

Claims

What is claimed is:

1. A method, performed by a wireless device, for setting Hybrid Automatic Repeat Request, HARQ, timing for Physical Downlink Shared Channel, PDSCH, the method comprising:

receiving (600,700) a first Downlink Control Information, DCI, (508) associated with a first Downlink, DL, data transmission (510), the first DCI (508) comprising a PDSCH-to-HARQ-timing-indicator having a predefined value indicating that ~~at the~~ HARQ feedback for the first DL data transmission is to occur once the wireless device has received a DCI comprising a numerical PDSCH-to-HARQ-timing-indicator having a value different from the predefined value;

receiving (602,702) the first DL data transmission (510);

~~determining (604,704) a HARQ feedback for the first DL data transmission (510);~~

receiving (606,706) a second DCI (514) associated with a second DL data transmission (516), the second DCI (514) comprising a numerical PDSCH-to-HARQ-timing-indicator indicating a location in time for HARQ feedback associated with the second DL data transmission;

~~setting (608,710) a location in time of HARQ feedback associated with the first DL data transmission to be the same as the location in time of HARQ feedback associated with the second DL data transmission; and~~

transmitting (610,712) the HARQ feedback associated with the first DL data transmission (522) at the ~~set location in time~~ same location in time as that of HARQ feedback associated with the second DL data transmission.

2. The method of claim 1, wherein receiving (606) the second DCI (514) comprises receiving information indicating a number of how many HARQ processes should be reported, the number including all pending PDSCHs and all PDSCHs having a DCI comprising a- PDSCH-to-HARQ-timing-indicator having the predefined value since a last PDSCH have a DCI comprising a numerical PDSCH-to-HARQ-timing-indicator having a value different from the predefined value.

3. The method of claim 2, wherein receiving the information indicating a number of how many HARQ processes should be reported comprises receiving a Downlink Assignment Indicator, DAI.

5 4. The method of any one of claims 1 - 3, further comprising, subsequent to receiving (606,706) the second DCI associated with the second DL data transmission, determining (708) that the second DL data transmission is of a same PDSCH group as the first DL data transmission,

10 wherein ~~setting (608,710) the location in time of HARQ feedback associated with the first DL data transmission to be the same as the location in time of HARQ feedback associated with the second DL data transmission, and transmitting (610,712) the HARQ feedback associated with the first DL data transmission (522) at the set location in time~~
same location in time as that of the HARQ feedback associated with the second DL data transmission ~~is~~ performed ~~only~~ upon determining that the second DL data
 15 transmission is indicated as being of a the same PDSCH group as the first DL data transmission.

5. The method of any one of claims 1 - 4 wherein receiving (606,706) the second DCI (514) associated with the second DL data transmission (516) comprises receiving a
 20 User Equipment, UE, -specific DCI transmitted on a Physical Downlink Control Channel, PDCCH, the UE-specific DCI comprising the PDSCH-to-HARQ-timing-indicator.

6. The method of claim 5 wherein the UE-specific DCI further comprises a HARQ process Identifier, ID.
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7. The method of claim 5 or 6 wherein the UE-specific DCI further comprises a New Data Indicator, NDI, value corresponding to the HARQ process ID.

8. The method of any one of claims 5 - 7 where the UE-specific DCI further
 30 comprises a PDSCH group ID and a corresponding Downlink Assignment Indicator, DAI.

9. The method of any one of claims 5 - 8 wherein the UE-specific DCI further comprises a trigger bit indicating that the PDSCH-to-HARQ-timing-indicator is applicable to all PDSCHs with a PDSCH-to-HARQ-timing-indicator having the predefined value.

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10. The method of claim 9 wherein the trigger bit comprises part of a DCI that is scheduling a PDSCH.

10 11. The method of claim 9 wherein the trigger bit comprises part of a DCI that is not scheduling a PDSCH.

