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Title: ACK/NACK Signal Structure in E-UTRA Downlink
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1. Introduction

The attachment of the UE ID to the ACK/NACK bits is inefficient because the ACK/NACK signal has only one bit per UE. Therefore, this paper proposes a basic structure for the downlink ACK/NACK signal without carrying the UE ID.

2. Mapping Scheme of Downlink ACK/NACK Signal

The ACK/NACK signal consists basically of one bit per UE especially when MIMO channel transmission is not employed. However, if the destination is indicated by also sending the UE ID, the required number of bits per UE becomes significantly larger such as 17 assuming a 16-bit UE ID. Therefore, indicating the destination without signaling is desirable for efficient control signaling and improving the ACK/NACK bit error rate.

The downlink ACK/NACK signals must be transmitted only to the UEs to which the uplink shared data channel is assigned at the previous transmission time interval (TTI). The UE is informed of the assignment of the uplink shared data channel using the downlink L1/L2 control channel (scheduling grant) in that TTI. Therefore, we propose predetermining a one-to-one relationship between the index of the downlink L1/L2 control channel (scheduling grant) for assignment of the uplink shared data channel and the index of radio resources (index of sub-carrier sets for FDM or code index for CDM) for the downlink ACK/NACK. By using this approach, the UE can find the ACK/NACK signal to be decoded without any additional side information as shown in Fig. 1.

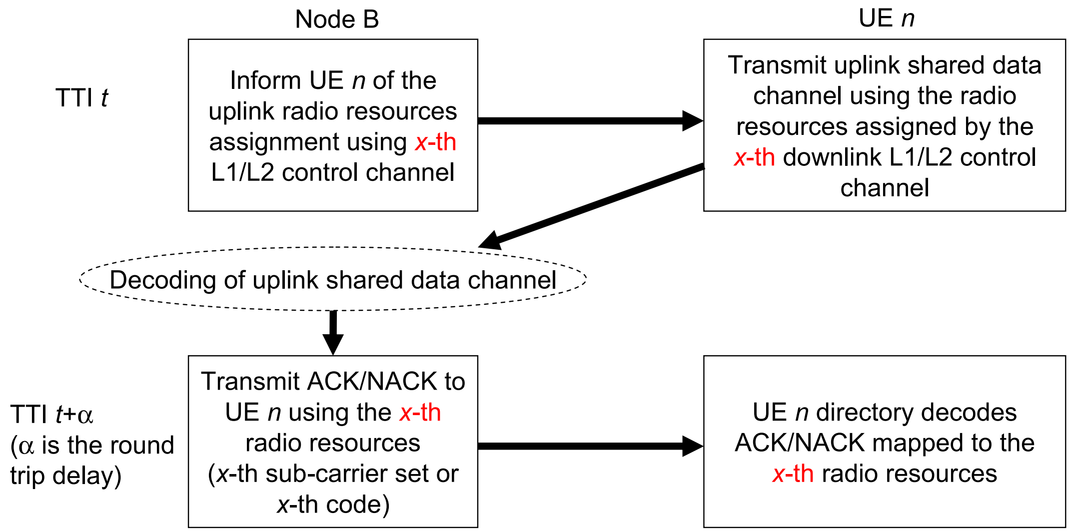

Figure 1 – Basic principle of proposed mapping scheme for downlink ACK/NACK signal

3. Transmission, Coding and Multiplexing Methods of Multiple Downlink ACK/NACK Signals

3.1. Transmission Scheme

Our view is that distributed transmission should be applied to the downlink ACK/NACK signal in order to achieve simple decoding at the UE and a large frequency diversity effect (similar view in [1]). If the downlink ACK/NACK signal is transmitted using localized transmission using the scheduled resource block (RB) with good channel condition for the destination UE, the received quality of the ACK/NACK signal is better than that for distributed transmission. However, the UE must detect the RB where ACK/NACK is mapped with blind detection. Therefore, pre-determined, i.e., non-scheduled, distributed transmission or localized transmission with frequency hopping is an appropriate transmission scheme to obtain frequency diversity.

3.2. Channel Coding Scheme

Employing joint coding between multiple ACK/NACKs for different UEs is beneficial to increase the coding gain. Meanwhile, separate coding including repetition coding is advantageous to achieve a larger power control gain. Based on the simulation results in [2], our preference is to employ separate coding. It should be noted that only for separate coding, the proposed efficient ACK/NACK mapping scheme in Sec. 2 can be applied. However, the coding gain using joint coding is FFS.

3.3. Multiplexing Scheme

When we assume separate coding, we can consider FDM and CDM [3]. Between FDM and CDM, our preference is to apply CDM since by using CDM, the transmission power of all sub-carriers allocated to the L1/L2 control channel can be made constant even when individual transmission power control is used for multiple user equipments (UEs) [4]. This property is beneficial in reducing the dynamic range of the transmission power of each sub-carrier and randomizing the other-cell interference. However, the impact of orthogonality destruction in CDM in a fading channel should be verified. Alternatively, FDM with cell-specific frequency mapping for multiple UEs or a hybrid of CDM and FDM can be used for the same purpose of interference randomization [4].

4. Conclusion

A basic structure for the downlink ACK/NACK signal was proposed. The features of the proposed downlink ACK/NACK signal structure are as follows.

- UE ID-less transmission based on the one-to-one relationship between the index of the downlink L1/L2 control channel for uplink radio resource assignment and the index of ACK/NACK radio resources
- Pre-decided distributed transmission or localized transmission with frequency hopping
- Separate coding between UEs
- CDM based multiplexing between UEs (FDM with cell-specific frequency mapping for multiple UEs or a hybrid of CDM and FDM are alternative candidates)

References

[1] 3GPP, R1-062625, Motorola, “Downlink Acknowledgement and Group Transmit Indicator Channels”

[2] 3GPP, R1-063322, NTT DoCoMo, Fujitsu, KDDI, Mitsubishi Electric, NEC, Toshiba Corporation, "Coding Scheme of L1/L2 Control Channel for E-UTRA Downlink"

[3] 3GPP, R1-063325, NTT DoCoMo, "Basic Multiplexing Schemes of Multiple L1/L2 Control Information in E-UTRA Downlink"

[4] 3GPP, R1-061668, NTT DoCoMo, "Fast Transmission Power Control in E-UTRA"