

WHAT IS CLAIMED IS:

1. — A terminal device comprising:

at least one processor; and

at least one memory including computer program code;

5 wherein the at least one memory and the computer program code are configured to, with the at least one processor, cause the terminal device to:

perform beam failure detection on a first number of serving cells configured for the terminal device;

10 determine information to at least indicate respective results of the beam failure detection on a second number of serving cells among the first number of serving cells, the second number being smaller than the first number; and

transmit the determined information to a network device serving the terminal device using a resource allocated for the terminal device.

15 2. — The terminal device of claim 1, wherein respective results of the beam failure detection on the first number of serving cells are expected to be indicated by the first number of bits in a bitmap corresponding to the first number of serving cells, and the determined information comprises a continuous part of the bitmap comprising the second number of bits corresponding to the second number of serving cells, and

20 wherein the at least one memory and the computer program code are configured to, with the at least one processor, cause the terminal device to transmit the continuous part of the bitmap without transmitting a remaining part of the bitmap.

25 3. — The terminal device of claim 2, wherein the determined information further comprises a first indication that further information concerning the beam failure detection on the first number of serving cells is to be conveyed to the network device.

30 4. — The terminal device of claim 2, wherein the first number of serving cells are corresponding to the first number of bits in an order of cell indices of the first number of serving cells, and

wherein the at least one memory and the computer program code are configured to, with the at least one processor, cause the terminal device to determine the information by:

in accordance with a determination that a beam failure is detected on at least

one of the first number of serving cells, determining whether at least one bit corresponding to the at least one serving cell is comprised in the continuous part of the bitmap based on at least one cell index of the at least one serving cell; and

in accordance with a determination that the at least one bit corresponding to the at least one serving cell is comprised in the continuous part of the bitmap, determining the continuous part of the bitmap to indicate the respective results of the beam failure detection on the second number of serving cells.

5. The terminal device of claim 4, wherein the determined information further comprises a second indication that no further information concerning the beam failure detection on the first number of serving cells is to be conveyed to the network device.

6. The terminal device of any of claims 1 to 5, wherein the at least one memory and the computer program code are configured to, with the at least one processor, cause the terminal device to transmit the determined information in accordance with at least one of the following:

a determination that a beam failure is detected on a predetermined cell of the first number of serving cells;

a determination that a random access procedure is initiated to transmit information concerning the beam failure detection, and

a determination that the allocated resource is insufficient for transmission of information indicating respective results of the beam failure detection on the first number of serving cells.

7. The terminal device of claim 6, wherein the predetermined cell comprises a primary cell or a primary secondary cell.

8. The terminal device of claim 1, wherein the at least one memory and the computer program code are configured to, with the at least one processor, cause the terminal device to determine the information by:

in accordance with a determination that a beam failure is detected on a predetermined cell of the first number of serving cells, determining whether the allocated resource is sufficient for transmission of a payload portion of an information element indicating respective results of the beam failure detection on the first number of serving cells or a third

~~predetermined number of serving cells, the third number being smaller than the first number and larger than the second number; and~~

~~in accordance with a determination that the allocated resource is insufficient for the transmission of the payload portion, assigning a field in a header portion of the information element with a predetermined value to indicate that the beam failure is detected on the predetermined cell.~~

9. ~~The terminal device of claim 8, wherein the at least one memory and the computer program code are configured to, with the at least one processor, cause the terminal device to determine the information further by:~~

~~in accordance with a detection that a further beam failure is detected on at least one further serving cell of the first number of serving cells, determining the header portion to comprise a first indication that further information concerning the beam failure detection on the first number of serving cells is to be conveyed to the network device; and~~

~~in accordance with a detection that a beam failure is detected on only the predetermined cell, determining the header portion to comprise a second indication that no further information concerning the beam failure detection on the first number of serving cells is to be conveyed to the network device.~~

10. ~~A network device comprising:~~

~~at least one processor; and~~

~~at least one memory including computer program code;~~

~~wherein the at least one memory and the computer program code are configured to, with the at least one processor, cause the network device to:~~