~~12.—A method, performed by a wireless device, for setting Hybrid Automatic Repeat Request, HARQ, timing for Physical Downlink Shared Channel, PDSCH, the method comprising:~~

15 ~~receiving (900) a first Downlink Control Information, DCI, associated with a first Downlink, DL, data transmission of a first PDSCH group, the first DCI comprising a numerical PDSCH to HARQ timing indicator;~~

~~determining (902) that a location in time for HARQ feedback that is associated with the first DL data transmission, indicated by the numerical PDSCH to HARQ timing indicator, is too close to the first DL data transmission; and~~

20 ~~in response to that determination, not transmitting (904) the HARQ feedback that is associated with the first DL data transmission at the indicated HARQ transmission time.~~

25 ~~13.—The method of claim 12, further comprising providing (906) an indication, on the Physical Uplink Control Channel, PUCCH, at the indicated HARQ transmission time, which informs the New Radio base station, gNB, that the HARQ feedback was postponed.~~

30 ~~14.—The method of claim 12 or 13, further comprising:~~

~~receiving a second DCI associated with a second DL data transmission, the second DCI comprising a numerical PDSCH to HARQ timing indicator indicating a location in time for HARQ feedback associated with the second DL data transmission;~~

setting the location in time of HARQ feedback associated with the first DL data transmission to be the same as the location in time of HARQ feedback associated with the second DL data transmission; and

5 transmitting the HARQ feedback associated with the first DL data transmission at the set location in time.

15. — A method, performed by a wireless device, for setting Hybrid Automatic Repeat Request, HARQ, timing for Physical Downlink Shared Channel, PDSCH, the method comprising:

10 receiving (900) a first Downlink Control Information, DCI, associated with a first Downlink, DL, data transmission of a first PDSCH group, the first DCI comprising a numerical PDSCH to HARQ timing indicator;

15 determining that the numerical PDSCH to HARQ timing indicator is a predefined value indicating that the corresponding HARQ transmission on a Physical Uplink Control Channel, PUCCH, should be postponed due to a later request for another HARQ transmission on a PUCCH corresponding to another PDSCH.

16. — The method of claim 15, further comprising:

20 receiving a second DCI associated with a second DL data transmission, the second DCI comprising a numerical PDSCH to HARQ timing indicator indicating a location in time for HARQ feedback associated with the second DL data transmission;

setting a location in time of HARQ feedback associated with the first DL data transmission to be the same as the location in time of HARQ feedback associated with the second DL data transmission; and

25 transmitting the HARQ feedback associated with the first DL data transmission at the set location in time.

17. — A method, performed by a wireless device, for setting Hybrid Automatic Repeat Request, HARQ, timing for Physical Downlink Shared Channel, PDSCH, the method comprising:

30 receiving (900) a first Downlink Control Information, DCI, associated with a first Downlink, DL, data transmission of a first PDSCH group, the first DCI comprising a numerical PDSCH to HARQ timing indicator;

determining that the numerical PDSCH to HARQ timing indicator is a predefined value indicating that a corresponding Uplink, UL, HARQ transmission on a Physical Uplink Control Channel, PUCCH, should be sent in a slot or set of symbols that can be dynamically chosen to be used for UL or DL;

5 determining that the slot or set of symbols has been set for DL transmission and thus is unavailable for the corresponding UL HARQ transmission;

in response to that determination, postponing the corresponding HARQ transmission.

10 18. The method of claim 17, further comprising:

receiving a second DCI associated with a second DL data transmission, the second DCI comprising a numerical PDSCH to HARQ timing indicator indicating a location in time for HARQ feedback associated with the second DL data transmission;

15 setting a location in time of HARQ feedback associated with the first DL data transmission to be the same as the location in time of HARQ feedback associated with the second DL data transmission; and

transmitting the HARQ feedback associated with the first DL data transmission at the set location in time.

