a synchronized reconfiguration to be executed at an given activation time indicated in the CPHY-RL-Commit-REQ primitive. After the first step, the target Node B starts transmission and reception on dedicated channels. At the indicated activation time, transmission of HS-DSCH is started in the target HS-DSCH Node B and stopped in the source HS-DSCH Node B.

The SRNC then sends a TRANSPORT CHANNEL RECONFIGURATION message on the old configuration. This message indicates the configuration after handover, both for DCH and HS-DSCH. The TRANSPORT CHANNEL RECONFIGURATION message includes a flag indicating that the MAC-sh entity in the UE shall be reset. The message also includes an update of transport channel related parameters for the HS-DSCH in the target HS-DSCH cell.

The UE terminates transmission and reception on the old radio link at the activation time indicated in the TRANSPORT CHANNEL RECONFIGURATION message, and configures its physical layer to begin reception on the new radio link. After L1 synchronisation has been established, the UE sends a TRANSPORT CHANNEL RECONFIGURATION COMPLETE message. The SRNC then terminates reception and transmission on the old radio link for dedicated channels and releases all resources allocated to the considered UE.

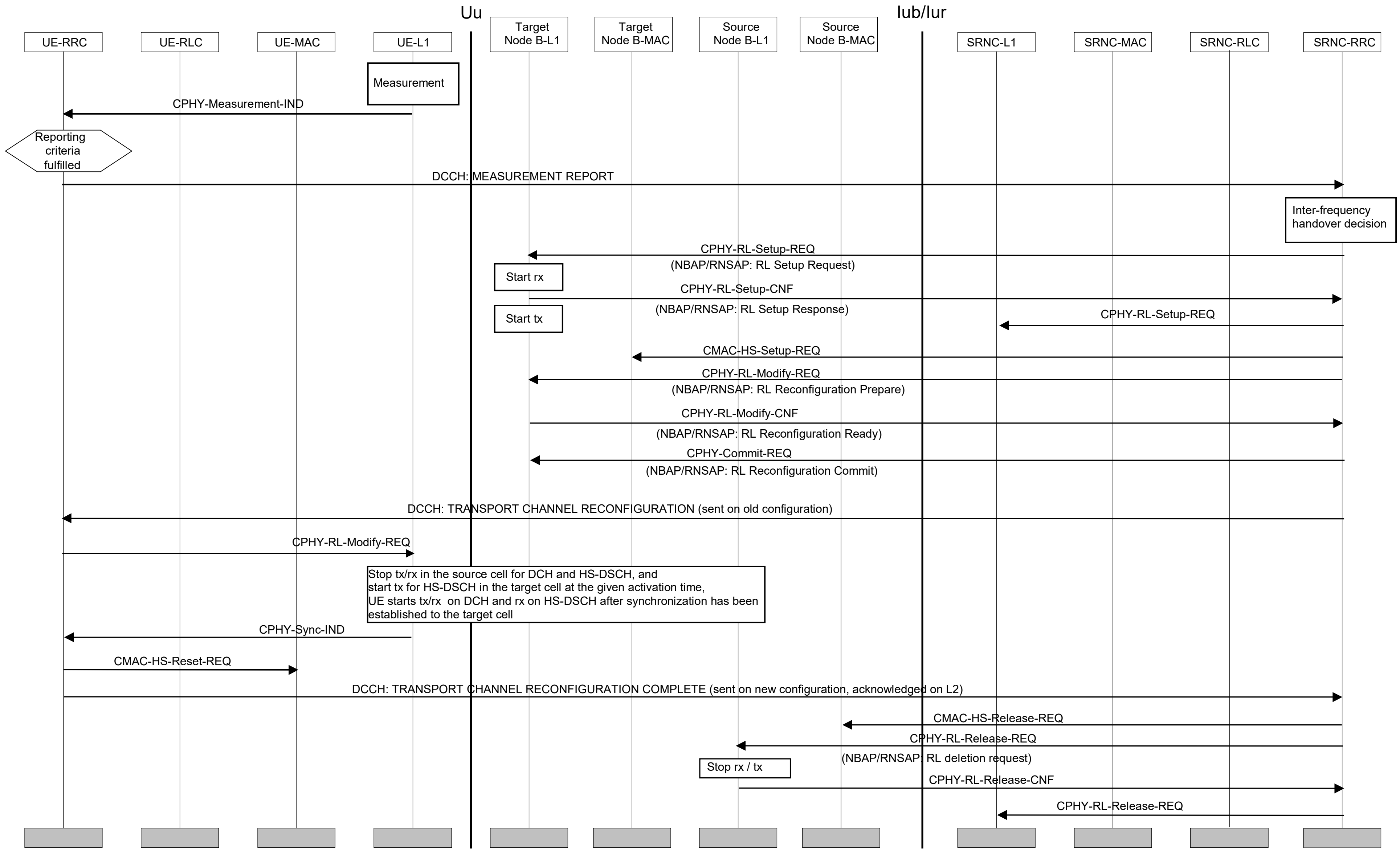

Figure 4: Inter-Node B synchronised serving HS-DSCH cell change during hard handover

3.3 Inter-Node B synchronized serving HS-DSCH cell change after active set update (radio link addition)

Figure 5 illustrates an inter-Node B serving HS-DSCH cell change performed subsequent to an active set update. In this example it is assumed that a new radio link is added which belongs to a target Node B different from the source Node B. The cell which is added to the active set is assumed to become the serving HS-DSCH cell in the second step. This combined procedure is comprised of an ordinary Active Set Update procedure in the first step and a synchronized serving HS-DSCH cell change in the second step.

