

A Combined Handover Scheme for LTE-Advanced System

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Abstract— On the progress of researching for key technology and standard of LTE-Advanced, enhanced mobility control and Carrier Aggregation (CA) are kept to be researching points. Injection of CA brings new challenge to handover procedure for one thing, for another it could be used to support handover mechanism to overcome outage probability of user plane from handover of R10. In this paper we propose a handover scheme under CA mode called Combined Handover Scheme, which makes use of data supporting from Secondary Cell (SCell) during handover execution to overcome outage probability of handover in R10. We make supplement to handover procedure of R10 in order to accommodate the proposed scheme.

Keywords—LTE-Advanced, Handover, Combined handover, Handover negotiation, Carrier aggregation

I. INTRODUCTION

On the progress of researching for key technology and standard of R10 for LTE-Advanced system, enhanced mobility control keeps to be one of the main points to research. LTE-Advanced system supports subscribers up to 350km/h traveling speed under different mode, which will bring new challenges to the handover performance.

There are two main handover technologies in wireless communication systems, hard handover and soft handover. Hard handover is a break-before-make method. It means that a new wireless link connection with the target eNodeB should be set up after the release of the connection with the source eNodeB. Soft handover is a make-before-break method. It means that a new wireless link connection is established with the target eNodeB while the connection with source eNodeB is maintained. The UE simultaneously receive all services data from several active eNodeBs[1].

The efficient handover algorithms can enhance the system capacity and the service quality cost effectively. And different system deployment scenarios present different constraints on

handover procedure. In the LTE and LTE-Advanced systems, the hard handover can be used. But the hard handover has its shortcoming, for example, the high handover outage probability, large delay. Paper[2] gives a handover scheme for OFDM system called Semi-Soft Handover, which could not only attains lowest handover outage probability, but also improves the reliability of VoIP service.

In LTE-Advanced system, Carrier Aggregation technique is to be supported, that eNB could configure a set of cells for UE currently under its service extend. The configured set of serving cells for a UE therefore always consists of one Primary Cell (PCell) and one or more Secondary Cells (SCell). PCell can only be changed with handover procedure[3]. In the downlink, the carrier corresponding to the PCell is the downlink Primary Component Carrier (PCC) as shown in Figure.1, while the carriers corresponding to the SCells are the downlink Secondary Component Carriers (SCC).

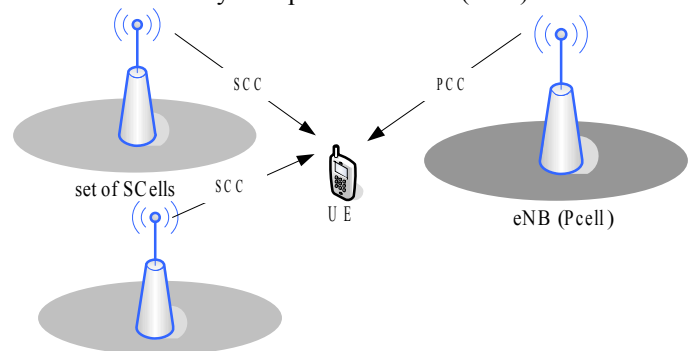


Figure 1. Example scenarios for the deployment of CA for LTE-Advanced

II. HANDOVER PERFORMANCE IN NON CA MODE

Handover in a cellular network can simply be defined as a change of access point on the radio link. In LTE release 10, network controlled, UE assisted handover is performed[4], UE

could have only one RRC connection with the network. The handover procedure can be subdivided into three stages of preparation, execution, and completion, as is shown in Figure 2.

