

CONTENTION RESOLUTION IN RANDOM ACCESS PROCEDURE

FIELD

5 [0001] Embodiments of the present disclosure generally relate to the field of telecommunication and in particular, to apparatuses, methods and computer readable storage media for contention resolution in random access procedure.

BACKGROUND

10 [0002] Various wireless cellular communication systems have been implemented and are being implemented. Mobile communication systems have been developed and are being developed to meet the increasing demand for communication services. With the rapid advance of technologies, the mobile communication systems have evolved to the level capable of providing high speed data communication service beyond the early
15 voice-oriented services.

[0003] A random access (RA) procedure refers to a procedure for a terminal device to establish or reestablish a connection with a network device such as an Evolved NodeB (eNB) or a 5G gNodeB (gNB). A contention based random access procedure can facilitate the possibility that multiple communication devices may be interested in attempting to
20 access the network device through the RA procedure at the same or similar point in time. Once access has been established and/or confirmed, the network device can assign resources to a particular terminal device in support of the uplink communication with the network device.

SUMMARY

[0004] In general, examples of the present disclosure provide a solution for contention resolution in random access procedure.

[0004a] In an aspect, the present disclosure refers to a first apparatus for wireless communication, the first apparatus comprising:

at least one processor; and

at least one memory storing instructions thereon that, when executed by the at least one processor, cause the first apparatus to perform at least:

transmitting, to a second apparatus, a random access request comprising a random
5 access preamble and an identifier of the first apparatus for a random access procedure;

receiving, from the second apparatus, control information on a control channel addressed to the identifier, the control information indicating a first resource for a downlink from the second apparatus to the first apparatus and timing information for an uplink from the first apparatus to the second apparatus; and

10 determining the random access procedure is successful in an instance in which both:

a timer maintained by the first apparatus is running, the timer being configured to indicate whether the first apparatus is in timing alignment with the second apparatus on the uplink from the first apparatus to the second apparatus, and

a timing advance command is received by using the first resource, the timing advance
15 command indicating an amount of timing adjustment to be used for timing alignment of the first apparatus with the second apparatus on the uplink from the first apparatus to the second apparatus.

[0004b] In an aspect, the present disclosure refers to a second apparatus for wireless communication, the second apparatus comprising:

20 at least one processor; and

at least one memory storing instructions thereon that, when executed by the at least one processor, cause the second apparatus to perform at least:

receiving, at the second apparatus, from a first apparatus, a random access request comprising a random access preamble and an identifier of the first apparatus for a random
25 access procedure;

in response to the random access request, determining control information indicating a first resource for a downlink from the second apparatus to the first apparatus and timing information for an uplink from the first apparatus to the second apparatus; and

transmitting, from the second apparatus, to the first apparatus, on a control channel
30 addressed to the identifier, the control information in response to the random access request

received from the first apparatus, wherein the control information is operable to cause the first apparatus to consider the random access request successful based on that both:

a timer maintained by the first apparatus is running, the timer being configurable to indicate whether the first apparatus is in timing alignment with the second apparatus on an uplink from the first apparatus to the second apparatus, and

a timing advance command is received by the first apparatus using the first resource, the timing advance command indicating an amount of timing adjustment to be used for timing alignment of the first apparatus with the second apparatus on the uplink from the first apparatus to the second apparatus.

[0004c] In an aspect, the present disclosure refers to a method for wireless communication, the method comprising:

transmitting, from a first apparatus, to a second apparatus, a random access request comprising a random access preamble and an identifier of the first apparatus for a random access procedure;

receiving, at the first apparatus, from the second apparatus, control information on a control channel addressed to the identifier, the control information indicating a first resource for a downlink from the second apparatus to the first apparatus and timing information for an uplink from the first apparatus to the second apparatus; and

determining the random access procedure is successful based on:

a timer maintained by the first apparatus being running, the timer being configured to indicate whether the first apparatus is in timing alignment with the second apparatus on the uplink from the first apparatus to the second apparatus, and

a timing advance command being received by using the first resource, the timing advance command indicating an amount of timing adjustment to be used for timing alignment of the first apparatus with the second apparatus on the uplink from the first apparatus to the second apparatus.

