3GPP TSG RAN WG1#52 **R1-081004**
Sorrento, Italy
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Agenda item: 6.1.4
Source: LG Electronics
Title: Multiplexing of ACK/NACK in PUSCH
Document for: Discussion & Decision

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1. Introduction

In Athens (#50) it was decided that when control information is to be multiplexed with data, data information is rate matched with control, and that the ACK/NACK information is to be inserted into PUSCH by either puncturing data or control information bits. Also it was decided that all control information should be positioned next to the reference signal, and positioned in both slots of the subframe. In this contribution we propose puncturing positions for the uplink ACK/NACK information when transmitted in PUSCH.

2. Puncturing positions for ACK/NACK information

Currently the actual insertion position of the ACK/NACK information in the PUSCH is not yet agreed. When we decided on the ACK/NACK information position in the PUSCH, we believe we also need to consider punctured out effects of the data information. Here we have proposed ACK/NACK puncturing position for data and control multiplexing structure A and B presented in document R1-080267 [2].

Data information multiplexed with control information may have several code blocks according to transport block payload size. Depending on how and how much the control information is multiplexed each code blocks in the data information will be placed in different resource elements. Figure 1 shows an example of where each code block is positioned in structure A. Due the control information multiplexing and time-first mapping rule, the number of virtual subcarriers used for each code block can be different. Basically the lowest code blocks may be mapped to more virtual subcarriers because control information has already taken place.

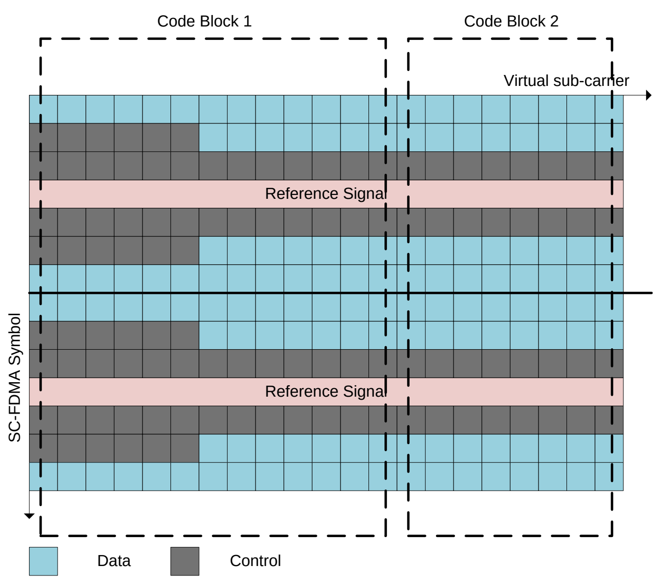
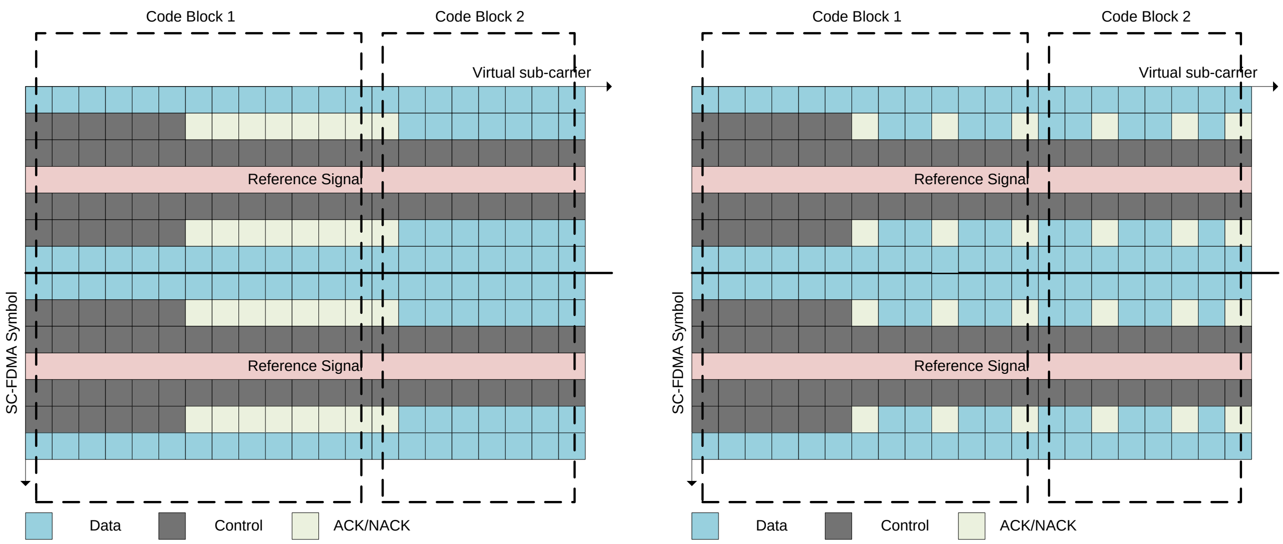


