3GPP TSG-RAN WG2#59
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Agenda Item: **4.5.1**

Source: Motorola

Title: On the need for a separate procedure for Synchronized Handover

Document for: Discussion and Decision

1 Introduction

During RAN2-58bis there was extensive discussion of procedures for Synchronized Handover. However, there was no clear comparison of these procedures to the basic handover procedure; thus the benefits of such procedures were unclear. Here we attempt to provide such a comparison and discuss whether a separate procedure for synchronized handover is necessary.

2 Discussion

The procedure for un-synchronized handover is shown in Figure 1.

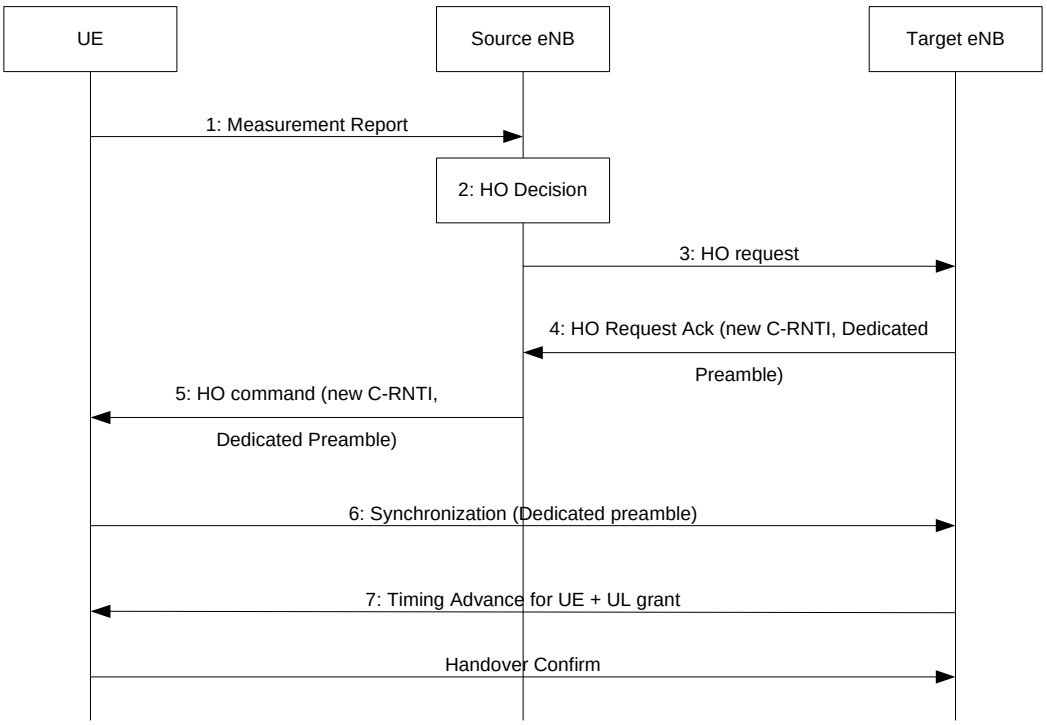

Figure 1: Handover procedure for Unsynchronized Networks

The primary difference between handovers in synchronized and unsynchronized networks is that in a synchronized network a UE does not need to obtain timing advance from the target cell. It has been argued ([1], [2] and [3]) that this property enables a new procedure that does not have step 6, i.e., transmission of the dedicated RACH preamble to the target eNB. Specifically, four options have been considered. *It should be noted that synchronized handover can be performed using the procedure of* Figure 1. *The discussion centers around optimizing the procedure with the intent of reducing RACH usage.*

2.1 Available Procedures

2.1.1 Pre-assigning of Target eNB UL resources

According to this procedure the UE is assigned UL-SCH resources in the HO command to transmit Handover confirm to the target eNB.