[0004d] In an aspect, the present disclosure refers to a method for wireless communication, the method comprising:

receiving, at a second apparatus, from a first apparatus, a random access request comprising a random access preamble and an identifier of the first apparatus for a random access procedure;

in response to the random access request, determining control information indicating a first resource for a downlink from the second apparatus to the first apparatus and timing information for an uplink from the first apparatus to the second apparatus; and

transmitting, from the second apparatus, to the first apparatus, on a control channel
5 addressed to the identifier, the control information in response to the random access request received from the first apparatus, wherein the control information is operable to cause the first apparatus to consider the random access request successful based on that both:

a timer maintained by the first apparatus is running, the timer being configurable to indicate whether the first apparatus is in timing alignment with the second apparatus on an
10 uplink from the first apparatus to the second apparatus, and

a timing advance command is received by the first apparatus using the first resource, the timing advance command indicating an amount of timing adjustment to be used for timing alignment of the first apparatus with the second apparatus on the uplink from the first apparatus to the second apparatus.

15 [0004e] In an aspect, the present disclosure refers to a first apparatus for wireless communication, the first apparatus comprising:

means for transmitting, at the first apparatus, to a second apparatus, a random access request comprising a random access preamble and an identifier of the first apparatus for a random access procedure;

20 means for receiving, at the first apparatus, from the second apparatus, control information on a control channel addressed to the identifier, the control information indicating at least one of a first resource for a downlink from the second apparatus to the first apparatus or timing information for an uplink from the first apparatus to the second apparatus; and

25 means for determining the random access procedure is successful in an instance in which both:

a timer maintained by the first apparatus is running, the timer being configured to indicate whether the first apparatus is in timing alignment with the second apparatus on the uplink from the first apparatus to the second apparatus, and

30 a timing advance command is received by using the first resource, the timing advance command indicating an amount of timing adjustment to be used for timing alignment of the

first apparatus with the second apparatus on the uplink from the first apparatus to the second apparatus.

[0004f] In an aspect, the present disclosure refers to a second apparatus for wireless communication, the second apparatus comprising:

5 means for receiving, at the second apparatus, from a first apparatus, a random access request comprising a random access preamble and an identifier of the first apparatus for a random access procedure;

means for, in response to the random access request, determining control information indicating a first resource for a downlink from the second apparatus to the first apparatus
10 and timing information for an uplink from the first apparatus to the second apparatus; and

means for transmitting, from the second apparatus, to the first apparatus, on a control channel addressed to the identifier, the control information in response to the random access request received from the first apparatus, wherein the control information is operable to cause the first apparatus to consider the random access request successful based on that
15 both:

a timer maintained by the first apparatus is running, the timer being configurable to indicate whether the first apparatus is in timing alignment with the second apparatus on an uplink from the first apparatus to the second apparatus, and

a timing advance command is received by the first apparatus using the first resource, the timing advance command indicating an amount of timing adjustment to be used for timing alignment of the first apparatus with the second apparatus on the uplink from the first apparatus to the second apparatus.
20

[0004g] In an aspect, the present disclosure refers to a non-transitory computer readable medium comprising program instructions for causing an apparatus to perform at least the method of any of the above aspects.
25

[0004h] In an aspect, the present disclosure refers to a non-transitory computer readable medium comprising program instructions for causing an apparatus to perform at least the method of any of the above aspects.

[0005] In a first example, there is provided an apparatus. The apparatus 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
30

processor, cause the apparatus to transmit a random access request to a second apparatus, the random access request comprising a random access preamble and an identifier of the apparatus for a

random access procedure; receive, from the second apparatus, control information on a control channel addressed to the identifier, the control information indicating at least one of a resource and timing information for communication between the apparatus and the second apparatus; and determine a result of the random access procedure based at least in part on the control information.

[0006] In a second example, there is provided an apparatus. The apparatus 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 apparatus to receive from a second apparatus a random access request, the random access request comprising a random access preamble and an identifier of the second apparatus for a random access procedure; in response to the random access request, determine control information indicating at least one of a resource and timing information for communication between the apparatus and the second apparatus; and transmit, to the second apparatus, the control information on a control channel addressed to the identifier.

[0007] In a third example, there is provided a method. The method comprises transmitting, at an apparatus, a random access request to a second apparatus, the random access request comprising a random access preamble and an identifier of the apparatus for a random access procedure; receiving, from the second apparatus, control information on a control channel addressed to the identifier, the control information indicating at least one of a resource and timing information for communication between the apparatus and the second apparatus; and determining a result of the random access procedure based at least in part on the control information.

