

TITLE OF INVENTION: IMPROVING IDLE MODE RADIO MEASUREMENTS

TECHNICAL FIELD

Various example embodiments relate generally to idle mode radio measurements.

5 BACKGROUND

A user equipment may perform idle mode radio measurements of surrounding environment. Results of the radio measurements may be provided to network. However, such measuring process needs improvements.

BRIEF DESCRIPTION

10 According some aspects, there is provided the subject matter of the independent claims. Some further aspects are defined in the dependent claims. In an aspect, the present disclosure refers to a method at a user equipment, comprising:
 determining a cell to connect with;
 determining capabilities of the user equipment in relation to carrier ag-
 15 gregation comprising a carrier of the cell;
 receiving a measurement indication identifying a plurality of carriers to be measured in idle mode, wherein the plurality of carriers comprise carriers that the user equipment can aggregate with the carrier of the cell and carriers that the user equipment cannot aggregate with the carrier of the cell; and
 20 performing, for early measurement reporting and based on the determined capabilities of the user equipment in relation to carrier aggregation, idle mode measurements of only those carriers from the plurality of carriers which the user equipment can aggregate with the carrier of the cell; and
 indicating results of the idle mode measurements to a network node of
 25 the cell upon connection establishment with the cell.
 In another aspect, the present disclosure refers to a user equipment, comprising means for performing:
 determining a cell to connect with;
 determining capabilities of the user equipment in relation to carrier ag-
 30 gregation comprising a carrier of the cell;
 receiving a measurement indication identifying a plurality of carriers to be measured in idle mode, wherein the plurality of carriers comprise carriers that

the user equipment can aggregate with the carrier of the cell and carriers that the user equipment cannot aggregate with the carrier of the cell; and

performing, for early measurement reporting and based on the determined capabilities of the user equipment in relation to carrier aggregation, idle mode measurements of only those carriers from the plurality of carriers which the user equipment can aggregate with the carrier of the cell; and

indicating results of the idle mode measurements to a network node of the cell upon connection establishment with the cell.

In another aspect, the present disclosure refers to a computer program product comprising program instructions which, when the program is executed by a user equipment, cause the user equipment to carry out the method according to any of the above aspects.

LIST OF THE DRAWINGS

In the following, the invention will be described in greater detail with reference to the embodiments and the accompanying drawings, in which

Figure 1A and 1B present communication networks, according to some embodiments;

Figure 2 shows a user equipment being in a coverage area of a plurality of cells;

Figures 3 and 4 show methods, according to some embodiments;

Figures 5 and 6 illustrate some examples of determining which carriers to measure and report, according to some embodiments;

Figure 7 shows a flow diagram, according to an embodiment; and

Figures 8 and 9 illustrate apparatuses, according to some embodiments.

DESCRIPTION OF EMBODIMENTS

The following embodiments are exemplary. Although the specification may refer to “an”, “one”, or “some” embodiment(s) in several locations of the text, this does not necessarily mean that each reference is made to the same embodiment(s), or that a particular feature only applies to a single embodiment. Single features of different embodiments may also be combined to provide other embodiments.

Embodiments described may be implemented in a radio system, such as one comprising at least one of the following radio access technologies (RATs): Worldwide Interoperability for Micro-wave Access (WiMAX), Global System for

CLAIMS

1. A method at a user equipment, comprising:

determining a ~~first~~ cell to connect with;

5 determining capabilities of the user equipment in relation to carrier aggregation comprising a carrier of the ~~first~~ cell;

~~performing receiving a measurement indication identifying a plurality of carriers to be measured in~~ idle mode ~~radio measurements, wherein the plurality of those carriers comprise~~ carriers that the user equipment can, ~~based on the determined capabilities,~~ aggregate with the carrier of the ~~first~~ cell; and ~~carriers that the user equipment cannot aggregate with the carrier of the cell;~~ ~~and~~

~~performing, for early measurement reporting and based on the determined capabilities of the user equipment in relation to carrier aggregation,~~ idle mode measurements of only those carriers from the plurality of carriers ~~which the user equipment can aggregate with the carrier of the cell; and~~

15 ~~indicating~~ results of the idle mode ~~radio~~ measurements to a network node of the ~~first~~ cell upon connection establishment with the ~~first~~ cell.
- 20 2. The method of claim 1, further comprising:

determining that the network node of the ~~first~~ cell supports reporting idle mode ~~radio~~ measurements during the connection establishment.
- 25 3. The method of any of claims 1 to 2, wherein the ~~reported~~ indicated results of the idle mode ~~radio~~ measurements cause triggering the carrier aggregation by the network node of the ~~first~~ cell, without the network node of the ~~first~~ cell asking for connected mode radio measurements to be performed.
- 30 4. The method of any of claims 1 to 3, further comprising:

