REDUCING CELL ACTIVATION DELAY

FIELD

[0001] Example embodiments of the present disclosure generally relate to the field of telecommunication and in particular, to a terminal device, a network device, methods, apparatuses and a computer readable storage medium for a solution of reducing cell activation delay.

BACKGROUND

[0002] In a communication system, such as New Radio (NR) and Long Term Evolution (LTE), a secondary cell (SCell) can be activated or deactivated to enable reasonable User Equipment (UE) battery consumption when Carrier Aggregation (CA) is configured. The transition between an activated state and a deactivated state may be based on Media Access Control (MAC) Control Element (CE) commands from a network device. For example, an activation command from the network device may indicate to activate the SCell.

[0003] It takes activation time, i.e., activation delay, for the UE to transition from the deactivated state to the activated state. In some conditions, the activation delay could become very long. How to reduce the activation delay needs to be further studied and developed.

SUMMARY

[0004] In general, example embodiments of the present disclosure provide a solution for reducing cell activation delay.

[0005] In a first aspect, there is provided a terminal device. The terminal device comprises at least one processor and at least one memory storing instructions that, when executed by the at least one processor, cause the terminal device at least to: determine, during an activation procedure of a secondary cell, at least one measurement result of the secondary cell at the terminal device; and determine a measurement delay

for a layer 1 measurement on the secondary cell based, at least partially, on the at least one measurement result, wherein the at least one measurement result comprises at least one layer 3 measurement result.

[0006] In a second aspect, there is provided a network device. The network device comprises at least one processor and at least one memory storing instructions that, when

executed by the at least one processor, cause the network device at least to: transmit, to a terminal device in a primary cell, an activation command indicating a permission that the terminal device is allowed to perform a fast layer 1 measurement during an activation procedure of a secondary cell; and receive, from the terminal device, a layer 1 measurement report of a layer 1 measurement indicating, based on a measurement delay, whether the layer 1 measurement performed at the terminal device is the fast layer 1 measurement, wherein the layer 1 measurement report is based, at least partially, on at least one layer 3 measurement result.

[0007] In a third aspect, there is provided a method performed by a terminal device. The method comprises: determining, at a terminal device during an activation procedure of a secondary cell, at least one measurement result of the secondary cell at the terminal device; and determine a measurement delay for a layer 1 measurement on the secondary cell based, at least partially, on the at least one measurement result, wherein the at least one measurement result comprises at least one layer 3 measurement result.

[0008] In a fourth aspect, there is provided a method performed by a network device. The method comprises: transmitting, at a network device to a terminal device in a primary cell, an activation command indicating a permission that the terminal device is allowed to perform a fast layer 1 measurement during an activation procedure of a secondary cell; and receiving, from the terminal device, a measurement report indicating whether a layer 1 measurement performed at the terminal device is the fast layer 1 measurement.

[0009] In a fifth aspect, there is provided an apparatus. The apparatus comprises: means for determining, at a terminal device during an activation procedure of a secondary cell, at least one measurement result of the secondary cell at the terminal device; and means for performing a layer 1 measurement on the secondary cell based, at least partially, on the at least one measurement result.

[0010] In a sixth aspect, there is provided an apparatus. The apparatus comprises: means for transmitting, at a network device to a terminal device in a primary cell, an activation command indicating a permission that the terminal device is allowed to perform a fast layer 1 measurement during an activation procedure of a secondary cell; and means for

receiving, from the terminal device, a measurement report indicating whether a layer 1 measurement performed at the terminal device is the fast layer 1 measurement.

[0011] In a seventh aspect, there is provided a non-transitory computer readable medium comprising program instructions for causing an apparatus to perform at least the method in the third or fourth aspect.

WHAT IS CLAIMED IS:

1. A terminal device comprising:

at least one processor; and

at least one memory storing instructions that, when executed by the at least one processor, cause the terminal device at least to:

determine, during an activation procedure of a secondary cell, at least one measurement result of the secondary cell at the terminal device; and

determine a measurement delay for a layer 1 measurement on the secondary cell based, at least partially, on the at least one measurement result,

wherein the at least one measurement result comprises at least one layer 3 measurement result.

2. The terminal device of claim 1, wherein the at least one memory storing instructions that, when executed by the at least one processor, cause the terminal device at least to:

determine whether at least one layer 3 measurement result is available for the secondary cell;

based on a determination that the at least one layer 3 measurement result is available, determine that the at least one measurement result being the at least one layer 3 measurement result; and

perform the layer 1 measurement on the secondary cell based, at least partially, on the at least one measurement result without a cell detection phase of the activation procedure.

3. The terminal device of claim 1, wherein the at least one memory storing instructions that, when executed by the at least one processor, cause the terminal device at least to:

determine whether at least one layer 3 measurement result is available for the secondary cell;

based on a determination that the at least one layer 3 measurement result is unavailable, determine the at least one measurement result within a cell detection phase of the activation procedure; and

perform the layer 1 measurement on the secondary cell based, at least partially, on the at least one measurement result within the cell detection phase of the activation procedure.

4. The terminal device of any one of claims 1-3, wherein the at least one memory storing instructions that, when executed by the at least one processor, cause the terminal device at least to perform the layer 1 measurement by:

performing a fast layer 1 measurement on at least one beam for the secondary cell.

5. The terminal device of claim 4, wherein the at least one memory storing instructions that, when executed by the at least one processor, cause the terminal device at least to determine the at least one beam based on at least one of:

a number of detectable synchronization signal blocks, SSBs, based on the at least one measurement result,

a number of SSBs being associated with a number of measurable channel state information reference signal, CSI-RS, resources based on the at least one measurement result,

a first predefined number of best measured SSBs based on the at least one measurement result,

a second predefined number of best measured CSI-RS resources based on the at least one measurement result,

a number of SSBs on which the at least one measurement result being larger than a first threshold,

a number of CSI-RS resources on which the at least one measurement result being larger than a second threshold, or

a number of beams selected from full beams for the at least one measurement result.