[0008] In a fourth example, there is provided a method. The method comprises receiving, at an apparatus, from a second apparatus a random access request, the random access request comprising a random access preamble and an identifier of the second apparatus for a random access procedure; in response to the random access request, determining control information indicating at least one of a resource and timing information for communication between the apparatus and the second apparatus; and transmitting, to the second apparatus, the control information on a control channel addressed to the identifier.

[0009] In a fifth example, there is provided an apparatus. The apparatus comprises means for transmitting, at the apparatus, a random access request to a second apparatus, the random access request comprising a random access preamble and an identifier of the

apparatus for a random access procedure; means for receiving, from the second apparatus, control information on a control channel addressed to the identifier, the control information indicating at least one of a resource and timing information for communication between the apparatus and the second apparatus; and means for determining a result of the random access procedure based at least in part on the control information.

[0010] In a sixth example, there is provided an apparatus. The apparatus comprises means for receiving, at the apparatus, from a second apparatus a random access request, the random access request comprising a random access preamble and an identifier of the second apparatus for a random access procedure; means for in response to the random access request, determining control information indicating at least one of a resource and timing information for communication between the apparatus and the second apparatus; and means for transmitting, to the second apparatus, the control information on a control channel addressed to the identifier.

[0011] In a seventh 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 third example.

[0012] In an eighth 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 fourth example.

[0013] It is to be understood that the summary section is not intended to identify key or essential features of embodiments 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

[0014] Some example embodiments will now be described with reference to the accompanying drawings, where:

[0015] Fig. 1 illustrates an example communication network in which embodiments of the present disclosure may be implemented;

[0016] Fig. 2A and Fig. 2B illustrate flowcharts illustrating example random access procedures;

WHAT IS CLAIMED IS:

1. A first apparatus for wireless communication, the first apparatus comprising:
at least one processor; and
5 at least one memory storing instructions thereon that, when executed by the at least one processor, cause the first apparatus to perform at least:
transmitting, to a second apparatus, a random access request comprising a random access preamble and an identifier of the first apparatus for a random access procedure;
receiving, from the second apparatus, control information on a control channel addressed to
10 the identifier, the control information indicating a first resource for a downlink from the second apparatus to the first apparatus and timing information for an uplink from the first apparatus to the second apparatus; and
determining the random access procedure is successful in an instance in which both:
a timer maintained by the first apparatus is running, the timer being configured to indicate
15 whether the first apparatus is in timing alignment with the second apparatus on the uplink from the first apparatus to the second apparatus, and
a timing advance command is received by using the first resource, the timing advance command indicating an amount of timing adjustment to be used for timing alignment of the first apparatus with the second apparatus on the uplink from the first apparatus to the second
20 apparatus.
2. The first apparatus of claim 1, wherein the instructions stored on the at least one memory, when executed by the at least one processor, further cause the first apparatus to perform:
determining that the random access procedure is unsuccessful based on a determination that
25 the timer is not running.
3. The first apparatus of claim 2, wherein the instructions stored on the at least one memory, when executed by the at least one processor, further cause the first apparatus to perform:
starting the timer in response to determining that the timing advance command is received.
30
4. The first apparatus of claim 1, wherein the identifier of the first apparatus comprises a cell radio network temporary identifier of the first apparatus.

5. The first apparatus of claim 4, wherein the control channel is a physical downlink control channel addressed to the cell radio network temporary identifier of the first apparatus.
6. The first apparatus of claim 1, wherein the first apparatus is in a connected state with the
5 second apparatus.
7. The first apparatus of claim 1, wherein the first apparatus is a terminal device and the second apparatus is a network device.
- 10 8. A second apparatus for wireless communication, the second apparatus comprising:
at least one processor; and
at least one memory storing instructions thereon that, when executed by the at least one processor, cause the second apparatus to perform at least:
receiving, at the second apparatus, from a first apparatus, a random access request comprising
15 a random access preamble and an identifier of the first apparatus for a random access procedure;
in response to the random access request, determining control information indicating a first resource for a downlink from the second apparatus to the first apparatus and timing information for an uplink from the first apparatus to the second apparatus; and
20 transmitting, from the second apparatus, to the first apparatus, on a control channel addressed to the identifier, the control information in response to the random access request received from the first apparatus, wherein the control information is operable to cause the first apparatus to consider the random access request successful based on that both:
a timer maintained by the first apparatus is running, the timer being configurable to indicate
25 whether the first apparatus is in timing alignment with the second apparatus on an uplink from the first apparatus to the second apparatus, and
a timing advance command is received by the first apparatus using the first resource, the timing advance command indicating an amount of timing adjustment to be used for timing alignment of the first apparatus with the second apparatus on the uplink from the first
30 apparatus to the second apparatus.
9. The second apparatus of claim 8, wherein the instructions stored on the at least one memory, when executed by the at least one processor, further cause the second apparatus to perform:

