

standardized radio access technologies include GSM (Global System for Mobile), EDGE (Enhanced Data for GSM Evolution) Radio Access Networks (GERAN), Universal Terrestrial Radio Access Networks (UTRAN) and evolved UTRAN (E-UTRAN). An example communication system architecture is the long-term evolution (LTE) of the Universal Mobile Telecommunications System (UMTS) radio-access technology. The LTE is standardized by the third Generation Partnership Project (3GPP). The LTE employs the Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access and a further development thereof which is sometimes referred to as LTE Advanced (LTE-A).

Since introduction of fourth generation (4G) services increasing interest has been paid to the next, or fifth generation (5G) standard. 5G may also be referred to as a NR network. Standardization of 5G or NR networks is ongoing in 3GPP.

Summary

According to an example, there is provided an apparatus comprising: at least one processor and at least one memory including computer program code, the at least one memory and the computer program code configured to, with the at least one processor, cause the apparatus at least to: responsive to deactivation of all of a plurality of active cells associated with a duplicate link, cause said duplicate link to be deactivated.

The at least one memory and the computer code may be configured, with the at least one processor, to cause the apparatus, responsive to deactivation of said duplicate link, to cause data in a buffer associated with said deactivated duplicate link to be transmitted from a user equipment to an access point.

The at least one memory and the computer code may be configured, with the at least one processor, to cause the apparatus to determine if said buffer has data to be transmitted after said deactivation of said duplicate link .

The buffer may be associated with a radio link control entity associated with said deactivated duplicate link.

A logical channel may be associated with said duplicate link, and the at least one memory and the computer code may be configured, with the at least one processor, to cause the apparatus to map said logical channel to at least one active cell associated with an original link such that said data is transmitted on said logical channel to said at least one active cell of said access point.

The at least one active cell may comprise at least one of a primary cell and a secondary cell.

The at least one memory and the computer code may be configured, with the at least one processor, to cause the apparatus to cause said data in said buffer associated with said deactivated duplicate link to be transmitted until one of: all of said data has been transmitted; and said duplicate link is reactivated.

The apparatus may be provided in a wireless device.

According to another example, there is provided an apparatus comprising: at least one processor and at least one memory including computer program code, the at least one memory and the computer program code configured to, with the at least one processor, cause the apparatus at least to: responsive to deactivation of all of a plurality of active cells associated with duplication, cause said duplication to be deactivated.

The at least one memory and the computer code may be configured, with the at least one processor, to cause the apparatus, responsive to deactivation of said duplication, to cause data in a buffer associated with said deactivated duplication to be transmitted from a user equipment to an access point.

The at least one memory and the computer code may be configured, with the at least one processor, to cause the apparatus to determine if said buffer has data to be transmitted after said deactivation of said duplication.

The buffer may be associated with a radio link control entity associated with said deactivated duplication.

A logical channel may be associated with said duplication, and the at least one memory and the computer code may be configured, with the at least one processor, to cause the apparatus to map said logical channel to at least one active cell associated with an original link such that said data is transmitted on said logical channel to said at least one active cell of said access point.

The at least one active cell may comprise at least one of a primary cell and a secondary cell.

The at least one memory and the computer code may be configured, with the at least one processor, to cause the apparatus to cause said data in said buffer associated with said deactivated duplication to be transmitted until one of: all of said data has been transmitted; and said duplication is reactivated.

The apparatus may be provided in a wireless device.

According to another example there is provided a method comprising: responsive to deactivation of all of a plurality of active cells associated with a duplicate link, causing said duplicated link to be deactivated.

The method may comprise responsive to deactivation of said duplicate link, causing data in a buffer associated with said deactivated duplicate link to be transmitted from a user equipment to an access point.

The method may comprise determining if said buffer has data to be transmitted after said deactivation of said duplicate link.

The buffer may be associated with a radio link control entity associated with said deactivated duplicate link.

A logical channel may be associated with said duplicate link, said method may comprise mapping said logical channel to at least one active cell associated with an original link such that said data is transmitted on said logical channel to said at least one active cell of said access point.

The active cell may be one of a primary cell and a secondary cell.

The method may comprise causing said data in said buffer associated with said deactivated duplicate link to be transmitted until one of: all of said data has been transmitted; and said duplicate link is reactivated.

According to another example there is provided a method comprising: responsive to deactivation of all of a plurality of active cells associated with a duplicate link, causing said duplication to be deactivated.

