

for SCell.

SUMMARY

[0005] In general, the examples ~~embodiments of~~ this present disclosure provide a solution for reporting beam failure.

[0006] In ~~an embodiment~~ one aspect, there is provided a terminal device. The terminal device comprises at least one processor; and at least one memory including computer program codes; the at least one memory and the computer program codes are configured to, with the at least one processor, cause the terminal device to detect a beam failure on one or more serving cells of the terminal device; in response to detecting the beam failure on the one or more serving cells, obtain information concerning one or more candidate beams and the one or more serving cells, each of the one or more candidate beams associated with a respective one of the one or more serving cells; and transmit at least a portion of the information to a network device associated with the one or more serving cells, determine, based on amount of the information, whether a resource allocated for transmitting the information is sufficient, and if the resource is sufficient, said transmitting at least a portion of the information to the network device associated with the one or more serving cells comprises transmitting, to the network device associated with the one or more serving cells, a full beam failure recovery (BFR) report in a medium access control (MAC) control element (CE), which contains all the information, and if the resource is insufficient, said transmitting at least a portion of the information to the network device associated with the one or more serving cells comprises transmitting, to the network device associated with the one or more serving cells, a truncated beam failure recovery (BFR) report in a medium access control (MAC) control element (CE), which contains only a portion of the information; wherein the information comprises a first bitmap including a plurality of bits corresponding to a plurality of serving cells for the terminal device, and wherein a bit of the plurality of bits corresponding to a respective serving cell is assigned with a predetermined value; wherein the information comprises a second bitmap including a plurality of bits corresponding to a plurality of serving cells for the terminal device, and wherein a bit of the plurality of bits is assigned with a predetermined value if the corresponding serving cell satisfies the following: that a candidate beam for the corresponding serving cell has a quality above a threshold; and/or that an indication of the candidate beam for the corresponding serving cell is included in the transmitted portion.

[0007] In another aspect, ~~embodiment~~ there is provided a network device. The network device

comprises at least one processor; and at least one memory including computer program codes; the at least one memory and the computer program codes are configured to, with the at least one processor, cause the network device to receive, from a terminal device, a truncated beam failure recovery (BFR) report in a medium access control (MAC) control element (CE), which contains only a portion of information, wherein the information concerns one or more candidate beams and one or more serving cells on which a beam failure is detected, each of the one or more candidate beams associated with a respective one of the one or more serving cells, or receive, from the terminal device, a full beam failure recovery (BFR) report in a medium access control (MAC) control element (CE), which contains all information; and determine, based on the received portion of information, that at least one beam failure has been detected for the one or more serving cells; wherein the information comprises a first bitmap including a plurality of bits corresponding to a plurality of serving cells for the terminal device, and wherein a bit of the plurality of bits corresponding to a respective serving cell of the one or more serving cell is assigned with a predetermined value; wherein the information comprises a second bitmap including a plurality of bits corresponding to a plurality of serving cells for the terminal device, and wherein a bit of the plurality of bits is assigned with a predetermined value if the corresponding serving cell satisfies the following: that a candidate beam for the corresponding serving cell has a quality above a threshold; and/or that an indication of the candidate beam for the corresponding serving cell is included in the portion of the information.~~at least a portion of information concerning one or more candidate beams and one or more serving cells on which a beam failure is detected, each of the one or more candidate beams associated with a respective one of the one or more serving cells; and determine, based on the received portion, at least that the beam failure is detected on the one or more serving cells.~~

[0008] In another aspect-embodiment, there is provided a method. The method comprises detecting, at a terminal device, a beam failure on one or more serving cells of the terminal device; in response to detecting the beam failure on the one or more serving cells, obtaining information concerning one or more candidate beams and the one or more serving cells, each of the one or more candidate beams associated with a respective one of the one or more serving cells; and transmitting at least a portion of the information to a network device associated with the one or more serving cells, determining, based on amount of the information, whether a resource allocated for transmitting the information is sufficient, and if the resource is sufficient, said transmitting at least a portion of the information to the network device associated with the one or more serving cells comprises transmitting, to the network device associated with the one or more serving cells, a full beam failure recovery (BFR) report in a medium access control