~~causing a reception, from the network node~~ determining, based on the capabilities of the ~~first cell, of an indication indicating that a user equipment in relation to~~ carrier aggregation ~~is to be triggered for the user equipment, wherein the carrier aggregation comprises receiving data over the carrier of the first cell and over one or more of the carriers that were measured during the idle mode radio measurements.~~

35 ~~5. The method of any of claims 1 to 4, further comprising:~~
~~causing a reception of a measurement indication identifying a, those~~

~~carriers from the plurality of carriers to be measured in idle mode, wherein the measurement indication comprises carriers that~~which ~~the user equipment can aggregate with the carrier of the first cell and carriers that the user equipment cannot aggregate with the carrier of the first cell; and~~

5 ~~autonomously determining the carriers to be measured by filtering out those carriers from the measurement configuration which the user equipment cannot, based on the determined capabilities, aggregate with the carrier of the first cell.~~

10 ~~6. The method of any of claims 1 to 4, further comprising: causing a reception of a measurement indication indicating to perform idle mode radio measurements; and autonomously cell, wherein the determining the cells to be measured based on the determined capabilities such that only those carriers that the~~
15 ~~user equipment can aggregate with the carrier of the first cell are measured.~~

~~7. The method of any of claims 5 to 6, wherein the autonomous determination~~ comprises utilizing information of at least one carrier aggregation configuration used by the user equipment within a past predetermined period
20 of time.

~~8. The method of any of claims 1 to 4, further comprising: causing a reception of a measurement indication identifying a plurality of carriers to be measured in idle mode, wherein the measurement indication comprises carriers that the user equipment can aggregate with the carrier of the first cell and carriers that the user equipment cannot aggregate with the carrier of the first cell;~~
25 ~~performing the measurements according to the received measurement configuration; and~~

30 ~~including in the results of the idle mode radio measurements an indication whether or not the user equipment can aggregate a given measured carrier with the carrier of the first cell.~~

~~9. The method of any of claims 1 to 8, wherein the measurement indication is received in a system information block.~~
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~~10. The method of any of claims 1 to 9, wherein those carriers that the user equipment can, based on the determined capabilities~~of the user equipment in relation to carrier aggregation~~, aggregate with the carrier of the first~~
40 cell are required to be associated with other cells than macro cells.

11. A method at a network node, comprising:
 detecting a connection establishment of a 7. The method of any of
 claims 1 to 6, wherein the indication of the results is provided in a radio re-
 source control connection setup completion message.

8. A user equipment to a first cell served by the network node;
 upon the connection establishment, cause a reception of results of
 idle mode radio measurements performed by the user equipment, wherein the
 results comprise radio measurements results, comprising means for those car-
 riers which the user equipment can aggregate with the carrier of the first cell;
 and performing:
 utilizing the received results for carrier aggregation setup for the
 user equipment.

12. The method of claim 11, further comprising:
 causing a broadcast of measurement indication indicating that the
 network node supports receiving results of idle mode radio measurements dur-
 ing the connection establishment, without identifying the carriers to be meas-
 ured in the broadcasted measurement indication.

13. The method of claim 11, further comprising:
 causing a broadcast of measurement indication identifying a plural-
 ity of carriers to be measured in the idle mode, wherein the measurement indi-
 cation comprises carriers that the user equipment can aggregate with the car-
 rier of the first cell and carriers that the user equipment cannot aggregate with
 the carrier of the first cell.

14. An apparatus, comprising:
 at least one processor and at least one memory including a computer
 program code, wherein the at least one memory and the computer program
 code are configured, with the at least one processor, to cause a user equipment
 to perform:-

determine a first determining a cell to connect with;
 determined determining capabilities of the user equipment in relation
 to carrier aggregation comprising a carrier of the first cell;
 perform receiving a measurement indication identifying a plurality
 of carriers to be measured in idle mode radio measurements, wherein the plu-
 rality of those carriers comprise carriers that the user equipment can, aggregate

with the carrier of the cell and carriers that the user equipment cannot aggregate with the carrier of the cell; and

performing, for early measurement reporting and based on the determined capabilities, of the user equipment in relation to carrier aggregation, idle mode measurements of only those carriers from the plurality of carriers which the user equipment can aggregate with the carrier of the ~~first~~ cell; and report~~indicating~~ results of the idle mode ~~radio~~ measurements to a network node of the ~~first~~ cell upon connection establishment with the ~~first~~ cell.

~~159.~~ The ~~apparatus~~user equipment of claim ~~148~~, wherein the ~~at least one memory and the computer program code~~means are further configured, ~~with the at least one processor, to cause the user equipment further~~ to perform: determine~~determining~~ that the network node of the ~~first~~ cell supports reporting idle mode ~~radio~~ measurements during the connection establishment.