We assume the UE transmits a MEASUREMENT REPORT message containing intra-frequency measurement results. The SRNC determines the need for the combined radio link addition and serving HS-DSCH cell change based on received measurement reports and/or load control algorithms (measurements may be performed in compressed mode for FDD).

As the first step, the SRNC establishes the new radio link in the target Node B for the dedicated physical channels and transmits an ACTIVE SET UPDATE message to the UE. The ACTIVE SET UPDATE message includes the necessary information for establishment of the dedicated physical channels in the added radio link (but not the HS-PDSCH). When the UE has added the new radio link it returns an ACTIVE SET UPDATE COMPLETE message.

The SRNC will now carry on with the next step of the procedure, which is the serving HS-DSCH cell change. The target HS-DSCH cell is the newly added radio link, so far only including dedicated physical channels. For the synchronized serving HS-DSCH cell change, both the source and target Node Bs are first prepared for execution of the handover at the activation time indicated with CPHY-RL-Commit-REQ primitive.

The SRNC then sends a TRANSPORT CHANNEL RECONFIGURATION message, which indicates the target HS-DSCH cell and the activation time to the UE. The message may also include a configuration of transport channel related parameters for the target HS-DSCH cell, including an indication to reset the MAC-hs entity.

Since source and target HS-DSCH cell are controlled by different Node Bs, MAC-hs in source and target Node B need to be released and setup, respectively, which is assumed to be done with CMAC-HS-Release-REQ and CMAC-HS-Setup-REQ primitives. These MAC-hs control primitives are assumed to be carried on the same NBAP/RNSAP messages, which carry the CPHY-RL-Reconfig-REQ primitives. Execution of release and setup of MAC-hs entities shall also be performed at the indicated activation time.

When the UE has completed the serving HS-DSCH cell change it returns a TRANSPORT CHANNEL RECONFIGURATION message to the network.