(MAC) control element (CE), which contains all the information, and if the resource is insufficient, said transmitting at least a portion of the information to the network device associated with the one or more serving cells comprises transmitting to the network device associated with the one or more serving cells, a truncated beam failure recovery (BFR) report in a medium access control (MAC) control element (CE), which contains only a portion of the information, wherein the information comprises a first bitmap including a plurality of bits corresponding to a plurality of serving cells for the terminal device, and wherein a bit of the plurality of bits corresponding to a respective serving cell of the one or more serving cell is assigned with a predetermined value, wherein the information comprises a second bitmap including a plurality of bits corresponding to a plurality of serving cells for the terminal device, and wherein a bit of the plurality of bits is assigned with a predetermined value if the corresponding serving cell satisfies the following: that a candidate beam for the corresponding serving cell has a quality above a threshold; and/or that an indication of the candidate beam for the corresponding serving cell is included in the transmitted portion.~~In an aspect, there is a terminal device comprising:~~

~~at least one processor; and~~

~~at least one memory including program codes;~~

~~the at least one memory and the program codes are configured to, with the at least one processor, cause the terminal device at least to:~~

~~detect a beam failure on one or more serving cells for the terminal device;~~

~~—— obtain information concerning one or more candidate beams and the one or more serving cells, each of the one or more candidate beams associated with a respective one of the one or more serving cells; and~~

~~—— transmit, to a network device associated with the one or more serving cells, a truncated beam failure recovery (BFR) report in a medium access control (MAC) control element (CE), which contains only a portion of the information.~~

~~In an aspect, there is a network device, comprising:~~

~~at least one processor; and~~

~~at least one memory including program codes;~~

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

~~—— receive, from a terminal device, a truncated beam failure recovery (BFR) report in a medium access control (MAC) control element (CE), which contains only a portion of information, wherein the information concerns one or more candidate beams and one or more~~

~~serving cells on which a beam failure is detected, each of the one or more candidate beams associated with a respective one of the one or more serving cells; and~~

~~———determine, based on the portion of the information, that at least one beam failure is reported for the one or more serving cells.~~

~~In an aspect, there is a method comprising:~~

~~detecting, at a terminal device, a beam failure on one or more serving cells for the terminal device;~~

~~obtaining information concerning one or more candidate beams and the one or more serving cells, each of the one or more candidate beams associated with a respective one of the one or more serving cells; and~~

~~transmitting to a network device associated with the one or more serving cells, a truncated beam failure recovery (BFR) report in a medium access control (MAC) control element (CE), which contains only a portion of the information. In an aspect, there is a method comprising:~~

~~detecting, at a terminal device, a beam failure on one or more serving cells for the terminal device;~~

~~obtaining information concerning one or more candidate beams and the one or more serving cells, each of the one or more candidate beams associated with a respective one of the one or more serving cells; and~~

~~transmitting to a network device associated with the one or more serving cells, a truncated beam failure recovery (BFR) report in a medium access control (MAC) control element (CE), which contains only a portion of the information. In an aspect, there is a method comprising:~~

~~receiving, at a network device and from a terminal device, a truncated beam failure recovery (BFR) report in a medium access control (MAC) control element (CE), which contains only a portion of information, wherein the information concerns one or more candidate beams and one or more serving cells on which a beam failure is detected, each of the one or more candidate beams associated with a respective one of the one or more serving cells; and~~

~~determining, based on the portion of the information, that at least one beam failure is reported for the one or more serving cells,~~

~~wherein the portion of information comprises a truncated beam failure recovery (BFR) report.~~

[0009] In another aspect-embodiment, there is provided a method. The method comprises

receiving, at a network device and from a terminal device, ~~at least a portion of information concerning~~