The method may comprise responsive to deactivation of said duplication, causing data in a buffer associated with said deactivated duplicate link to be transmitted from a user equipment to an access point.

The method may comprise determining if said buffer has data to be transmitted after said deactivation of said duplication.

The buffer may be associated with a radio link control entity associated with said deactivated duplicate link.

A logical channel may be associated with said duplicate link, said method may comprise mapping said logical channel to at least one active cell associated with an original link such that said data is transmitted on said logical channel to said at least one active cell of said access point.

The active cell may be one of a primary cell and a secondary cell.

The method may comprise causing said data in said buffer associated with said deactivated duplicate link to be transmitted until one of: all of said data has been transmitted; and said duplication is reactivated.

According to another example, there is provided a method comprising: allowing a logical channel to use only a subset of available cells when a duplicate link is activated; and allowing the logical channel to use any of said available cells when said duplicate link is deactivated.

According to another example, there is provided an apparatus comprising: at least one processor and at least one memory including computer program code, the at least one memory and the computer program code configured to, with the at least one processor, cause the apparatus at least to: allow a logical channel to use only a subset of available cells when a duplicate link is

activated; and allow the logical channel to use any of said available cells when said duplicate link is deactivated.

According to another example, there is provided a method comprising responsive to deactivation of duplication of a radio bearer, causing a default logical channel to be mapped to any one or more of active serving cells.

According to another example, there is provided an apparatus comprising: at least one processor and at least one memory including computer program code, the at least one memory and the computer program code configured to, with the at least one processor, cause the apparatus at least to: responsive to deactivation of duplication of a radio bearer, cause a default logical channel to is mapped to any one or more of active serving cells.

According to another example, there is provided a method comprising: allowing a logical channel to use only a subset of available serving cells when duplication of the associated radio bearer is activated; and allowing the logical channel to use any of said available serving cells when said duplication of the associated radio bearer is deactivated.

According to another example, there is provided a method comprising: allowing a logical channel to use only a subset of available serving cells when duplication is activated; and allowing the logical channel to use any of said available serving cells when said is deactivated.

According to another example, there is provided an apparatus comprising: at least one processor and at least one memory including computer program code, the at least one memory and the computer program code configured to, with the at least one processor, cause the apparatus at least to: allow a logical channel to use only a subset of available serving cells when duplication of the associated radio bearer is activated; and allow the logical channel to use any of said available serving cells when said duplication of the associated radio bearer is deactivated.

According to another example, there is provided an apparatus comprising: at least one processor and at least one memory including computer program code, the at least one memory and the computer program code configured to, with the at least one processor, cause the apparatus at least to: allow a logical channel to use only a subset of available serving cells when duplication is activated; and allow the logical channel to use any of said available serving cells when said is deactivated.

According to another example, there is provided a method comprising: causing at an access node deactivation of at least one of a plurality of cells associated with a duplicate link to deactivate said duplicate link. According to another example, there is provided a computer program product for a computer, comprising software code portions for performing the steps of any of the above aspects, when the

program is run on the computer.

A computer program comprising program code means adapted to perform the methods may also be provided. In an aspect, there is provided an apparatus comprising: at least one processor and at least one memory including computer program code, the at least one memory and the computer

5 program code configured to, with the at least one processor, cause the apparatus at least to:

determine that packet data layer convergence protocol, PDCP, duplication for a radio bearer is deactivated, wherein a radio bearer configured for PDCP duplication is associated with an original radio link control, RLC, and a duplicate RLC; responsive to deactivation of PDCP duplication for the radio bearer, cause mapping a logical channel associated with the duplicate RLC of the radio bearer

10 to at least one active cell associated with the original RLC of the radio bearer such that data in a buffer associated with the duplicate RLC is transmitted on the logical channel to the at least one active cell. In another aspect, there is provided a method comprising: determining that packet data

layer convergence protocol, PDCP, duplication for a radio bearer is deactivated, wherein a radio bearer configured for PDCP duplication is associated with an original radio link control, RLC, and a duplicate RLC, responsive to deactivation of PDCP duplication for the radio bearer, mapping a

15 logical channel associated with the duplicate RLC of the radio bearer to at least one active cell associated with the original RLC of the radio bearer such that data in a buffer associated with the duplicate RLC is transmitted on the logical channel to the at least one active cell

In the above, many different embodiments have been described. It should be appreciated that further embodiments may be provided by the combination of any two or more of the embodiments described above.