20 129. A method of any one of claims 1-11, performed by a wireless device, for setting Hybrid Automatic Repeat Request, HARQ, timing for Physical Downlink Shared Channel, PDSCH, the method comprising:

25 receiving a first Downlink Control Information, DCI, associated with a first Downlink, DL, data transmission, the first DCI comprising a numerical wherein the PDSCH-to-HARQ-timing-indicator having a predefined value is a numerical PDSCH-to-HARQ-timing-indicator indicating that HARQ feedback for the first DL data transmissions should be delayed until the wireless device has received a DCI comprising a numerical PDSCH-to-HARQ-timing-indicator having a value different from the predefined value;

receiving the first DL data transmission;

30 determining a HARQ feedback for the first DL data transmission;

receiving a second DCI associated with a second DL data transmission, the second DCI comprising a numerical PDSCH to HARQ timing indicator indicating a location in time for HARQ feedback associated with the second DL data transmission;

~~setting a location in time of HARQ feedback associated with the first DL data transmission to be the same as the location in time of HARQ feedback associated with the second DL data transmission; and~~

~~transmitting the HARQ feedback associated with the first DL data transmission at the set location in time.~~

1320. The method of claim 129, wherein the predefined value comprises an existing PDSCH-to-HARQ-timing-indicator value that has been remapped from indicating a delay value to indicating that HARQ transmissions should be delayed until the wireless device has received a DCI comprising a numerical PDSCH-to-HARQ-timing-indicator having a value different from the predefined value.

1421. The method of claim 1320 wherein, prior to receiving the first DCI, the wireless device receives an instruction to remap the existing PDSCH-to-HARQ-timing-indicator value from indicating a delay value to indicating that HARQ transmissions should be delayed until the wireless device has received a DCI comprising a numerical PDSCH-to-HARQ-timing-indicator having a value different from the predefined value.

1522. The method of claim 129, wherein the predefined value comprises an additional bit that has been added to an existing PDSCH-to-HARQ-timing-indicator value bit field in the DCI.

16. The method of any one of claims 12-15, wherein the numerical PDSCH-to-HARQ-timing-indicator value indicates that a corresponding Uplink, HARQ transmission on a Physical Uplink Control Channel, PUCCH, should be sent in a slot or set of symbols that are configured to be dynamically chosen to be used for UL or DL; and the method further comprises:

postponing the corresponding HARQ transmission when the slot or set of symbols has been set for DL transmission and thus is unavailable for the corresponding UL HARQ transmission.

1723. A method, performed by a base station, for setting Hybrid Automatic Repeat Request, HARQ, timing for Physical Downlink Shared Channel, PDSCH, the method comprising:

determining a PDSCH-to-HARQ-timing for an upcoming Downlink, DL, data transmission to a User Equipment, UE;

determining that the HARQ feedback for the upcoming DL data transmission should be delayed by the UE until further notification from the base station; ~~and~~

transmitting, to the UE, a first Downlink Control Information, DCI, associated with the upcoming DL data transmission, the first DCI comprising a predefined PDSCH-to-HARQ-timing-indicator value for indicating to the UE that HARQ feedback for the upcoming DL data transmission should be delayed until further notification from the base station; and

transmitting, to the UE, a second DCI as the further notification, the second DCI being associated with a second DL data transmission and comprising a numerical PDSCH-to-HARQ-timing-indicator.

1824. The method of claim 1723 wherein determining that the HARQ feedback for the upcoming DL data transmission should be delayed by the UE until further notification from the base station comprises determining that a processing delay from the end of the upcoming DL data transmission to the beginning of the HARQ feedback opportunity is less than a minimum threshold delay.

1925. The method of claim 1723 or 1824 wherein the predefined PDSCH-to-HARQ-timing-indicator value comprises a non-applicable ~~numerical~~ value.

206. The method of claim 1723 or 1824 wherein the predefined PDSCH-to-HARQ-timing-indicator value comprises an existing PDSCH-to-HARQ-timing-indicator value that has been remapped from indicating a delay value to indicating that HARQ transmissions should be delayed until a wireless device has received a DCI comprising a numerical PDSCH-to-HARQ-timing-indicator having a value different from the predefined value.

217. The method of claim 206 wherein, prior to sending the first DCI, the base station sends, to the UE, an instruction to remap the existing PDSCH-to-HARQ-timing-indicator

value from indicating a delay value to indicating that HARQ transmissions should be delayed until the wireless device has received a DCI comprising a numerical PDSCH-to-HARQ-timing-indicator having a value different from the predefined value.