~~one or more candidate beams and one or more serving cells on which a beam failure is detected, each of the one or more candidate beams associated with a respective one of the one or more serving cells; and determining, based on the received portion, at least that the beam failure is detected on the one or more serving cells.~~ a truncated beam failure recovery (BFR) report in a medium access control (MAC) control element (CE), which contains only a portion of information, wherein the information concerns one or more candidate beams and one or more serving cells on which a beam failure is detected, each of the one or more candidate beams associated with a respective one of the one or more serving cells, or receiving, at the network device and from the terminal device, a full beam failure recovery (BFR) report in a medium access control (MAC) control element (CE), which contains all information; and determining, based on the received portion of information, that at least one beam failure has been detected for the one or more serving cells, wherein the information comprises a first bitmap including a plurality of bits corresponding to a plurality of serving cells for the terminal device, and wherein a bit of the plurality of bits corresponding to a respective serving cell is assigned with a predetermined value; wherein the information comprises a second bitmap including a plurality of bits corresponding to a plurality of serving cells for the terminal device, and wherein a bit of the plurality of bits is assigned with a predetermined value if the corresponding serving cell satisfies the following: that a candidate beam for the corresponding serving cell has a quality above a threshold; and/or that an indication of a candidate beam for the corresponding serving cell is included in the portion of the information.

[0010] In an embodiment example, there is provided an apparatus comprising means for detecting, at a terminal device, a beam failure on one or more serving cells of the terminal device; means for in response to detecting the beam failure on the one or more serving cells, obtaining information concerning one or more candidate beams and the one or more serving cells, each of the one or more candidate beams associated with a respective one of the one or more serving cells; and means for transmitting at least a portion of the information to a network device associated with the one or more serving cells.

[0011] In an embodiment example, there is provided an apparatus comprising means for receiving, at a network device and from a terminal device, at least a portion of information concerning one or more candidate beams and one or more serving cells on which a beam failure is detected, each of the one or more candidate beams associated with a respective one of the one or more serving cells; and means for determining, based on the received portion, at least that the beam failure is detected on the one or more serving cells.

[0012] In an embodiment example, there is provided a non-transitory computer readable

medium comprising program instructions for causing an apparatus to perform at least the method according to the above third aspect.

[0013] In an [embodimentexample](#), there is provided a non-transitory computer readable medium comprising program instructions for causing an apparatus to perform at least the method according to the above fourth aspect.

[0014] It is to be understood that the summary section is not intended to identify key or essential features of [embodimentexamples](#) of the present disclosure, nor is it intended to be used to limit the scope of the present disclosure. Other features of the present disclosure will become easily comprehensible through the following description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] Some example embodiments will now be described with reference to the accompanying drawings, where:

[0016] Fig. 1 illustrates an example communication network in which embodiments of the

WHAT IS CLAIMED IS:

1. A terminal device comprising:

at least one processor; and

at least one memory including program codes;

the at least one memory and the program codes are configured to, with the at least one processor, cause the terminal device at least to:

detect a beam failure on one or more serving cells for the terminal device;

in response to detecting the beam failure on the one or more serving cells, obtain information concerning one or more candidate beams and the one or more serving cells, each of the one or more candidate beams associated with a respective one of the one or more serving cells; and

transmit at least a portion of the information to a network device associated with the one or more serving cells,

determine, based on amount of the information, whether a resource allocated for transmitting the information is sufficient, and

if the resource is sufficient, said transmitting at least a portion of the information to the network device associated with the one or more serving cells comprises transmitting, to the network device associated with the one or more serving cells, a full beam failure recovery (BFR) report in a medium access control (MAC) control element (CE), which contains all the information, and

if the resource is insufficient,

—said transmitting at least a portion of the information to the network device associated with the one or more serving cells comprises transmitting, to the network device associated with the one or more serving cells, a truncated beam failure recovery (BFR) report in a medium access control (MAC) control element (CE), which contains only a portion of the information;

2. The terminal device of Claim 1, wherein the information comprises a first bitmap including a plurality of bits corresponding to a plurality of serving cells for the terminal device, and wherein a bit of the plurality of bits corresponding to a respective each serving cell of the one or more serving cell is assigned with a predetermined value;

3. The terminal device of Claim 1 or Claim 2, wherein the information comprises a

second bitmap including a plurality of bits corresponding to a plurality of serving cells for the terminal device, and wherein a bit of the plurality of bits is assigned with a predetermined value if the corresponding serving cell satisfies ~~one of~~ the following:

that a candidate beam for the corresponding serving cell has a quality above a threshold; and/or

that an indication of athe candidate beam for the corresponding serving cell is included in the transmitted portion.

