Source: Panasonic
Title: Support of UL/DL asymmetric carrier aggregation
Agenda Item: 12 Study Item on LTE-Advanced
Document for: Discussion and Decision

1. Introduction

Support of wider bandwidth is one of important enhancements for LTE Advanced. Carrier aggregation has been proposed in order to support backward compatibility to LTE UEs and higher peak throughput to LTE-A UEs simultaneously[1]-[3]. However, the required peak rate for DL and that for UL are different. In this document, we discuss how the carrier aggregation works in case DL allocated frequency band is wider than UL allocated frequency band. We propose to have asymmetric combination of carrier aggregation for the efficient usage.

2. Asymmetric carrier aggregation in DL and UL

Figure 1 shows 2 alternatives for allocating 40MHz in DL and 20MHz in UL system frequency. In the figure 1(a), there are 2 independent pairs of DL/UL component carriers (i.e. symmetric carrier aggregation). In the figure 1(b), there are only one component carriers in UL and 2 component carriers in DL (i.e. asymmetric carrier aggregation). Comparing these two alternatives, to use UL 20 MHz band as one component carrier has advantages of higher peak rate, lower PAPR, reduced control channel overhead and more user diversity gain. Therefore, to have asymmetric carrier aggregation is benefitical. So we focus on supporting asymmetric carrier aggregation in LTE-A.

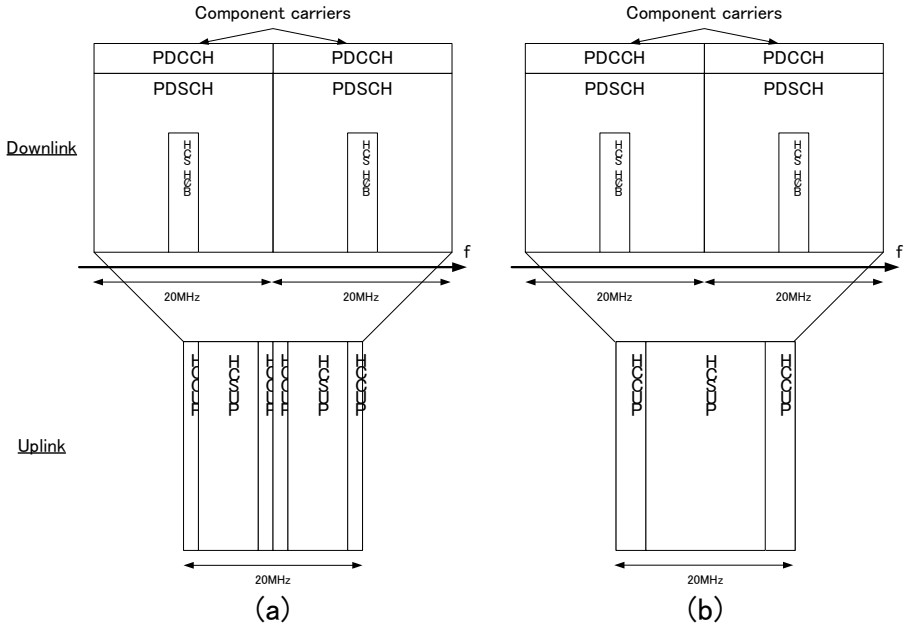

Figure 1 Asymmetric carrier aggregation and symmetric carrier aggregation (DL: 40MHz, UL: 20MHz)

3. Discussions on backward compatibility to LTE UE

Needless to say, the symmetric carrier aggregation supports LTE UE because there is no difference between one pair of DL/UL band and that of Release 8 from UE perspective.

Regarding asymmetric carrier aggregation, backward compatibility aspects to LTE UE on some physical channels are discussed below.

1. PCFICH

No problem since PCFICH can be sent via each component carriers. Note that, the value of PCFICH on each component carriers could be different.

2. **PDCCH**

No problem since PDCCH to each LTE UE can be sent via each component carriers where LTE UE camps.