- 5 ~~228.~~ The method of claim ~~1723~~ or ~~1824~~, wherein the predefined PDSCH-to-HARQ-timing-indicator value comprises an additional bit that has been added to an existing PDSCH-to-HARQ-timing-indicator value bit field in the DCI.

10 ~~29.~~ ~~The method of any one of claims 23–28 further comprising transmitting the further notification to the UE.~~

15 ~~30.~~ ~~The method of claim 29 wherein transmitting the further notification to the UE comprises transmitting a second DCI associated with a second DL data transmission, the second DCI comprising a numerical PDSCH to HARQ timing indicator.~~

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~~2331.~~ The method of claim ~~1729~~ or ~~30~~ wherein transmitting the second DCI further comprises transmitting at least one of the following: a HARQ process Identifier, ID; a New Data Indicator, NDI, value; a PDSCH group ID; a Downlink Assignment Indicator, DAI; or a trigger bit.

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~~2432.~~ A wireless device for setting Hybrid Automatic Repeat Request, HARQ, timing for Physical Downlink Shared Channel, PDSCH, , the wireless device comprising processing circuitry configured to:

25 receive (600,700) a first Downlink Control Information, DCI, (508) associated with a first Downlink, DL, data transmission (510), the first DCI (508) comprising a PDSCH-to-HARQ-timing-indicator having a predefined value indicating that the HARQ feedback for the first DL data transmission is to occur once the wireless device has received a DCI comprising a numerical PDSCH-to-HARQ-timing-indicator having a value different from the predefined value;

30 receive (602,702) the first DL data transmission (510);

~~determine (604,704) a HARQ feedback for the first DL data transmission (510);~~

 receive (606,706) a second DCI (514) associated with a second DL data transmission (516), the second DCI (514) comprising a numerical PDSCH-to-HARQ-

timing-indicator indicating a location in time for HARQ feedback associated with the second DL data transmission;

~~set (608,710) a location in time of HARQ feedback associated with the first DL data transmission to be the same as the location in time of HARQ feedback associated~~
 5 ~~with the second DL data transmission; and~~

transmit (610,712) the HARQ feedback associated with the first DL data transmission (522) at the ~~set location in time~~ same location in time as that of HARQ feedback associated with the second DL data transmission.

10 2533. The wireless device of claim 2432 wherein the processing circuitry is further configured to perform the methodsteps of any one of claims 2 - 1622.

2634. The wireless device of claim 2432 or 2533 wherein the processing circuitry comprises one or more processors and memory storing instructions executable by the
 15 one or more processors whereby the wireless device is operable to perform the methodsteps.

2735. A base station for setting Hybrid Automatic Repeat Request, HARQ, timing for Physical Downlink Shared Channel, PDSCH,- the base station comprising processing
 20 circuitry configured to:

determine a PDSCH-to-HARQ-timing for an upcoming Downlink, DL, data transmission to a User Equipment, UE;

determine that the HARQ feedback for the upcoming DL data transmission should be delayed by the UE until further notification from the base station; ~~and~~

25 transmit, to the UE, a first Downlink Control Information, DCI, associated with a first DL data transmission, the first DCI comprising a predefined PDSCH-to-HARQ-timing-indicator value for indicating to the UE that HARQ feedback for the first DL data transmission should be delayed until further notification from the base station; and
 30 transmit, to the UE, a second DCI as the further notification, the second DCI being associated with a second DL data transmission and comprising a numerical PDSCH-to-HARQ-timing-indicator.

2836. The base station of claim 2735 wherein the processing circuitry is further configured to perform the methodsteps of any one of claims 1824 - 231.

5 2937. The base station of claim 2735 or 2836 wherein the processing circuitry comprises one or more processors and memory storing instructions executable by the one or more processors whereby the ~~wireless device~~base station is operable to perform the methodsteps of any one of claims 18-23.