~~42~~. The terminal device of any of Claims ~~1 to 3~~, wherein the terminal device is caused to transmit at the truncated BFR report after determining that a resource allocated for transmitting the information in full is insufficient.

~~53~~. The terminal device of any of Claims 1 to ~~24~~, wherein a full BFR MAC CE is otherwise transmitted which contains the information in full.

~~64~~. The terminal device of any of Claims 1 to ~~35~~, wherein the terminal device is further caused to

select at least one candidate beam of the one or more candidate beams; and

include an indication of the selected at least one candidate beam in the portion of the information.

~~75~~. The terminal device of Claim ~~64~~, wherein the at least one candidate beam is associated with a secondary cell of the one or more serving cells, wherein the one or more serving cells are indicated by one or more indices, and the at least one candidate beam is selected based at least on one of the following criteria:

a signal quality of ~~the a~~ first candidate beam exceeds a threshold quality,

the secondary cell has the lowest index of the indices of the one or more serving cells,

the secondary cell has the highest index of the indices of the one or more serving cells,

the secondary cell belongs to a same group with a primary cell for the terminal device,

the secondary cell is associated with a plurality of further secondary cells,

the secondary cell is configured with intra-band carriers, or

a transmission has been scheduled on the secondary cell.

~~86~~. The terminal device of any of Claims 1 to ~~57~~, wherein the portion of the

information includes information concerning at least one of the one or more candidate beams, which is selected based on a priority order of the one or more candidate beams.

~~97.~~ The terminal device of Claim ~~86~~, wherein the priority order is based on an ascending order of indices of the one or more serving cells, wherein the one or more serving cells are SCells or SCell groups.

~~108.~~ A network device, comprising:
at least one processor; and
at least one memory including program codes;
the at least one memory and the program codes are configured to, with the at least one processor, cause the network device at least to:
receive, from a terminal device, a truncated beam failure recovery (BFR) report in a medium access control (MAC) control element (CE), which contains only a portion of information, wherein the information concerns one or more candidate beams and one or more serving cells on which a beam failure is detected, each of the one or more candidate beams associated with a respective one of the one or more serving cells, or
receive, from the terminal device, a full beam failure recovery (BFR) report in a medium access control (MAC) control element (CE), which contains all information; and
determine, based on the received portion of ~~the~~ information, that at least one beam failure ~~is has been detected~~reported for the one or more serving cells;

~~11. The network device of Claim 10,~~ wherein the information comprises a first bitmap including a plurality of bits corresponding to a plurality of serving cells for the terminal device, and wherein a bit of the plurality of bits corresponding to a respective each serving cell of the one or more serving cell is assigned with a predetermined value;

~~12. The network device of Claim 10 or Claim 11,~~ wherein the information comprises a second bitmap including a plurality of bits corresponding to a plurality of serving cells for the terminal device, and wherein a bit of the plurality of bits is assigned with a predetermined value if the corresponding serving cell satisfies ~~one of~~ the following:

that a candidate beam for the corresponding serving cell has a quality above a threshold; and/or

that an indication of ~~a the~~ candidate beam for the corresponding serving cell is included

in the portion of the information.

~~139~~. The network device of ~~any of Claims 10 to 128~~, wherein the network device is caused to receive the truncated BFR report in an instance in which a resource allocated for transmitting the information in full is insufficient.

~~1410~~. The network device of claim ~~139~~, wherein a full BFR MAC CE is otherwise received which contains the information in full.

~~1511~~. The network device of any of Claims ~~10-8~~ to ~~1410~~, wherein the portion of the information comprises an indication of at least one candidate beam of the one or more candidate beams, and the network device is further caused to:

determine, from the one or more serving cells, at least one serving cell associated with the at least one candidate beam.