3. **PHICH**

No problem from the view point of the backward compatibility although some PHICH resources would not be used depending on the allocation of corresponding UL grants in each component carrier.

4. **PDSCH**

No problem since PDSCH to each LTE UE can be sent with PDCCH (DL assignment) via each component carriers where LTE UE camps.

5. **PRACH**

No problem from the view point of the backward compatibility although there are still FFS in release 8.

If "*PUCCH-resource-size*" is explicitly signaled in release 8, eNB can allocate the same physical frequency/time resources and the different sequence numbers to each DL component carrier via D-BCH. eNB can distinguish in which component carrier the RACH response should be sent based on the used sequence number.

If "*PUCCH-resource-size*" is not explicitly signaled in release 8 and UE derives the frequency resources for PRACH by the offset values for D-ACK and maximum number of CCEs, eNB has to manage the possible collision of PUSCH and PRACH. Thus there might be some restrictions to the eNB's scheduler.

6. **PUCCH**

No problems for the CQIs, P-ACKs and SRIs since the resources are explicitly signaled to each UE. Also no problem for D-ACKs since D-BCH in each DL component carrier can indicate different offset values for D-ACK resources as shown in Figure 2.

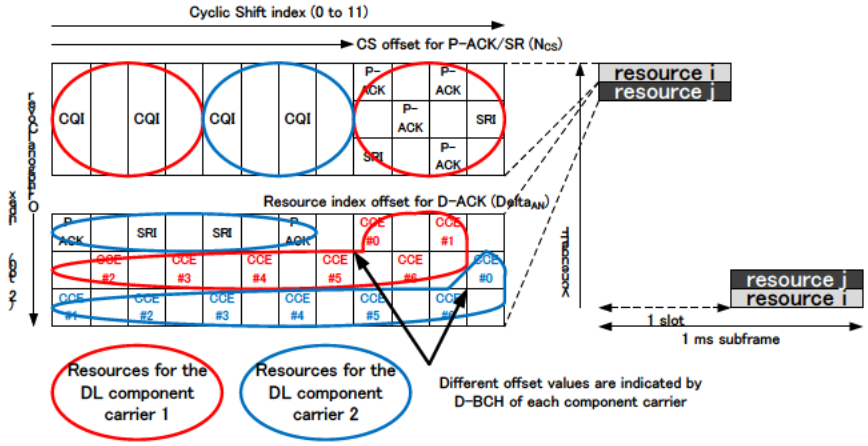

Figure 2 An example of PUCCH allocations for supporting asymmetric carrier aggregation

7. **PUSCH**

No problem from the view point of the backward compatibility since PUSCH can be assigned by PDCCH (UL grant) via each component carriers where LTE UE camps.

When UL FH is configured, there would be some restrictions to the eNB's scheduler based on the signaling of the "*PUCCH-resource-size*" so that the hopped PUSCH doesn't collide with D-ACKs.

- If "*PUCCH-resource-size*" is explicitly signaled in release 8, this collision can be avoided by signalling appropriate value of "*PUCCH-resource-size*" in each component carrier.
- If "*PUCCH-resource-size*" is not explicitly signaled (i.e. UE derives the frequency resources for FH by the offset values for D-ACK and number of CCE) in release 8, eNB scheduler should manage this possible collision of PUSCH and D-ACK by e.g. not to assign such FH resources to the UEs.

4. Conclusion

In this paper, we discussed the support of asymmetric carrier aggregation. Based on the considerations here, it would be possible that LTE UE can coexist in the system with asymmetric carrier aggregation. So we propose to support asymmetric carrier aggregation in LTE-A system to handle asymmetric DL/UL traffic effectively.

In addition, we found that it is preferable to signal the "*PUCCH-resource-size*" explicitly in release 8 at least in FDD system to ensure the extensibility of the LTE spec.

References

[1] R1-082468, Ericsson, "Carrier aggregation in LTE-Advanced"
[2] R1-082448, Huawei, "Carrier aggregation in Advanced E-UTRA"
[3] R1-082575, NTT DOCOMO, "Proposals for LTE-Advanced Technologies"