determining the timing advance command for the amount of timing adjustment usable by the first apparatus for timing alignment of the first apparatus with the second apparatus;
determining the control information based on the first resource; and
transmitting, to the first apparatus, the timing advance command by using the first resource
5 for the uplink from the first apparatus to the second apparatus.

10. The second apparatus of claim 8, wherein the instructions stored on the at least one memory, when executed by the at least one processor, further cause the second apparatus to perform:
10 determining the timing advance command for the amount of timing adjustment, the amount of timing adjustment being used for timing alignment of the first apparatus with the second apparatus; and
determining the control information based on the timing advance command.

15 11. The second apparatus of claim 8, wherein the instructions stored on the at least one memory, when executed by the at least one processor, further cause the second apparatus to perform:
indicating, to the first apparatus, that the timing advance command is in response to the random access request.

20 12. The second apparatus of claim 8, wherein the instructions stored on the at least one memory, when executed by the at least one processor, further cause the second apparatus to perform:
determining the control information based further on a determination of whether a second
25 timer maintained by the second apparatus is running, the second timer being configured to indicate whether the second apparatus is in timing alignment with the first apparatus on the uplink from the first apparatus to the second apparatus.

13. The second apparatus of claim 12, wherein the instructions stored on the at least one
30 memory, when executed by the at least one processor, further cause the second apparatus to perform:
in response to determining that the second timer is running, determining the control information to indicate a second resource for the downlink.

14. The second apparatus of claim 8, wherein the identifier of the first apparatus comprises a cell radio network temporary identifier of the first apparatus.
15. The second apparatus of claim 14, wherein the control channel is a physical downlink control channel addressed to the cell radio network temporary identifier of the first apparatus.
16. The second apparatus of claim 8, wherein the first apparatus is in a connected state with the second apparatus.
17. The second apparatus of claim 8, wherein the second apparatus is a network device and the first apparatus is a terminal device.
18. A method for wireless communication, the method comprising:
transmitting, from a first apparatus, to a second apparatus, a random access request comprising a random access preamble and an identifier of the first apparatus for a random access procedure;
receiving, at the first apparatus, from the second apparatus, control information on a control channel addressed to the identifier, the control information indicating a first resource for a downlink from the second apparatus to the first apparatus and timing information for an uplink from the first apparatus to the second apparatus; and
determining the random access procedure is successful based on:
a timer maintained by the first apparatus being running, the timer being configured to indicate whether the first apparatus is in timing alignment with the second apparatus on the uplink from the first apparatus to the second apparatus, and
a timing advance command being received by using the first resource, the timing advance command indicating an amount of timing adjustment to be used for timing alignment of the first apparatus with the second apparatus on the uplink from the first apparatus to the second apparatus.
19. The method of claim 18, wherein the determining the result of the random access procedure is further based on the determination that the timer is not running.
20. The method of claim 18, further comprising:
starting the timer in response to determining that the timing advance command is received.

21. The method of claim 18, wherein the identifier of the first apparatus comprises a cell radio network temporary identifier of the first apparatus.

5 22. The method of claim 21, wherein the control channel is a physical downlink control channel addressed to the cell radio network temporary identifier of the first apparatus.

23. The method of claim 18, wherein the first apparatus is in a connected state with the second apparatus.

10

24. The method of claim 18, wherein the first apparatus is a terminal device and the second apparatus is a network device.