~~1612~~. The network device of Claim ~~1511~~, wherein a first candidate beam of the at least one candidate beam is associated with a secondary cell of the one or more serving cells, wherein the one or more serving cells are indicated by one or more indices, and the network device is configured to determine the secondary cell as one of the at least one serving cell if:

the secondary cell has the lowest index of the indices of the one or more serving cells,
the secondary cell has the highest index of the indices of the one or more serving cells,
the secondary cell belongs to a same group with a primary cell for the terminal device,
the secondary cell is associated with a plurality of further secondary cells,
the secondary cell is configured with intra-band carriers, or
a transmission has been scheduled on the secondary cell.

~~1713~~. The network device of any of Claims ~~10-8~~ to ~~1612~~, wherein the portion of the information includes information concerning at least one of the one or more candidate beams which is selected based on a priority order of the one or more candidate beams.

~~1814~~. The network device of Claim ~~1713~~, wherein the priority order is based on an ascending order of indices of the serving cells, wherein the one or more serving cells are SCells or SCell groups.

1915. A method comprising:

detecting, at a terminal device, a beam failure on one or more serving cells for the terminal device;

in response to detecting the beam failure on the one or more serving cells, obtaining information concerning one or more candidate beams and the one or more serving cells, each of the one or more candidate beams associated with a respective one of the one or more serving cells; and

transmitting at least a portion of the information to a network device associated with the one or more serving cells,

determining, based on amount of the information, whether a resource allocated for transmitting the information is sufficient, and

if the resource is sufficient, said transmitting at least a portion of the information to the network device associated with the one or more serving cells comprises transmitting, to the network device associated with the one or more serving cells, a full beam failure recovery (BFR) report in a medium access control (MAC) control element (CE), which contains all the information, and

if the resource is insufficient,

—said transmitting at least a portion of the information to the network device associated with the one or more serving cells comprises transmitting to a-the network device associated with the one or more serving cells, a truncated beam failure recovery (BFR) report in a medium access control (MAC) control element (CE), which contains only a portion of the information, wherein the information comprises a first bitmap including a plurality of bits corresponding to a plurality of serving cells for the terminal device, and wherein a bit of the plurality of bits corresponding to a respective serving cell of the one or more serving cell is assigned with a predetermined value,

wherein the information comprises a second bitmap including a plurality of bits corresponding to a plurality of serving cells for the terminal device, and wherein a bit of the plurality of bits is assigned with a predetermined value if the corresponding serving cell satisfies the following:

that a candidate beam for the corresponding serving cell has a quality above a threshold; and/or

that an indication of the candidate beam for the corresponding serving cell is included in the transmitted portion.

~~2016~~. A method comprising:

receiving, at a network device and from a terminal device, a truncated beam failure recovery (BFR) report in a medium access control (MAC) control element (CE), which contains only a portion of information, wherein the information concerns one or more candidate beams and one or more serving cells on which a beam failure is detected, each of the one or more candidate beams associated with a respective one of the one or more serving cells, or

receiving, at the network device and from the terminal device, a full beam failure recovery (BFR) report in a medium access control (MAC) control element (CE), which contains all information; and

determining, based on the received portion of ~~the~~ information, that at least one beam failure ~~is reported~~ has been detected for the one or more serving cells,

~~wherein the portion of information comprises a truncated beam failure recovery (BFR) report~~ wherein the information comprises a first bitmap including a plurality of bits corresponding to a plurality of serving cells for the terminal device, and wherein a bit of the plurality of bits corresponding to a respective serving cell is assigned with a predetermined value; wherein the information comprises a second bitmap including a plurality of bits corresponding to a plurality of serving cells for the terminal device, and wherein a bit of the plurality of bits is assigned with a predetermined value if the corresponding serving cell satisfies the following:

that a candidate beam for the corresponding serving cell has a quality above a threshold; and/or

that an indication of a candidate beam for the corresponding serving cell is included in the portion of the information.