

One non-limiting and exemplary embodiment provides apparatuses and methods for using multiple subframe allocation while still providing efficient control information granularity.

An aspect of the present disclosure provides an apparatus for receiving a resource grant for multiple subframes in a communication system, the apparatus comprising a transceiver, which, in operation, receives a signal comprising a control information including: the resource grant for multiple subframes in a licensed assisted access (LAA) cell, wherein each subframe of the multiple subframes comprises a first transport block (TB) and a second TB, a precoding indication common for the multiple subframes, and a first modulation and coding scheme (MCS) indicator for the first TB and a second MCS indicator for the second TB, which are common for the multiple subframes, wherein the first MCS indicator and the second MCS indicator are capable of taking one of a plurality of values including values indicating one of a plurality of MCSs and at least one value not indicating MCS; and processing circuitry, which is coupled to the transceiver and which, responsive to the first MCS indicator taking a value not indicating MCS, determines that all of the first TBs in the multiple subframes are disabled and, responsive to the second MCS indicator taking a value not indicating MCS, determines that all of the second TBs in the multiple subframes are disabled.

Another aspect of the present disclosure provides an apparatus for transmitting a resource grant for multiple subframes in a communication system, the apparatus comprising: processing circuitry, which, in operation, sets a first modulation and coding scheme (MCS) indicator for a first transport block (TB) to a value not indicating MCS to indicate that all of the first TBs in the multiple subframes are disabled, and sets a second MCS indicator for a second TB to a value not indicating MCS to indicate that all of the second TBs in the multiple subframes are disabled; and a transceiver, which is coupled to the processing circuitry and which, in operation, transmits a signal comprising-a control information including: the resource grant for multiple subframes in a licensed assisted access (LAA) cell, wherein each subframe of the multiple subframes comprises the first TB and the second TB, a precoding indication common for the multiple subframes, and the first MCS indicator for the first TB and the second MCS indicator for the second TB, which are common for the multiple subframes, wherein the first MCS indicator and the second MCS indicator are capable of taking one of a plurality of values including values indicating one of a plurality of MCSs and at least one value not indicating MCS.

Another aspect of the present disclosure provides a method for receiving a resource grant for multiple subframes in a communication system, the method comprising: receiving a signal comprising-a control information including: the resource grant for multiple subframes in a licensed assisted access (LAA) cell, wherein each subframe of the multiple subframes

comprises a first transport block (TB) and a second TB, a precoding indication common for the multiple subframes, and a first modulation and coding scheme (MCS) indicator for the first TB and a second MCS indicator for the second TB, which are common for the multiple subframes, wherein the first MCS indicator and the second MCS indicator are capable of taking one of a plurality of values including values indicating one of a plurality of MCSs and at least one value not indicating MCS; responsive to the first MCS indicator taking a value not indicating MCS, determining that all of the first TBS in the multiple subframes are disabled; and responsive to the second MCS indicator taking a value not indicating MCS, determining that all of the second TBs in the multiple subframes are disabled.

There is also disclosed an apparatus for receiving a resource grant for multiple subframes in a communication system, the apparatus comprising a transceiver for receiving signal comprising a control information including the resource grant for multiple subframes and a plurality of codewords for each subframe, a precoding indication common for the multiple subframes, a modulation and coding scheme, MCS, indicator common for the granted multiple subframes and individual for each of the plurality of codewords, the MCS indicator taking one of a plurality of values including values indicating one of a plurality of MCSs and at least one value not indicating MCS; and a processing device configured to determine that a codeword from the plurality of codewords in the multiple subframes is disabled if the MCS indicator for at least one of the plurality of codewords has a value not indicating MCS and not disabled otherwise.

There is also disclosed an apparatus for receiving a resource grant for multiple subframes in a communication system, the apparatus comprising a transceiver for receiving signal comprising a control information including the resource grant common for multiple subframes and a plurality of codewords for each subframe, a codeword indication indicating enabling or disabling of one or more codewords for each of the multiple subframes, a processing device configured to determine for each subframe whether a codeword from the plurality of codewords in said subframes is enabled or disabled according to the codeword indication and/or which codeword is enabled or disabled.