25. A method for wireless communication, the method comprising:

15 receiving, at a second apparatus, from a first apparatus, a random access request comprising a random access preamble and an identifier of the first apparatus for a random access procedure;

in response to the random access request, determining control information indicating a first resource for a downlink from the second apparatus to the first apparatus and timing
20 information for an uplink from the first apparatus to the second apparatus; and

transmitting, from the second apparatus, to the first apparatus, on a control channel addressed to the identifier, the control information in response to the random access request received from the first apparatus, wherein the control information is operable to cause the first apparatus to consider the random access request successful based on that both:

25 a timer maintained by the first apparatus is running, the timer being configurable to indicate whether the first apparatus is in timing alignment with the second apparatus on an uplink from the first apparatus to the second apparatus, and

a timing advance command is received by the first apparatus using the first resource, the timing advance command indicating an amount of timing adjustment to be used for timing
30 alignment of the first apparatus with the second apparatus on the uplink from the first apparatus to the second apparatus.

26. The method of claim 25, further comprising:

determining the timing advance command for the amount of timing adjustment usable by the

first apparatus for timing alignment of the first apparatus with the second apparatus;
determining the control information based on the first resource; and
transmitting, to the first apparatus, the timing advance command by using the first resource
for the uplink from the first apparatus to the second apparatus.

5

27. The method of claim 25, further comprising:
determining the timing advance command for the amount of timing adjustment, the amount
of timing adjustment being used for timing alignment of the first apparatus with the second
apparatus; and
10 determining the control information based on the timing advance command.

28. The method of claim 25, further comprising:
indicating, to the first apparatus, that the timing advance command is in response to the
random access request.

15

29. The method of claim 25, further comprising:
determining the control information based further on a determination of whether a second
timer maintained by the second apparatus is running, the second timer being configured to
indicate whether the second apparatus is in timing alignment with the first apparatus on the
20 uplink from the first apparatus to the second apparatus.

30. The method of claim 29, further comprising:
in response to determining that the second timer is running, determining the control
information to indicate a second resource for the downlink.

25

31. The method of claim 25, wherein the identifier of the first apparatus comprises a cell
radio network temporary identifier of the first apparatus.

32. The method of claim 31, wherein the control channel is a physical downlink control
30 channel addressed to the cell radio network temporary identifier of the first apparatus.

33. The method of claim 25, wherein the first apparatus is in a connected state with the
second apparatus.

34. The method of claim 25, wherein the second apparatus is a network device and the first apparatus is a terminal device.

35. A first apparatus for wireless communication, the first apparatus comprising:

5 means for transmitting, at the first apparatus, to a second apparatus, a random access request comprising a random access preamble and an identifier of the first apparatus for a random access procedure;

means for receiving, at the first apparatus, from the second apparatus, control information on a control channel addressed to the identifier, the control information indicating at least one
10 of a first resource for a downlink from the second apparatus to the first apparatus or timing information for an uplink from the first apparatus to the second apparatus; and

means for determining the random access procedure is successful in an instance in which both:

a timer maintained by the first apparatus is running, the timer being configured to indicate
15 whether the first apparatus is in timing alignment with the second apparatus on the uplink from the first apparatus to the second apparatus, and

a timing advance command is received by using the first resource, the timing advance command indicating an amount of timing adjustment to be used for timing alignment of the first apparatus with the second apparatus on the uplink from the first apparatus to the second
20 apparatus.

36. A second apparatus for wireless communication, the second apparatus comprising:

means for receiving, at the second apparatus, from a first apparatus, a random access request comprising a random access preamble and an identifier of the first apparatus for a random
25 access procedure;

means for, in response to the random access request, determining control information indicating a first resource for a downlink from the second apparatus to the first apparatus and timing information for an uplink from the first apparatus to the second apparatus; and

means for transmitting, from the second apparatus, to the first apparatus, on a control channel
30 addressed to the identifier, the control information in response to the random access request received from the first apparatus, wherein the control information is operable to cause the first apparatus to consider the random access request successful based on that both:

a timer maintained by the first apparatus is running, the timer being configurable to indicate whether the first apparatus is in timing alignment with the second apparatus on an uplink

from the first apparatus to the second apparatus, and
a timing advance command is received by the first apparatus using the first resource, the
timing advance command indicating an amount of timing adjustment to be used for timing
alignment of the first apparatus with the second apparatus on the uplink from the first
5 apparatus to the second apparatus.

37. A non-transitory computer readable medium comprising program instructions for
causing an apparatus to perform at least the method of any of claims 18-24.

10 38. A non-transitory computer readable medium comprising program instructions for
causing an apparatus to perform at least the method of any of claims 25-34.