6. The terminal device of claim 5, wherein the at least one memory storing instructions that, when executed by the at least one processor, cause the terminal device at least to:

receive, from a network device, at least one of spatial information associated with a reference signal or a scaling factor, for determining the at least one beam.

7. The terminal device of claim 6, wherein the at least one of the spatial information or the scaling factor is received in an activation command for the activation procedure.

8. The terminal device of claim 4, wherein the at least one memory storing instructions that, when executed by the at least one processor, cause the terminal device at least to perform the fast layer 1 measurement result by:

performing the fast layer 1 measurement on a beam corresponding to an SSB with a best result in the at least one measurement result.

9. The terminal device of any one of claims 1-3, wherein the at least one memory storing instructions that, when executed by the at least one processor, cause the terminal device at least to perform the layer 1 measurement by:

perform a fast layer 1 measurement based on the at least one measurement result and a predefined refinement factor.

10. The terminal device of any one of claims 4-9, wherein the at least one memory storing instructions that, when executed by the at least one processor, cause the terminal device at least to perform the fast layer 1 measurement based on at least one of the following conditions:

a signal noise ratio is not lower than a threshold,

capability information has been transmitted to a network device, the capability information indicating whether the terminal device supports the fast layer 1 measurement,

an activation command from the network device indicates a permission that the terminal device is allowed to perform the fast layer 1 measurement, or

an indication that the terminal device is to perform the fast layer 1 measurement based on a predefined refinement factor.

11. The terminal device of claim 10, wherein the at least one memory storing instructions that, when executed by the at least one processor, cause the terminal device at least to transmit capability information to a network device, the capability information indicating at least one of:

whether the terminal device supports the fast layer 1 measurement,

the predefined refinement factor, or

a minimum required number of beams for the fast layer 1 measurement.

12. The terminal device of any one of claims 1-11, wherein the at least one memory storing instructions that, when executed by the at least one processor, cause the terminal device at least to transmit a measurement report to a network device, the measurement report indicating at least one of:

a layer 1 measurement result on the secondary cell,

whether the layer 1 measurement result is based on full beams,

a number of beams on which the layer 1 measurement result is based,

whether a configured SSB or a configured CSI-RS resource is measured, or

whether the layer 1 measurement is a fast layer 1 measurement.

13. A method comprising:

determining, at a terminal device during an activation procedure of a secondary cell, at least one measurement result of the secondary cell at the terminal device; and

determine a measurement delay for a layer 1 measurement on the secondary cell based, at least partially, on the at least one measurement result,

wherein the at least one measurement result comprises at least one layer 3 measurement result.

14. The method of claim 13, further comprising:

determining whether at least one layer 3 measurement result is available for the secondary cell;

wherein determining at least one measurement result of the secondary cell comprises: based on a determination that the at least one layer 3 measurement result is available, determining that the at least one measurement result being the at least one layer 3 measurement result; and

wherein performing the layer 1 measurement comprises: performing the layer 1 measurement on the secondary cell based, at least partially, on the at least one measurement result without a cell detection phase of the activation procedure.

15. The method of claim 13, further comprising:

determining whether at least one layer 3 measurement result is available for the secondary cell;

wherein determining that at least one measurement result of the secondary cell comprises: based on a determination that the at least one layer 3 measurement result is unavailable, determining the at least one measurement result within a cell detection phase of the activation procedure; and

wherein performing the layer 1 measurement comprises: performing the layer 1 measurement on the secondary cell based, at least partially, on the at least one measurement result within the cell detection phase of the activation procedure.

16. The method of any one of claims 13-15, wherein performing the layer 1 measurement comprises:

performing a fast layer 1 measurement on at least one beam for the secondary cell.

17. The method of claim 16, wherein performing the fast layer 1 measurement result comprises: performing the fast layer 1 measurement based on at least one of the following conditions:

a signal noise ratio is not lower than a threshold,

capability information has been transmitted to a network device, the capability information indicating whether the terminal device supports the fast layer 1 measurement,

an activation command from the network device indicates a permission that the terminal device is allowed to perform the fast layer 1 measurement, or

an indication that the terminal device is to perform the fast layer 1 measurement based on a predefined refinement factor.

18. The method of claim 17, further comprising:

transmitting capability information to a network device, the capability information indicating at least one of:

whether the terminal device supports the fast layer 1 measurement,

the predefined refinement factor, or

a minimum required number of beams for the fast layer 1 measurement.

19. The method of any one of claims 13-18, further comprising:

transmitting a measurement report to a network device, the measurement report indicating at least one of:

a layer 1 measurement result on the secondary cell,

whether the layer 1 measurement result is based on full beams,

a number of beams on which the layer 1 measurement result is based,

whether a configured SSB or a configured CSI-RS resource is measured, or

whether the layer 1 measurement is a fast layer 1 measurement.

20. A network device comprising:

at least one processor; and

at least one memory storing instructions that, when executed by the at least one processor, cause the network device at least to:

transmit, to a terminal device in a primary cell, an activation command indicating a permission that the terminal device is allowed to perform a fast layer 1 measurement during an activation procedure of a secondary cell; and

receive, from the terminal device, a layer 1 measurement report of a layer 1 measurement indicating, based on a measurement delay, whether the layer 1 measurement performed at the terminal device is the fast layer 1 measurement,

wherein the layer 1 measurement report is based, at least partially, on at least one layer 3 measurement result.