

As mentioned above, the implicit ACK/NACK resource allocation in LTE Release 8 is based on the CCE indexing. However, such indexing scheme does not exist currently for ePDCCH.

In LTE Rel-8, the PDCCH resources are divided into CCEs which are then simply numbered. However, such an approach is not an attractive one in the case of ePDCCH as due to the nature of ePDCCH the number of resources and hence also the UL overhead would easily become excessive. This is shown in Figure 2 which illustrates a straightforward extension of Rel-8 approach to support ePDCCH.

Summary

According to the present disclosure, there are provided a method, apparatus and a program for a control channel element indexing scheme.

According to a first aspect of the present disclosure, there is provided a method comprising:

- obtaining information regarding first partition elements related to a first partitioning of channel resource elements carrying in downlink a configurable first control channel for allocating channel resources to a data channel,

- determining a number of second partition elements related to a second partitioning of channel resource elements per first partition element, wherein determining the number of second-partition elements comprises deriving the number of a subframe type,

- determining for at least one second partition element a second-partition element index based on information regarding the first partition elements and the determined number,

- determining for at least one third partition element related to a third partitioning of channel resource elements, a third-partition element index,

- wherein the second partitioning is related to the allocation of channel resources of the first control channel, and

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wherein the third partitioning is related to allocating channel resources of a second control channel, and

wherein the first partitioning is related to a partitioning used for allocating channel resources to the data channel.

According to further refinements of the disclosure as defined under the above aspect

- the method further comprises
 - receiving a data packet transmitted on the data channel, and
 - providing feedback information in uplink direction on the second control channel about successful or unsuccessful reception of the data packet;
- wherein the first partitioning is related to allocating channel resources of the data channel;
- at least one of the second-partition element index and information regarding first partition elements is unique in a cell;
- at least one of the second-partition element index and information regarding first partition elements is unique per user equipment;
- each second-partition element index is mapped to one or more third-partition element indexes.
- determining the number of second-partition elements comprises deriving the number from a subframe type;
- the second-partition element indices are determined so as to form a continuous set of indices;
- the second-partition element indices are determined starting from the second-partition element on the first partition element with the lowest index;
- the second-partition element indices are determined starting from the second-partition element on the first partition element with the highest index.
- determining at least one third-partition element index comprises one-to-one mapping between the second-partition element index and the third-partition element index starting from the lowest second-partition element index;
- determining at least one third-partition element index comprises many-to-one mapping between the second-partition element index and the third-partition element index;
- the method further comprises a collision avoidance mechanism;
- the collision avoidance mechanism comprises including a specific field modifying the implicit uplink channel resource allocation;
- the collision avoidance mechanism comprises first control channel scheduling including selecting at least one second-partition element used for the first control channel;

- the many-to-one mapping comprises one-to-one mapping between the second-partition element index and the third-partition element index for the second-partition elements contained on one first-partition element;
- the method is executed by a user equipment, wherein obtaining information regarding first partition elements includes receiving the information from a base station;
- the method further comprises receiving an offset parameter indicating the first second-partition element index from a base station;
- the information is included in system information and received via broadcast.
- the information is received via a broadcast channel or enhanced broadcast channel;
- the information is included in a master information block or system information block;
- the information is received via dedicated higher layer radio resource control signaling;
- the method is executed by a base station;
- the method further comprises
 - defining an offset parameter indicating the first second-partition element index;
 - transmitting the offset parameter to a user equipment;

According to a second aspect of the present disclosure, there is provided an apparatus comprising:

- a receiver/transmitter configured to communicate with at least another apparatus,
- a memory configured to store computer program code, and
- a processor configured to cause the apparatus to perform:
 - obtaining information regarding first partition elements related to a first partitioning of channel resource elements carrying in downlink a configurable first control channel associated with a data channel,
 - determining a number of second partition elements related to a second partitioning of channel resource elements per first partition element, wherein determining the number of second-partition elements comprises deriving the number of a subframe type,

determining for at least one second partition element a second-partition element index based on information regarding the first partition elements and the determined number,

determining for at least one third partition element related to a third partitioning of channel resource elements, a third-partition element index,

wherein the second partitioning is related to the allocation of channel resources of the first control channel, and

wherein the third partitioning is related to allocating channel resources of a second control channel, and

wherein the first partitioning is related to a partitioning used for allocating channel resources to the data channel.

According to further refinements of the present disclosure as defined under the above aspects,

- the processor is further configured to cause the apparatus to perform
 - receiving a data packet transmitted on the data channel, and
 - providing feedback information in uplink direction on the second control channel about successful or unsuccessful reception of the data packet;
- the first partitioning is related to allocating channel resources of the data channel;
- at least one of the second-partition element index and information regarding first partition elements is unique in a cell;
- at least one of the second-partition element index and information regarding first partition elements is unique per user equipment;
- each second-partition element index is mapped to one or more third-partition element indexes;
- determining the number of second-partition elements comprises deriving the number from a subframe type;
- the second-partition element indices are determined so as to form a continuous set of indices;
- the second-partition element indices are determined starting from the second-partition element on the first partition element with the lowest index;
- the second-partition element indices are determined starting from the second-partition element on the first partition element with the highest index;

According to a third aspect, there is provided a computer program product including a program for a processing device, comprising software code portions for performing the steps of the first aspect when the program is run on the processing device.