~~receive, from a terminal device, information at least indicating respective results of beam failure detection performed on a second number of serving cells; and~~

~~in accordance with a determination that a first number of serving cells are configured with beam failure detection by the terminal device, determine, based on the received information, an overall result of the beam failure detection on the first number of serving cells, the second number being smaller than the first number.~~

11. ~~The network device of claim 10, wherein respective results of the beam failure detection on the first number of serving cells are expected to be indicated by the first number of bits in a bitmap corresponding to the first number of serving cells, and the received~~

information comprises a continuous part of the bitmap comprising the second number of bits corresponding to the second number of serving cells, and

wherein the at least one memory and the computer program code are configured to, with the at least one processor, cause the network device to receive the continuous part of the bitmap without receiving a remaining part of the bitmap.

12. The network device of claim 11, wherein the received information further comprises a first indication that further information concerning the beam failure detection on the first number of serving cells is to be conveyed to the network device, and

wherein the at least one memory and the computer program code are configured to, with the at least one processor, cause the network device to determine the overall result of beam failure detection on the first number of serving cells by:

determining, based on the continuous part of the bitmap and the first indication, that a beam failure is potentially detected by the terminal device on at least one further serving cell of the first number of serving cells other than the second number of serving cells.

13. The network device of claim 11, wherein the first number of serving cells are corresponding to the first number of bits in an order of cell indices of the first number of serving cells; and wherein the received information further comprises a second indication that no further information concerning the beam failure detection on the first number of serving cells is to be conveyed to the network device; and

wherein the at least one memory and the computer program code are configured to, with the at least one processor, cause the network device to determine the overall result of the beam failure detection on the first number of serving cells by:

determining, from the continuous part of the bitmap and the second indication, that no beam failure is detected by the terminal device on remaining serving cells of the first number of serving cells other than the second number of serving cells.

14. The network device of claim 10, wherein the received information comprises a field in a header portion of an information element assigned with a predetermined value to indicate that a beam failure is detected on a predetermined cell of the first number of serving cells.

15. ~~The network device of claim 14, wherein the at least one memory and the computer program code are configured to, with the at least one processor, cause the network device to determine the overall result of the beam failure detection on the first number of serving cells by:~~

5 ~~in accordance with the received information further comprising in the header portion a first indication that further information concerning the beam failure detection on the first number of serving cells is to be conveyed to the network device,~~

~~determining, based on the header portion and the first indication, that that a further beam failure is detected on at least one further serving cell of the first number of serving cells other than the predetermined cell, and~~

10 ~~in accordance with the received information further comprising in the header portion a second indication that no further information concerning the beam failure detection on the first number of serving cells is to be conveyed to the network device,~~

~~determining, based on the header portion and the second indication, that no beam failure is detected on remaining serving cells of the first number of serving cells other than the predetermined cell.~~

16. ~~A method comprising:~~

20 ~~performing, at a terminal device, beam failure detection on a first number of serving cells configured for the terminal device;~~

~~determining information to at least indicate respective results of the beam failure detection on a second number of serving cells among the first number of serving cells, the second number being smaller than the first number; and~~

25 ~~transmitting the determined information to a network device serving the terminal device using a resource allocated for the terminal device.~~

17. ~~The method of claim 16, wherein respective results of the beam failure detection on the first number of serving cells are expected to be indicated by the first number of bits in a bitmap corresponding to the first number of serving cells, and the determined information comprises a continuous part of the bitmap comprising the second number of bits corresponding to the second number of serving cells, and~~

30 ~~wherein transmitting the determined information comprises: transmitting the continuous part of the bitmap without transmitting a remaining part of the bitmap.~~

18. — The method of claim 17, wherein the determined information further comprises a first indication that further information concerning the beam failure detection on the first number of serving cells is to be conveyed to the network device.