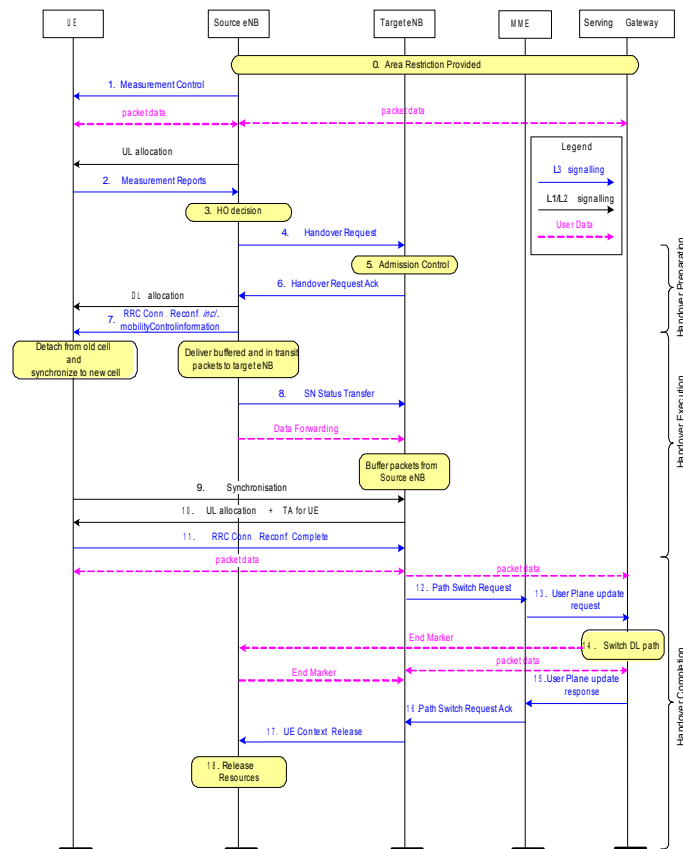


Figure 2. Handover in LTE Release 10

During the preparation stage, based on the measurement results it is getting from the UE, the source eNB decides whether to handover the connection to another eNB or not. Then the handover execution stage is entered, and the decision to handover is communicated to the target eNB, and if the target eNB is able to admit the UE, a message is sent to the UE to initiate the handover. Downlink (DL) data arriving at the source eNB to the UE are then forwarded to the new target eNB. The handover completion stage is entered once the target eNB and the UE are synchronized, and a handover confirm message is received by the target eNB. The performance of handover procedure for LTE-Advanced is shown in Figure 3.

Once the HO command has been processed by the UE, it leaves the source cell and stops receiving data. This is the point in time where data interruption starts. The first step after that is the radio synchronisation, after that, UE detaches from the source PCell and attempts to access the target PCell at the first available RACH occasion according to Random Access

resource selection[6], i.e. the handover is asynchronous. UE should complete handover within D_{handover} [7].

- $D_{\text{handover}} = N + T_{\text{interrupt}}$
- $T_{\text{interrupt}} = T_{\text{search}} + T_{\text{IU}} + 20\text{ms}$

Where N is the maximum RRC procedure delay. T_{search} is the time required to search the target cell. T_{IU} is the interruption uncertainty in acquiring the first available PRACH occasion in the target cell.

Besides, we should notice that Because forwarding is initiated before the UE moves and establishes connection to the target cell and because the backhaul is faster than the radio interface, forwarded data is already awaiting transmission in the target when the UE is ready to receive. This component therefore does not affect the overall delay.

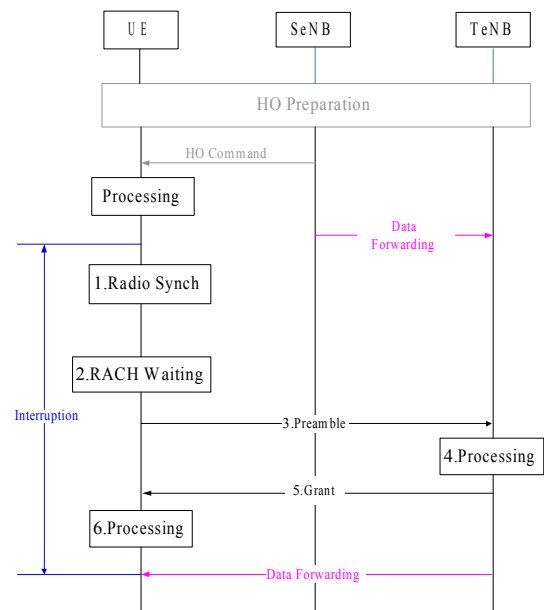


Figure 3. Handover Performance in Non CA Mode

III.COMBINED HANDOVER SCHEME FOR LTE-ADVANCED

The injection of CA technique changes the overall architecture of the network. Therefore new handover procedure needs to be defined to accommodate the changes. As mentioned before, we focus on reduce the outage probability of handover in R10, The proposed scheme provides an optimised strategy for intra-RAT handover under the CA mode, which reduces the interruption time of handover under non CA mode through data supporting to UE from source SCell. The main idea of the proposed scheme is to achieve physical separation and combined transfer between control information and user data during handover region by CA technique. The proposed handover procedure is shown in Figure.3.

When under CA mode, the handover mechanism could be achieved through one component carrier (CC) to make access to target eNB, meanwhile maintain packet data through another CC from source eNB. During handover preparation stage, once handover decision is done, handover negotiation is

processed between source eNB and target eNB. Target eNB will pre-assign SCC for UE, so that the data on the carrier could be recovered after RACH as soon as possible, which has no need to make complex carriers handoff. During pre-assignment, source eNB should transfer quality and configuration information of neighbour carriers to target eNB, in order to help target eNB pre-assign SCC for UE, also the information of pre-assignment will be transferred with handover command signalling to UE.