It should be noted that general or specific embodiments may be implemented as a signal, a system, a method, an integrated circuit, a computer program, a storage medium, or any selective combination thereof.

Additional benefits and advantages of the disclosed embodiments will become apparent from the specification and drawings. The benefits and/or advantages may be individually obtained by the various embodiments and features of the specification and drawings, which need not all be provided in order to obtain one or more of such benefits and/or advantages.

BRIEF DESCRIPTION OF THE FIGURES

In the following exemplary embodiments are described in more detail with reference to the attached figures and drawings.

5 Fig. 1 shows an exemplary architecture of a 3GPP LTE system,

CLAIMS

1. An apparatus for receiving a resource grant for multiple subframes in a communication system, the apparatus comprising
 - a transceiver, which, in operation, receives a signal comprising a control information including:
 - the resource grant for multiple subframes in a licensed assisted access (LAA) cell, wherein each subframe of the multiple subframes comprises a first transport block (TB) and a second TB,
 - a precoding indication common for the multiple subframes, and
 - a first modulation and coding scheme (MCS) indicator for the first TB and a second MCS indicator for the second TB, which are common for the multiple subframes, wherein the first MCS indicator and the second MCS indicator are capable of taking one of a plurality of values including values indicating one of a plurality of MCSs and at least one value not indicating MCS; and
 - processing circuitry, which is coupled to the transceiver and which, responsive to the first MCS indicator taking a value not indicating MCS, determines that all of the first TBs in the multiple subframes are disabled and, responsive to the second MCS indicator taking a value not indicating MCS, determines that all of the second TBs in the multiple subframes are disabled.
2. The apparatus according to claim 1, wherein the plurality of values include 32 indexed values, out of which three with the highest indexes do not indicate MCS.
3. The apparatus according to claim 1, wherein
 - the control information includes a redundancy version indication, which is individual for each of the multiple subframes and common for the first TB and the second TB in each subframe, and
 - the processing circuitry, responsive to at least one of the first MCS indicator and the second MCS indicator taking a value not indicating MCS and the redundancy version indication taking a defined value for one of the multiple subframes, determines that at least one of the first TB and the second TB in said one of the multiple subframes are disabled.
4. The apparatus according to claim 3, wherein in a subframe in which one of the first TB and the second TB is enabled and the other of the first TB and the second TB is

disabled, the processing circuitry determines a redundancy version for the enabled TB based on the redundancy version indication and on the value not indicating MCS to indicate disabling of the disabled TB.

5. The apparatus according to claim 3, wherein in a subframe in which the first TB and the second TB are enabled, the processing circuitry determines the MCS for the first and second TBs based on the redundancy version indication and on the value indicating MCS.
6. The apparatus according to claim 1, wherein the precoding indication is common for the multiple subframes in which only one of the first TBs or the second TBs are enabled codeword.
7. The apparatus according to claim 1, wherein the precoding indication is a combination of transmitted precoding matrix indication (TPMI) and number of transmission layers, which is selected from:
 - a plurality of predefined combinations of TPMI and number of transmission layers; or
 - a plurality of combinations of TPMI and number of transmission layers in a candidate set preconfigured by means of a semi-static signaling; or
 - a first plurality of predefined combinations of TPMI and number of transmission layers which are selectable for a single-layer configuration using a single TB per subframe, or a second plurality of predefined combinations of TPMI and number of transmission layers which are not selectable for the single-layer configuration, wherein values of the precoding indication in the second plurality are reserved values in the first plurality.
8. An apparatus for transmitting a resource grant for multiple subframes in a communication system, the apparatus comprising:
 - processing circuitry, which, in operation, sets a first modulation and coding scheme (MCS) indicator for a first transport block (TB) to a value not indicating MCS to indicate that all of the first TBs in the multiple subframes are disabled, and sets a second MCS indicator for a second TB to a value not indicating MCS to indicate that all of the second TBs in the multiple subframes are disabled; and
 - a transceiver, which is coupled to the processing circuitry and which, in operation, transmits a signal comprising-a control information including:

the resource grant for multiple subframes in a licensed assisted access (LAA) cell, wherein each subframe of the multiple subframes comprises the first TB and the second TB,

a precoding indication common for the multiple subframes, and

the first MCS indicator for the first TB and the second MCS indicator for the second TB, which are common for the multiple subframes, wherein the first MCS indicator and the second MCS indicator are capable of taking one of a plurality of values including values indicating one of a plurality of MCSs and at least one value not indicating MCS.