5 19. — The method of claim 17, wherein the first number of serving cells are corresponding to the first number of bits in an order of cell indices of the first number of serving cells, and

wherein determining the information comprises:

10 in accordance with a determination that a beam failure is detected on at least one of the first number of serving cells, determining whether at least one bit corresponding to the at least one serving cell is comprised in the continuous part of the bitmap based on at least one cell index of the at least one serving cell; and

15 in accordance with a determination that the at least one bit corresponding to the at least one serving cell is comprised in the continuous part of the bitmap, determining the continuous part of the bitmap to indicate the respective results of the beam failure detection on the second number of serving cells.

20 20. — The method of claim 19, wherein the determined information further comprises a second indication that no further information concerning the beam failure detection on the first number of serving cells is to be conveyed to the network device.

21. — The terminal device of any of claims 16 to 20, wherein transmitting the determined information comprises:

25 transmitting the determined information in accordance with at least one of the following:

a determination that a beam failure is detected on a predetermined cell of the first number of serving cells;

a determination that a random access procedure is initiated to transmit information concerning the beam failure detection, and

30 a determination that the allocated resource is insufficient for transmission of information indicating respective results of the beam failure detection on the first number of serving cells.

22. — The method of claim 21, wherein the predetermined cell comprises a primary

cell or a primary secondary cell.

23. — The method of claim 16, wherein determining the information comprises:

in accordance with a determination that a beam failure is detected on a predetermined
5 cell of the first number of serving cells, determining whether the allocated resource is
sufficient for transmission of a payload portion of an information element indicating
respective results of the beam failure detection on the first number of serving cells or a third
predetermined number of serving cells, the third number being smaller than the first number
and larger than the second number; and

10 in accordance with a determination that the allocated resource is insufficient for the
transmission of the payload portion, assigning a field in a header portion of the information
element with a predetermined value to indicate that the beam failure is detected on the
predetermined cell.

24. — The method of claim 23, wherein determining the information further comprises:

15 in accordance with a detection that a further beam failure is detected on at least one
further serving cell of the first number of serving cells, determining the header portion to
comprise a first indication that further information concerning the beam failure detection on
the first number of serving cells is to be conveyed to the network device; and

20 in accordance with a detection that a beam failure is detected on only the
predetermined cell, determining the header portion to comprise a second indication that no
further information concerning the beam failure detection on the first number of serving cells
is to be conveyed to the network device.

25. — A method comprising:

25 receiving, at a network device and from a terminal device, information at least
indicating respective results of beam failure detection performed on a second number of
serving cells; and

30 in accordance with a determination that a first number of serving cells are configured
with beam failure detection by the terminal device, determining, based on the received
information, an overall result of the beam failure detection on the first number of serving
cells, the second number being smaller than the first number.

26. — The method of claim 25, wherein respective results of the beam failure detection

on the first number of serving cells are expected to be indicated by the first number of bits in a bitmap corresponding to the first number of serving cells, and the received information comprises a continuous part of the bitmap comprising the second number of bits corresponding to the second number of serving cells, and

5 wherein receiving the information comprises: receiving the continuous part of the bitmap without receiving a remaining part of the bitmap.

27. The method of claim 26, wherein the received information further comprises a first indication that further information concerning the beam failure detection on the first
10 number of serving cells is to be conveyed to the network device, and

 wherein determining the overall result of beam failure detection comprises:

 determining, based on the continuous part of the bitmap and the first indication,
 that a beam failure is potentially detected by the terminal device on at least one further
 serving cell of the first number of serving cells other than the second number of
15 serving cells.

28. The method of claim 26, wherein the first number of serving cells are corresponding to the first number of bits in an order of cell indices of the first number of serving cells; and wherein the received information further comprises a second indication
20 that no further information concerning the beam failure detection on the first number of serving cells is to be conveyed to the network device; and

 wherein determining the overall result of beam failure detection comprises:

 determining, from the continuous part of the bitmap and the second indication,
 that no beam failure is detected by the terminal device on remaining serving cells of
25 the first number of serving cells other than the second number of serving cells.

