3GPP TSG-RAN WG2 meeting#68bis
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R2-100423

Agenda item: 7.1.1

Source: Qualcomm Incorporated

Title: Supporting multiple timing advance groups

Document for: Discussion and decision

1. Introduction

The need for multiple timing advance with carrier aggregation has been discussed in RAN2. In a reply LS from RAN4 [1], it was stated that multiple timing advances are needed in scenarios 2-4 identified by RAN4 are considered important for deployment. In RAN2#68, it was noted that operator input will be used to decide the importance of the scenarios.

In this paper, we describe a design for multiple timing advances, and recommend adoption of this design in case multiple timing advances are adopted in LTE-A.

2. Discussion

2.1 Background

The following scenario is copied from [1].

Scenario #2: Frequency Selective Repeaters

The different component carriers could see substantially different propagation environments due to different frequency selective repeaters and hence see different time-of-flights.

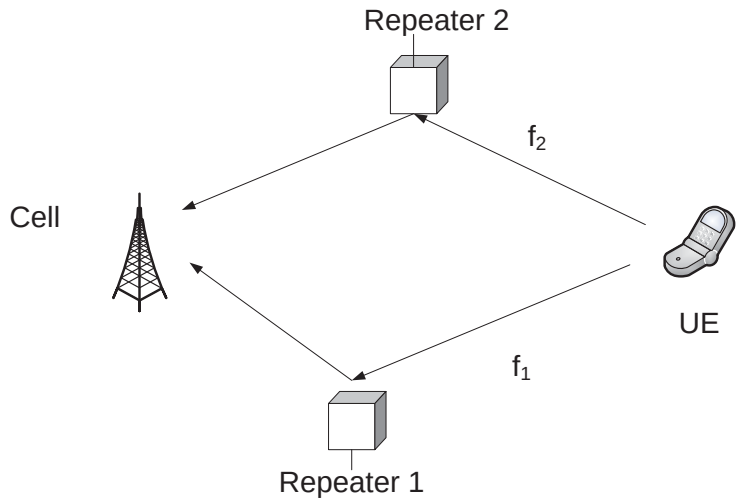


Figure 1 Frequency Selective Repeaters

2.2 Need for timing groups

In the scenario above, it is possible that f1 and f2 each constitute multiple LTE CCs.

- CCs within f1 or f2 will share the same timing delays,

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- CCs in f1 will need timing delays that are different from CCs in f2

From the above observations, it can be concluded that the configured component carriers can be divided into groups to reduce the number of separate timings to be maintained by the UE

Proposal 1: The UL component carriers configured for a UE should be divided into timing groups, where the network controls the grouping of component carriers.

Proposal 2: The UL component carriers within a timing group share the same timing.

2.3 Calculation of timing reference

The UE calculates uplink timing by adding a timing advance to the received downlink reference timing. When different timing groups are present, the downlink reference needs to be specified. There are two options

- All timing groups use a common DL carrier as timing reference, e.g. the component carrier of the special cell.
- Each timing group uses a network specified DL carrier as timing reference

Having a DL timing reference that is specific to a timing group is important as it reduces the magnitude of the timing advance values. Also, for scenarios 3 and 4 described in [1], the timing advances commands may originate from different nodes in the network, and having group specific references is important.

Proposal 3: A unique DL carrier is identified by the network as the DL timing reference for each UL timing group.

2.4 Delivery of Timing Advance

The timing advance is delivered to the UE using a DL MAC control element. In Rel-8, there is no ambiguity of DL to UL mapping. However, in LTE-A, this mapping has to be specified, so that a timing command received on a given DL CC uniquely addresses a timing group. When there are more UL timing groups than DL carriers, this mapping may not be unique, and can need an extension of the MAC control element. However, given the use case for multiple timing groups (as specified by RAN4), it is likely that this case is not common.

Proposal 4: A unique DL carrier is identified as the TA-providing carrier for each timing group. The signalling formats for TA are as specified in Rel-8. Note: As a result of proposal 4, the number of timing groups can not be more than the number of configured DL carriers.

In order to obtain a timing advance, the UE has to send a RACH. In case there is more than one CC in a timing group, there is the question of which CC to use. The simplest solution is for the network to assign one UL CC per timing group where the UE sends RACH. The load can be balanced among UEs by the network making even assignments of UEs to different CCs in a timing group.

Proposal 5: A unique UL carrier is identified to be used for RACH on each timing group.

2.4 Initiating use of timing groups other than those containing special cell

It is already agreed that configured carriers are added by dedicated RRC signalling, subsequent to the connection establishment. If a newly configured UL carrier is indicated by the network as belonging to a new timing group, then the UE should perform RACH before starting any other UL transmissions. The same issue arises after handover, in the case where the handover command configures multiple timing groups at the target cell.

There are two options to initiate a RACH for the UE to acquire timing on this carrier

- UE initiates RACH (either with a randomly selected RACH preamble, or with a RACH preamble assigned by the network)
- Network commands UE to initiate RACH using PDCCH command

Relying on the the network initiated procedure can cause additional latency, and is hence undesirable.

Proposal 6: The UE initiates RACH upon configuration of a new timing group. In case of handover, if multiple timing groups are configured, the UE initiates RACH on all the timing groups.

Note that proposal 5 may require revisiting the understanding that there is only one outstanding RACH at a time (also noted in [2]).

2.5 Maintenance of UE Timing Alignment

A single timing alignment timer is currently maintained by the UE. With multiple timing groups, the UE should maintain one timer instance for each timing group, and the timer maintenance should be as per existing Rel-9 rules.

Proposal 7: A separate timing alignment timer instance should be maintained by the UE for each timing group.

3. Conclusion

This document described proposals for incorporating multiple timing groups with carrier aggregation.

References

[1] R2-095422: Reply LS on RAN2 status on carrier aggregation, from RAN WG4, RAN2#67bis

[2] R2-096844: RACH and carrier aggregation, RAN2 #67bis, Nokia, NSN