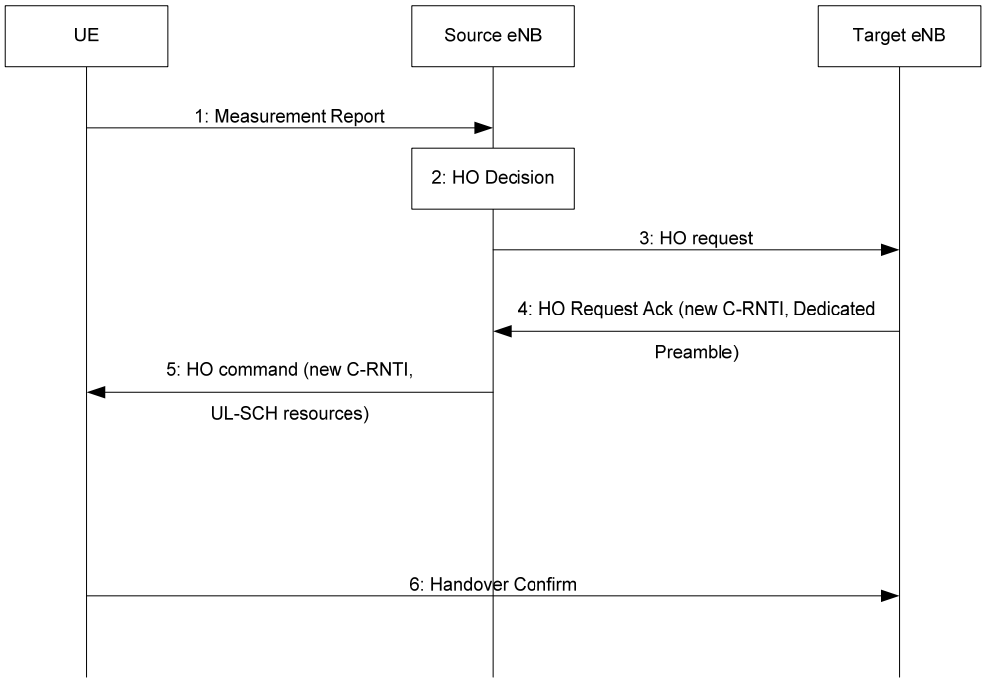

Figure 2 : Preassigning of Target UL-SCH resources

This procedure can be very wasteful of resources, given that HO command can take several HARQ transmissions to be correctly received by the UE. Minimization of this wastage could be done by using an activation time to tell the UE when it should transmit the Handover command. However, the activation time would need to be conservative and this leads to increase in handover interruption times and handover durations.

Also, resources may be wasted in situations where the HO command is not delivered. This can potentially be prevented by making the resources available at the target eNB only after receiving the HARQ ack to the HO command. This however requires the source eNB to signal the completion of HO command transmission to the target eNB which introduces additional X2 delay and increases handover interruption time and handover duration.

2.1.2 Using Activation time and L1/L2 control from target eNB

According to this procedure the UE is provided an activation time in the HO command. At the activation time a L1/L2 control channel is transmitted from the target eNB and UL-SCH resources are assigned to the UE.

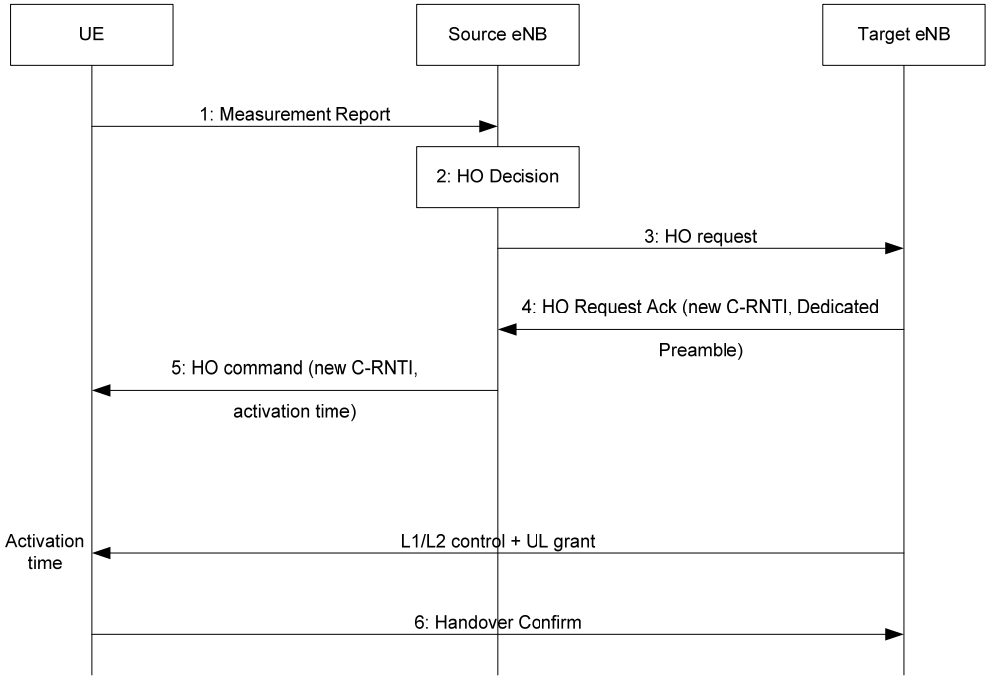

Figure 3 : Using Activation time and L1/L2 control

This procedure suffers from the same problems as the previous approach. That is, (a) the activation time has to be conservative, which leads to longer interruptions and handover durations, and (b) in order to ensure that L1/L2 control is not wasted, source eNB would need to signal to the target eNB successful transmission of HO command. This would also increase interruptions and handover durations.

Additionally, comparing to the unsynchronized handover procedure, this procedure is replacing use of a RACH preamble with the use of a L1/L2 control channel, which could be a more expensive resource.

2.1.3 Transmitting a Scheduling Request/CQI channel by UE

According to this procedure, the UE detaches from the source eNB after receiving the HO command and transmits an SR/CQI channel to the target. The target transmits an L1/L2 control channel in response and provides the UE UL-SCH resources to transmit the HO command.