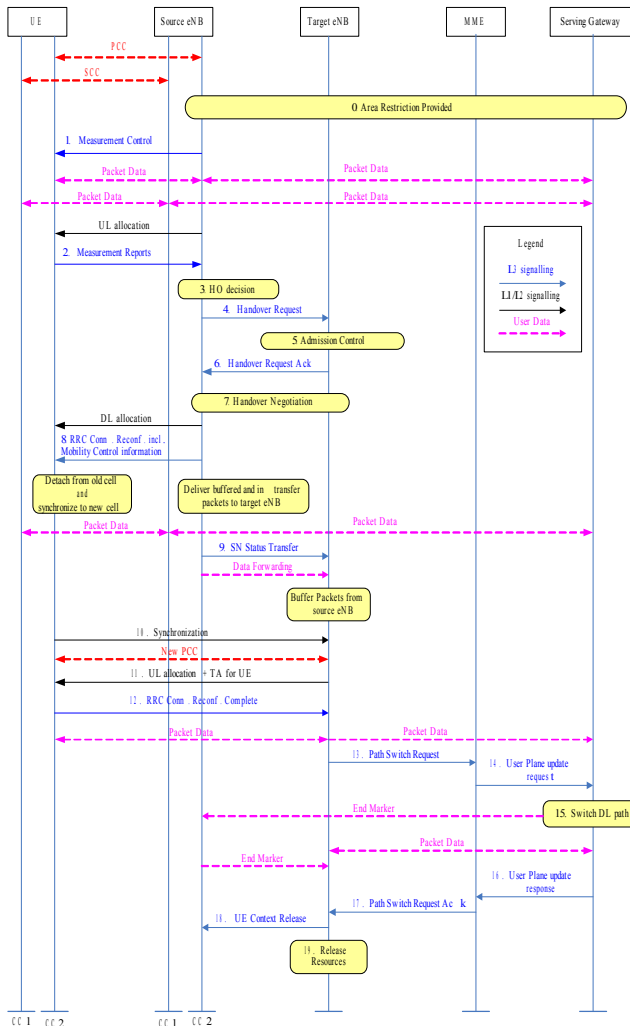


Figure 4. Combined Handover Procedure

A. Handover Preparation with Handover Negotiation

In handover preparation stage, source eNB prepares one or more target cells. The source eNB selects the target PCell. The source eNB may also provide the target eNB with a list of cells. The target eNB selects and identifies SCells that are configured for use after handover. The target eNB use the *RRCConnectionReconfiguration* message, either including the *mobilityControlInfo* or not, to configure SCells.

Once target eNB receives handover command message from the source eNB, the handover negotiation mechanism is

executed between the two eNBs. Target eNB detects the current identified SCells once upon receiving the *Handover Negotiation Request* message. If there are duplications between the identified SCells by target eNB and the current configured SCells by source eNB, target eNB will pre-assign CC for UE, also the target eNB should send *Handover Negotiation Request Ack* message back to the source eNB, as is shown in Figure. 5; if not, then sends *Handover Negotiation Reject* message, as is shown in Figure.6.

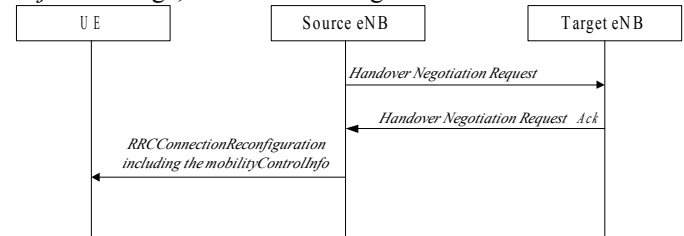


Figure 5. Handover Negotiation Successful

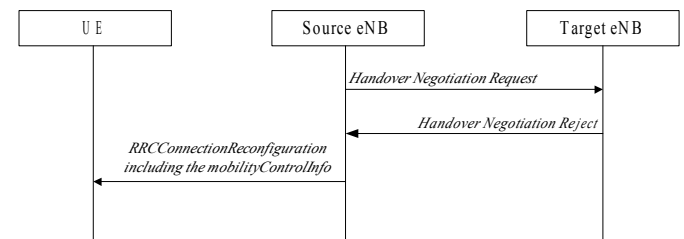


Figure 6. Handover Negotiation Reject

B. Synchronous Handover Execution

When handover negotiation has been executed successfully, a dedicated RACH preamble that is allocated for UE by target PCell is sent to source PCell with handover command ACK message and transparently forwarded to UE. Then handover execution is processed by means of the *RRCConnectionReconfiguration including the mobilityControlInfo*. UE reconfigures PCell and a set of SCells, then attempts to access the target PCell at the first available RACH occasion according to Random Access resource selection. Since there are duplications between the reconfigured SCells by UE and original configured SCells by source PCell before handover, i.e. current SCells maintain the user data forwarded to UE by source eNB, then the duplicated SCells could provide UE with user data during the RACH access process, i.e. the handover is synchronous.

If handover negotiation is rejected, which means that there is no duplication between reconfigured SCells and original configured SCells, then the proposed combined handover scheme could not be achieved. The handover procedure under non CA mode should be executed.

IV. CONCLUSIONS

CA technique is expected to play a pivotal role in future release of LTE-Advanced system, by helping to enhance network coverage and improve service quality. In this paper, the proposed scheme called combined handover scheme, is a handover optimized strategy under CA mode. As is shown above, the proposed approach can reduce much of the

interruption time in handover region. Also it is flexible and easy to implement, as well as backward compatible to LTE release 10. Thus, it could be made use of further research of mobility control mechanism under CA mode.

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