Figure 1. An example of data code block mapping into the PUSCH subframe

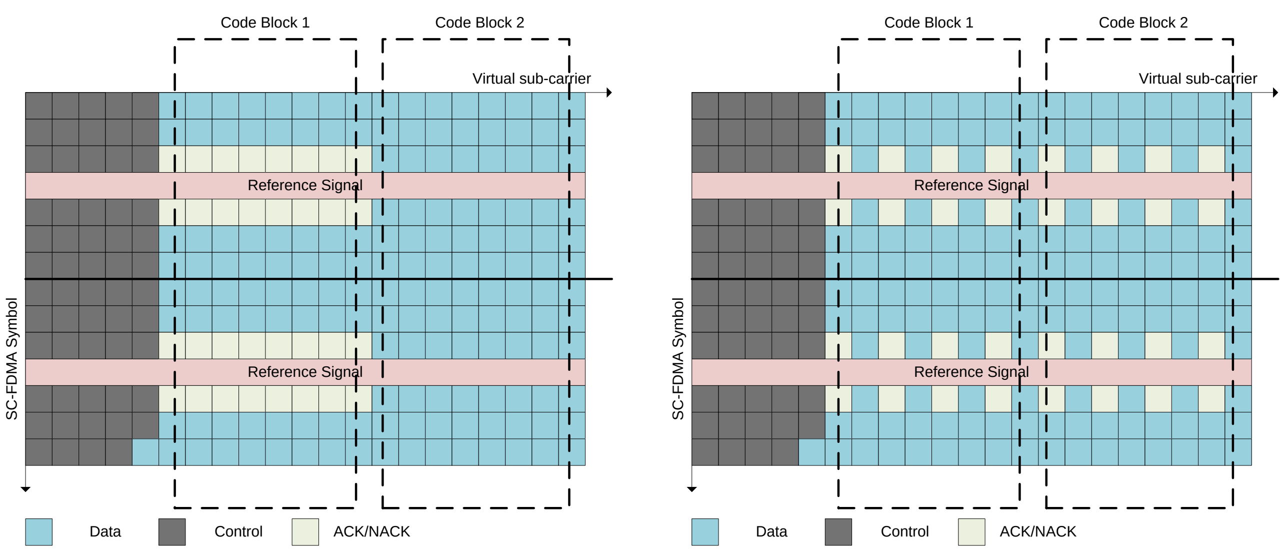
If we assume that the ACK/NACK information is punctured to certain positions so that it is continuing where the control signal left off (like in the example in figure 2a) then this will lead to unequal puncturing of data information in each code block. So we propose to <u>spread the ACK/NACK information across the virtual subcarrier evenly</u> when puncturing ACK/NACK information into the data information resources. The proposed scheme is shown in figure 2 (b). We can intuitively see that evenly spread ACK/NACK information will alleviate un-equal puncturing of code blocks.



(a) Alternative ACK/NACK positioning (b) Proposed ACK/NACK positioning

Figure 2. An example relationship between ACK/NACK puncturing position and data code block mappings in PUSCH

The same can be said for the proposed control information multiplexing structure which is structure B. If we positioned the ACK/NACK signals to be consecutive in virtual subcarrier domain then we risk of puncturing only one or few of the code blocks out of many. Figure 3 shows the Proposed ACK/NACK positioning and the Alternative ACK/NACK positioning method for the proposed control information multiplexing structure B.



(a) Alternative ACK/NACK positioning (b) Proposed ACK/NACK positioning

Figure 3. An example relationship between ACK/NACK puncturing position and data code block mappings in PUSCH

3. Conclusion

So in summary we propose the following, in order to achieve even puncturing of information bits from code blocks;

- **Positioning ACK/NACK information near the RS**
  - **Spreading the ACK/NACK puncturing positions to be evenly spread over virtual subcarriers (prior to DFT input).**

Reference

[1] R1-071839, "LS on target quality requirements on L1/L2 control channel", RAN WG1, 3GPP TSG RAN WG1 Meeting #48bis, St.Julians, Malta, March, 2007.

[2] R1-080267, "PUSCH multiplexing of data, control, and ACK/NACK information", LG Electronics, Inc., 3GPP TSG RAN WG1 Meeting #49bis, Sevilla, Spain, January, 2008.