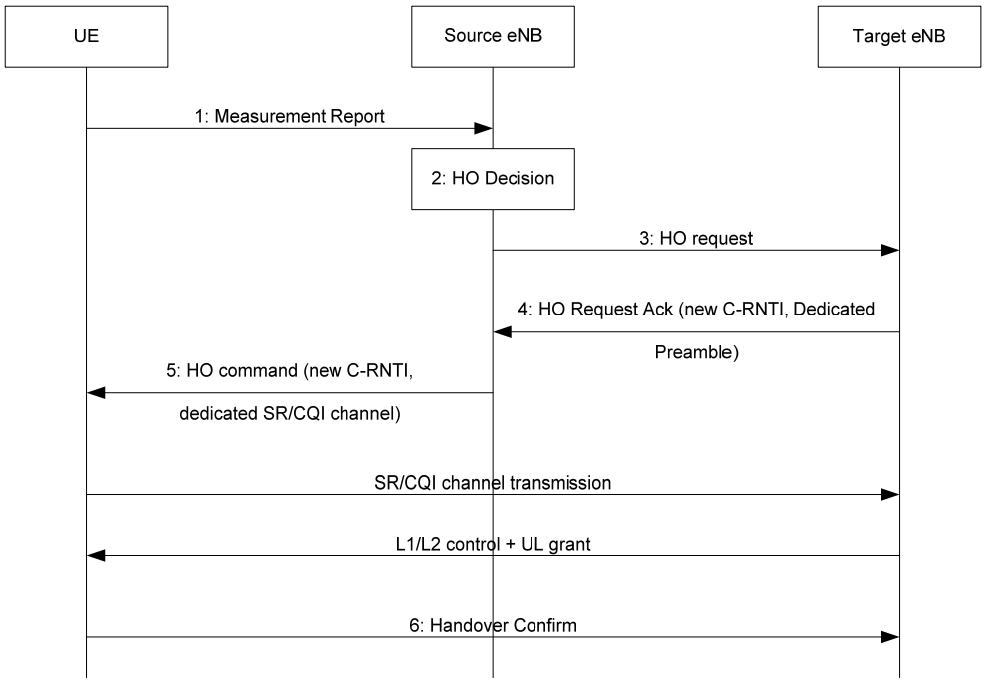

Figure 4 : Transmitting an SR/CQI channel

This procedure overcomes some of the issues with the other two procedures. Specifically, since there isn't an activation time the interruption time and handover duration are not increased.

However, comparing to the unsynchronized handover procedure, we note that the only difference is that the transmission of the RACH preamble is replaced with the transmission of the SR/CQI channel.

2.2 Comments on Resource usage and Interruption times

The different procedures for synchronized handover replace RACH usage with other alternatives. Instead of using RACH resources, other resources are used. Specifically, in the first procedure, UL-SCH resources have to be pre-allocated. In the second procedure, the L1/L2 control channel has to be transmitted. In the third procedure the UE transmits the SR/CQI channel.

It has been argued that the RACH load is low for most deployment scenarios (For example [4] and [5] have claimed that only 3.37 dedicated RACH preambles need to be allocated every 10 ms based on a relatively high RACH load, and this requires only 9 RACH preambles). Given that, the need to find alternatives to the use of RACH for synchronized handovers is very unclear. The proponents of the synchronized handover procedure have not demonstrated that there is a significant problem with the RACH load. We do not see the value in replacing one (relatively inexpensive) UL resource with a different UL or DL resource.

One could claim that TDD systems need to conserve resources used for RACH because the RACH opportunity might constitute a larger portion of the uplink bandwidth in a TDD system. However, comparing a 10 MHz FDD system (10 MHz each for uplink and downlink) to a 10 MHz TDD system (10 MHz split between uplink and downlink) we see that the expectation is that the 10 MHz TDD serve approximately half the number of UEs as in a 10 MHz FDD system. This should proportionally reduce the demand for RACH resources. This will allow for relaxation of the frequency of RACH opportunities while still meeting performance requirements.

Furthermore, if the RACH load is indeed a problem then there might be simpler methods to mitigate the problem; for example it is not necessary to reserve RACH preambles for long durations during handover.

3 Conclusion

From the analysis above we fail to see a clear need for having a separate procedure for synchronized handover that relies on not sending the RACH preamble. Having multiple procedures for the same functionality complicates UE procedures. Given that the currently agreed procedure does not in any way limit synchronized handover we feel that no further discussion on synchronized handover is needed. We propose that RAN2 agree to the following:

- There will be a single handover procedure for both synchronized and unsynchronized handovers.

4 References

[1] R2-072799, *UL Time Synchronized Handover*, Samsung, NTTDoCoMo

[2] R2-072476, *Inter eNB handover in a synchronous network*, Nortel.

[3] R2-072518, *Contention-free Intra-LTE handover in synchronous network*, IPWireless.

[4] R2-070206, *Collision Probability on RACH*, Samsung.

[5] R2-070205, *LTE Cell load/RACH load estimations*, Samsung.