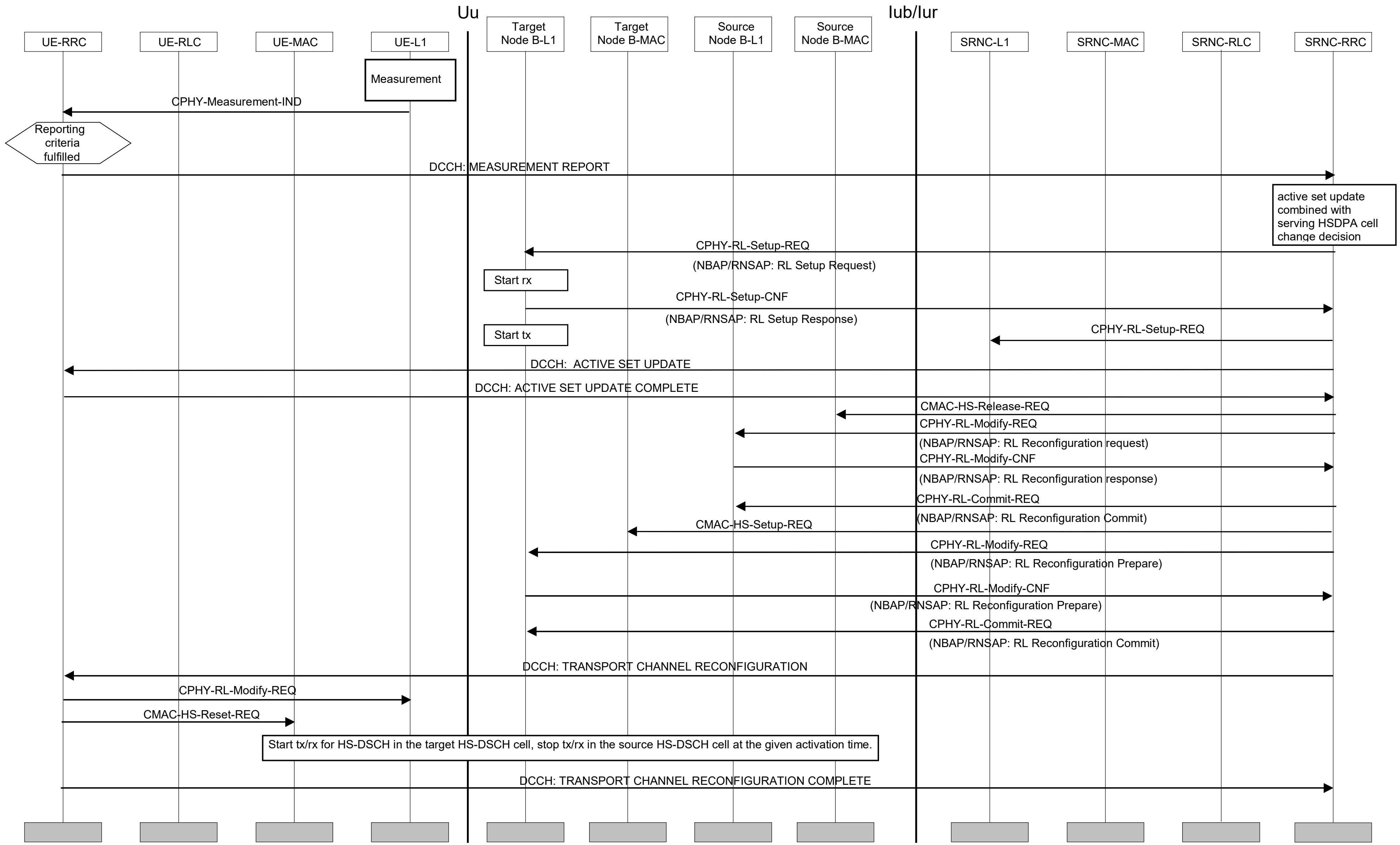

Figure 5: Inter-Node B synchronised serving HS-DSCH cell change after active set update

4 Proposal

The proposal is to add the signalling sequences presented in chapter 3 of this contribution into TS 25.308 [2].

5 References

[1] R2-012329, HS-DSCH mobility definitions; Source: Ericsson
[2] 3GPP TS 25.308, UTRA High Speed Downlink Packet Access (HSDPA); Overall description; Stage 2 (Release 5)
[3] R2-012391, HS-DSCH Cell Change; Source: Motorola