Brief description of Figures

Some embodiments will now be described in further detail, by way of example only, with reference to the following examples and accompanying drawings, in which:

25 Figure 1 shows a schematic example of a wireless communication system;

Figure 2 shows an example of a communication device;

Figure 3 shows an example of logical channel mapping in a user equipment; and

Figure 4 shows a method flow of an embodiment.

Detailed description

30 Before explaining in detail the examples, certain general principles of a wireless communication system and mobile communication devices are briefly explained with reference to Figures 1 to 2 to assist in understanding the technology underlying the described examples.

In a wireless communication system 100, such as that shown in Figure 1, wireless communication devices, for example, user equipment (UE) or MTC devices 102, 104, 105 are provided wireless access via at least one base station or similar wireless transmitting and/or

receiving wireless infrastructure node or point. Such a node can be, for example, a base station or an eNodeB (eNB), or in a 5G system a Next Generation NodeB (gNB), or other wireless infrastructure node. These nodes will be generally referred to as base stations. Base stations are typically controlled by at least one appropriate controller apparatus, so as to enable operation thereof and management of mobile communication devices in communication with the base stations. The controller apparatus may be located in a radio access network (e.g. wireless communication system 100) or in a core network (CN) (not shown) and may be implemented as one central apparatus or its functionality may be distributed over several apparatus. The controller apparatus may be part of the base station and/or provided by a separate entity such as a Control Unit (CU). In Figure 1 control apparatus 108 and 109 are shown to control the respective macro level base stations 106 and 107. In some systems, the control apparatus may additionally or alternatively be provided in a CU. Other examples of radio access system comprise those provided by base stations of systems that are based on technologies such as 5G

WHAT IS CLAIMED IS:

- 5 1. An apparatus comprising: at least one processor and at least one memory including computer program code, the at least one memory and the computer program code configured to, with the at least one processor, cause the apparatus at least to:

determine that packet data layer convergence protocol, PDCP, duplication for a radio bearer is deactivated, wherein a radio bearer configured for PDCP duplication is associated with an original
10 radio link control, RLC, and a duplicate RLC;

responsive to deactivation of PDCP duplication for the radio bearer, cause mapping a logical channel associated with the duplicate RLC of the radio bearer to at least one active cell associated with the original RLC of the radio bearer such that data in a buffer associated with the duplicate RLC is transmitted on the logical channel to the at least one active cell.
- 15 3. An apparatus as claimed in claim 2, wherein the at least one memory and the computer code are configured, with the at least one processor, to cause the apparatus to determine if said buffer has data to be transmitted after said deactivation of PDCP duplication.
- 20 6. An apparatus as claimed in claim 5, wherein said at least one active cell comprises at least one of a primary cell and a secondary cell.
- 25 7. An apparatus as claimed in claim 2 or any claim appended thereto, wherein the at least one memory and the computer code are configured, with the at least one processor, to cause the apparatus to cause said data in said buffer associated with the duplicate RLC to be transmitted until
30 one of: all of said data has been transmitted; and said PDCP duplication is reactivated.
8. An apparatus as claimed in claim 1, wherein determine that PDCP duplication for a radio bearer is deactivated is responsive to deactivation of all of a plurality of active cells associated with a duplicate RLC.
9. A user equipment, UE, comprising the apparatus as claimed in any preceding claim.
10. A method comprising:

determining that packet data layer convergence protocol, PDCP, duplication for a radio bearer is deactivated, wherein a radio bearer configured for PDCP duplication is associated with an original radio link control, RLC, and a duplicate RLC

responsive to deactivation of PDCP duplication for the radio bearer, mapping a logical channel associated with the duplicate RLC of the radio bearer to at least one active cell associated with the original RLC of the radio bearer such that data in a buffer associated with the duplicate RLC is transmitted on the logical channel to the at least one active cell.

11. A method as claimed in claim 10, comprising determining if said buffer has data to be transmitted after said deactivation of PDCP duplication.

12. A method as claimed in claim 10 or any claim appended thereto, comprising causing said data in said buffer associated with the duplicate RLC to be transmitted until one of: all of said data has been transmitted; and said PDCP duplication is reactivated.

13. A computer program comprising computer executable code which when run causes the method of any of claims 9 to 14 to be performed.