29. The method of claim 25, wherein the received information comprises a field in a header portion of an information element assigned with a predetermined value to indicate that a beam failure is detected on a predetermined cell of the first number of serving cells.
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30. The method of claim 29, wherein determining the overall result of beam failure detection comprises:

 in accordance with the received information further comprising in the header portion a first indication that further information concerning the beam failure detection on the first

~~number of serving cells is to be conveyed to the network device;~~

~~determining, based on the header portion and the first indication, that that a further beam failure is detected on at least one further serving cell of the first number of serving cells other than the predetermined cell; and~~

~~in accordance with the received information further comprising in the header portion a second indication that no further information concerning the beam failure detection on the first number of serving cells is to be conveyed to the network device;~~

~~determining, based on the header portion and the second indication, that no beam failure is detected on remaining serving cells of the first number of serving cells other than the predetermined cell.~~

~~31.—A first apparatus comprising means for:~~

~~performing beam failure detection on a first number of serving cells configured for the first apparatus;~~

~~determining information to at least indicate respective results of the beam failure detection on a second number of serving cells among the first number of serving cells, the second number being smaller than the first number; and~~

~~transmitting the determined information to a second apparatus serving the first apparatus using a resource allocated for the first apparatus.~~

~~32.—A second apparatus comprising means for:~~

~~receiving, from a first apparatus, information at least indicating respective results of beam failure detection performed on a second number of serving cells; and~~

~~in accordance with a determination that a first number of serving cells are configured with beam failure detection by the first apparatus, determining, based on the received information, an overall result of the beam failure detection on the first number of serving cells, the second number being smaller than the first number.~~

~~33.—A computer readable medium comprising program instructions for causing an apparatus to perform at least the method of any of claims 16 to 24, or the method of any of claims 25 to 30.~~

WHAT IS CLAIMED IS:

1. A terminal device comprising:
at least one processor; and
at least one memory including program code;
wherein the at least one memory and the program code are configured to, with the at
least one processor, cause the terminal device at least to:

perform beam failure detection on a first number of serving cells configured for the
terminal device; and

determine that a beam failure is detected on a predetermined serving cell of the first
number of serving cells, wherein the predetermined serving cell comprises a primary cell or a
primary secondary cell; and

determine a bitmap comprising a number of bits indicating results of the beam failure
detection at least on the first number of serving cells or a second number of serving cells,
wherein the second number of serving cells includes some but not all of the first number of
serving cells; and

determine that (a) random access procedure is initiated to transmit indication of the
beam failure detection using a resource allocated for the terminal device; and

transmit, using the resource allocated for the terminal device, to a network device
serving the terminal, the indication including the bitmap, wherein the bitmap comprises the
predetermined serving cell and the first or the second number of serving cells.

2. The terminal device of claim 1, wherein the resource allocated for the terminal device
is sufficient for the transmission of the indication of the results of the beam failure detection
on the first number of serving cells.

3. The terminal device of claim 1, wherein the resource allocated for the terminal device
is insufficient for the transmission of the indication of the results of the beam failure detection
on the first number of serving cells.

4. The terminal device of claim 1, wherein the resource allocated for the terminal device
is sufficient for the transmission of the indication of the results of the beam failure detection
on the second number of serving cells.

5. The terminal device of claim 1, wherein the resource allocated for the terminal device is insufficient for the transmission of the indication of the results of the beam failure detection on the first number of serving cells and sufficient for the transmission of the indication of the results of the beam failure detection on the second number of serving cells.

6. The terminal device of claim 1, wherein each bit of the bitmap indicates whether the beam failure is detected or not on one serving cell of the first or the second number of serving cells.

7. The terminal device of claim 6, wherein each cell is associated with a different cell index.

8. The terminal device of claim 7, wherein one bit of the bitmap corresponds to one cell associated with the cell index of that serving cell.

9. The terminal device of claim 7, wherein one bit corresponds to the cell index of the predetermined serving cell.

10. The terminal device of claim 1, wherein the bitmap is one-octet.