According to another embodiment of the present disclosure there is provided a computer program product comprising code means adapted to produce steps of any of the methods as described above when loaded into the memory of a computer.

According to a still further embodiment of the disclosure there is provided a computer program product as defined above, wherein the computer program product comprises a computer-readable medium on which the software code portions are stored.

According to a still further embodiment of the disclosure there is provided a computer program product as defined above, wherein the program is directly loadable into an internal memory of the processing device.

Brief Description of the Drawings

These and other objects, features, details and advantages will become more fully apparent from the following detailed description of embodiments of the present invention which is to be taken in conjunction with the appended drawings, in which:

Fig. 1 is a diagram illustrating a principle of implicit ACK/NACK resource allocation on PUCCH in LTE Rel 8.

Fig. 2 is a diagram illustrating an exemplary eCCE indexing assuming 50 PRBs and 4 eCCEs per PRB.

Fig. 3 is a diagram illustrating a principle of cell specific eCCE indexing according to the first embodiment of the present invention.

Fig. 4 is a diagram illustrating an example of many-to-one mapping between eCCE index and PUCCH index according to the first embodiment of the present invention.

CLAIMS

1. A method, comprising:

obtaining information regarding first partition elements related to a first partitioning of channel resource elements carrying in downlink a configurable first control channel for allocating channel resources to a data channel,

determining a number of second partition elements related to a second partitioning of channel resource elements per first partition element, wherein determining the number of second-partition elements comprises deriving the number of a subframe type,

determining for at least one second partition element a second-partition element index based on information regarding the first partition elements and the determined number,

determining at least one third partition element related to a third partitioning of channel resource elements, associated with a third-partition element index,

wherein the second partitioning is related to the allocation of channel resources of the first control channel,

wherein the third partitioning is related to allocating channel resources of a second control channel, and

wherein the first partitioning is related to a partitioning used for allocating channel resources to the data channel.

2. The method according to claim 1, further comprising

receiving on the first control channel control information for allocating channel resources to the data channel,

receiving a data packet transmitted on the data channel, and

providing feedback information in uplink direction on the second control channel about successful or unsuccessful reception of the data packet,

wherein the feedback information is provided on the at least one third partition element, and

wherein the second partition element index is used in determining the third-partition element index.

3. The method according to any one of claims 1 to 2,
wherein the second-partition element indexing scheme is specified per cell.
4. The method according to any one of according to claims 1 to 2,
wherein at least one of the second-partition element index and information
regarding first partition elements is unique per user equipment.
5. The method according to any one of claims 1 to 4,
wherein each second-partition element index is mapped to one or more third-
partition element indexes.
6. The method according to any one of claims 1 to 5, wherein
the second-partition element indices are determined so as to form a
continuous set of indices.
7. The method according to any one of claims 1 to 6, wherein
the second-partition element indices are determined starting from the second-
partition element on the first partition element with the lowest index.
8. The method according to any one of claims 1 to 6, wherein
the second-partition element indices are determined starting from the second-
partition element on the first partition element with the highest index.
9. The method according to any one of claims 1 to 8, wherein
determining at least one third-partition element index comprises one-to-one
mapping between the second-partition element index and the third-partition element
index starting from the lowest second-partition element index.
10. The method according to any one of claims 1 to 8, wherein
determining at least one third-partition element index comprises many-to-one
mapping between the second-partition element index and the third-partition element
index.

11. The method according to claim 10, further comprising a collision avoidance mechanism,

12. The method according to claim 11, wherein

the collision avoidance mechanism comprises including a specific field modifying the implicit uplink channel resource allocation.

13. The method according to claim 11, further comprising a collision avoidance mechanism, wherein

the collision avoidance mechanism comprises first control channel scheduling including selecting at least one second-partition element used for the first control channel.

14. The method according to claim 10, wherein

the many-to-one mapping comprises one-to-one mapping between the second-partition element index and the third-partition element index for the second-partition elements contained on one first-partition element.

15. The method according to any one of claims 1 to 14, wherein

the method is executed by a user equipment, wherein obtaining information regarding first partition elements includes receiving the information from a base station.

16. The method according to claim 15, further comprising

receiving an offset parameter indicating the first second-partition element index from a base station.

17. An apparatus comprising

a receiver/transmitter configured to communicate with at least another apparatus,

a memory configured to store computer program code, and

a processor configured to cause the apparatus to perform:

obtaining information regarding first partition elements related to a first partitioning of channel resource elements carrying in downlink a configurable first control channel associated with a data channel,

determining a number of second partition elements related to a second partitioning of channel resource elements per first partition element, wherein determining the number of second-partition elements comprises deriving the number of a subframe type,

determining for at least one second partition element a second-partition element index based on information regarding the first partition elements and the determined number,

determining at least one third partition element related to a third partitioning of channel resource elements, associated with a third-partition element index,

wherein the second partitioning is related to the allocation of channel resources of the first control channel, and

wherein the third partitioning is related to allocating channel resources of a second control channel, and

wherein the first partitioning is related to a partitioning used for allocating channel resources to the data channel.

18. A computer program product including a program for a processing device, comprising software code portions for performing the steps of any one of claims 1 to 16 when the program is run on the processing device.