9. The apparatus according to claim 8, wherein the plurality of values include 32 indexed values, out of which three with the highest indexes do not indicate MCS.
10. The apparatus according to claim 8, wherein
 - the control information includes a redundancy version indication, which is individual for each of the multiple subframes and common for the first TB and the second TB in each subframe, and
 - the processing circuitry sets at least one of the first MCS indicator and the second MCS indicator to a value not indicating MCS and sets the redundancy version indication to a defined value for one of the multiple subframes, to indicate that at least one of the first TB and the second TB in said one of the multiple subframes are disabled.
11. The apparatus according to claim 10, wherein in a subframe in which one of the first TB and the second TB is enabled and the other of the first TB and the second TB is disabled, the processing circuitry defines a redundancy version for the enabled TB based on the redundancy version indication and on the value not indicating MCS to indicate disabling of the disabled TB.
12. The apparatus according to claim 10, wherein in a subframe in which the first TB and the second TB are enabled, the processing circuitry defines the MCS for the first and second TBs based on the redundancy version indication and on the value indicating MCS.
13. The apparatus according to claim 8, wherein the precoding indication is common for the multiple subframes in which only one of the first TBs or the second TBs are enabled.

14. A method for receiving a resource grant for multiple subframes in a communication system, the method comprising:
 - receiving a signal comprising-a control information including:
 - the resource grant for multiple subframes in a licensed assisted access (LAA) cell, wherein each subframe of the multiple subframes comprises a first transport block (TB) and a second TB,
 - a precoding indication common for the multiple subframes, and
 - a first modulation and coding scheme (MCS) indicator for the first TB and a second MCS indicator for the second TB, which are common for the multiple subframes, wherein the first MCS indicator and the second MCS indicator are capable of taking one of a plurality of values including values indicating one of a plurality of MCSs and at least one value not indicating MCS; responsive to the first MCS indicator taking a value not indicating MCS, determining that all of the first TBs in the multiple subframes are disabled; and
 - responsive to the second MCS indicator taking a value not indicating MCS, determining that all of the second TBs in the multiple subframes are disabled.
15. The method according to claim 14, wherein the plurality of values include 32 indexed values, out of which three with the highest indexes do not indicate MCS.
16. The method according to claim 14, wherein
 - the control information includes a redundancy version indication, which is individual for each of the multiple subframes and common for the first TB and the second TB in each subframe, and the method comprises:
 - responsive to at least one of the first MCS indicator and the second MCS indicator taking a value not indicating MCS and the redundancy version indication taking a defined value for one of the multiple subframes, determining that at least one of the first TB and the second TB in said one of the multiple subframes are disabled.
17. The method according to claim 16, comprising:
 - in a subframe in which one of the first TB and the second TB is enabled and the other of the first TB and the second TB is disabled, determining a redundancy version for the enabled TB based on the redundancy version indication and on the value not indicating MCS to indicate disabling of the disabled TB.

18. The method according to claim 16, comprising:
 - in a subframe in which the first TB and the second TB are enabled, determining the MCS for the first and second TBs based on the redundancy version indication and on the value indicating MCS.
19. The method according to claim 14, wherein the precoding indication is common for the multiple subframes in which only one of the first TBs or the second TBs are enabled.
20. The method according to claim 14, wherein the precoding indication is a combination of transmitted precoding matrix indication (TPMI) and number of transmission layers, which is selected from:
 - a plurality of predefined combinations of TPMI and number of transmission layers; or
 - a plurality of combinations of TPMI and number of transmission layers in a candidate set preconfigured by means of a semi-static signaling; or
 - a first plurality of predefined combinations of TPMI and number of transmission layers which are selectable for a single-layer configuration using a single TB per subframe, or a second plurality of predefined combinations of TPMI and number of transmission layers which are not selectable for the single-layer configuration, wherein values of the precoding indication in the second plurality are reserved values in the first plurality.