~~1610.~~ The ~~apparatus~~user equipment of any of claims ~~148~~ to ~~159~~, wherein the ~~reported~~indicated results of the idle mode ~~radio~~ measurements cause triggering the carrier aggregation by the network node of the ~~first~~ cell, without the network node of the ~~first~~ cell asking for connected mode radio measurements to be performed.

~~1711.~~ The ~~apparatus~~user equipment of any of claims ~~148~~ to ~~16~~, wherein the ~~at least one memory and the computer program code~~ are configured, ~~with the at least one processor, to cause the user equipment 10, further to perform:~~comprising:

~~cause a reception, from the network node of the first cell, of an indication indicating that a carrier aggregation is to be triggered for the user equipment, wherein the carrier aggregation comprises receiving data over the carrier of the first cell and over one or more of the carriers that were measured during the idle mode radio measurements.~~

~~18.~~ The apparatus of any of claims 14 to 17, wherein the ~~at least one memory and the computer program code~~ are configured, ~~with the at least one processor, to cause the user equipment further to perform:~~

~~cause a reception of a measurement indication identifying a plurality of carriers to be measured in idle mode, wherein the measurement indication comprises carriers that the user equipment can aggregate with the carrier of the first cell and carriers that the user equipment cannot aggregate with the~~

carrier of the first cell; and

~~autonomously determine the carriers to be measured by filtering out means for determining, based on the capabilities of the user equipment in relation to carrier aggregation, those carriers from the measurement configuration plurality of carriers which the user equipment cannot, based on the determined capabilities, aggregate with the carrier of the first cell.~~

~~19. The apparatus of any of claims 14 to 17, wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause the user equipment further to perform:~~

~~receive a measurement indication indicating to perform idle mode radio measurements; and~~

~~autonomously determine the cells to be measured based on the determined capabilities such that only those carriers that the user equipment can aggregate with the carrier of the first cell are measured.~~

~~20. The apparatus of any of claims 18 to 19, wherein the autonomous determination determining comprises utilizing information of at least one carrier aggregation configuration used by the user equipment within a past predetermined period of time.~~

~~21. The apparatus of any of claims 14 to 17, wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause the user equipment further to perform:~~

~~cause a reception of a measurement indication identifying a plurality of carriers to be measured in idle mode, wherein the measurement indication comprises carriers that the user equipment can aggregate with the carrier of the first cell and carriers that the user equipment cannot aggregate with the carrier of the first cell;~~

~~perform the measurements according to the received measurement configuration; and~~

~~include in the results of the idle mode radio measurements an indication whether or not the user equipment can aggregate a given measured carrier with the carrier of the first cell.~~

~~22. The apparatus of any of claims 14 to 21~~12. The user equipment of any of claims 8 to 11, wherein the measurement indication is received in a system information block.

~~23~~13. The ~~apparatus~~user equipment of any of claims ~~14~~8 to ~~22~~12,

wherein those carriers that the user equipment can, based on the determined capabilities of the user equipment in relation to carrier aggregation, aggregate with the carrier of the ~~first~~ cell are required to be associated with other cells than macro cells.

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~~2414.~~ The apparatus-user equipment of any of claims ~~148~~ to ~~2313~~, wherein the apparatus-indication of the results is provided in a ~~user-equipment and the apparatus is operating according to the long term evolution or according to the long term evolution advanced, or according to new radio ,5G.~~

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~~25.~~ An apparatus, comprising:
at least one processor and at least one memory including a computer program code, wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause a network node to perform:

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~~detect a resource control connection establishment of a user equipment to a first cell served by the network node;~~

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~~upon the connection establishment, cause a reception of results of idle mode radio measurements performed by the user equipment, wherein the results comprise radio measurements results for those carriers which the user equipment can aggregate with the carrier of the first cell; and~~

~~utilize the received results for carrier aggregation setup for the user equipment completion message.~~

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~~26.~~ The apparatus of claim 25, wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause the network node further to perform:

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~~cause broadcast of measurement indication indicating that the network node supports receiving results of idle mode radio measurements during the connection establishment, without identifying the carriers to be measured in the broadcasted measurement indication.~~

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~~27.~~ The apparatus of claim 25, wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause the network node further to perform:

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~~causing a broadcast of measurement indication identifying a plurality of carriers to be measured in the idle mode, wherein the measurement indication comprises carriers that the user equipment can aggregate with the carrier of the first cell and carriers that the user equipment cannot aggregate with the carrier of the first cell.~~

5 ~~2815. A computer program product embodied on a distribution medium readable by a computer and comprising program instructions which, when loaded into an apparatus, execute the program is executed by a user equipment, cause the user equipment to carry out~~ the method according to any of claims 1 to ~~10 or 11 to 13.~~

10 ~~29. A computer program product comprising program instructions which, when loaded into an apparatus, execute the method according to any of claims 1 to 10 or 11 to 13.~~

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30. ~~An apparatus, comprising means for performing the method according to any of claims 1 to 10 or 11 to 13.~~