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(54) **COMMUNICATION METHOD OF NETWORK ENTITY AND RELATED WIRELESS COMMUNICATION SYSTEM**

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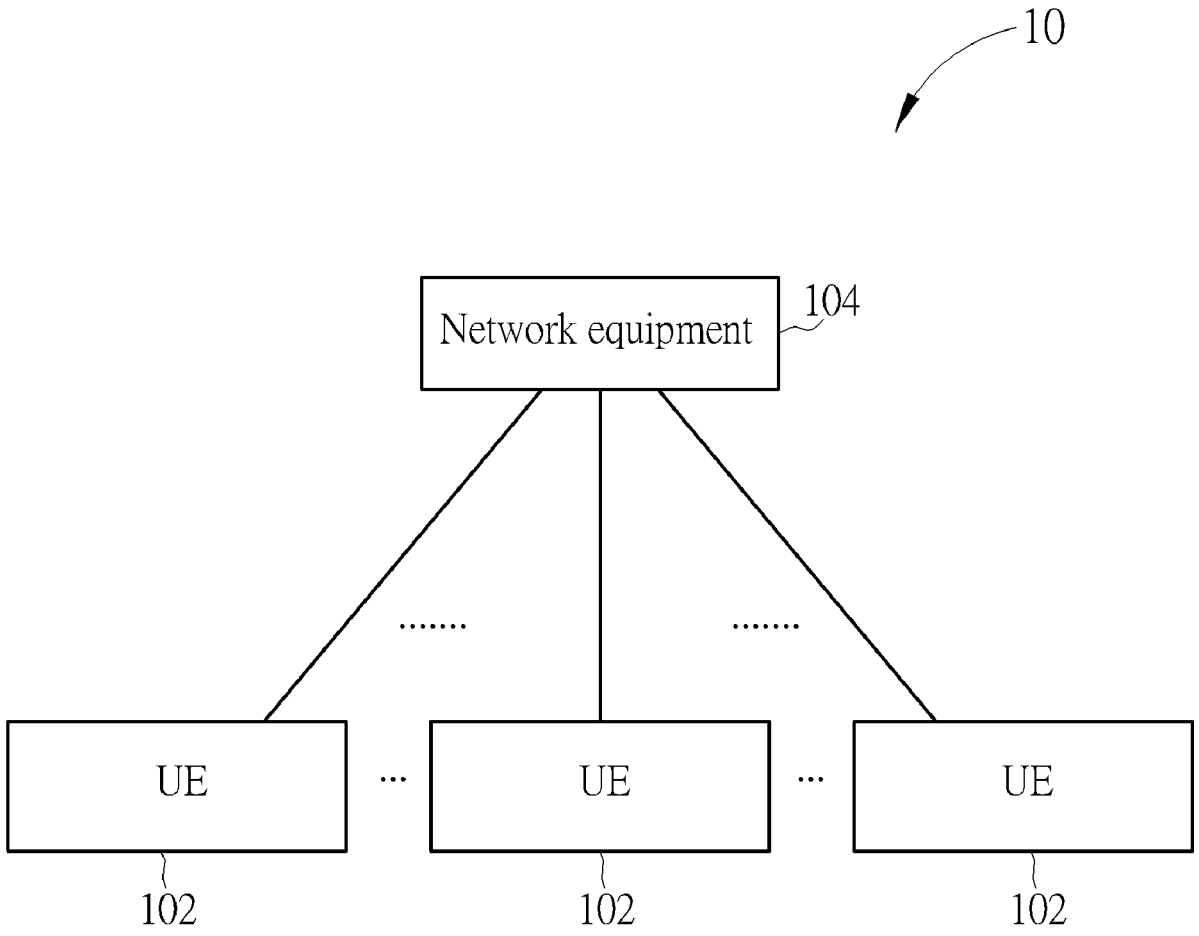
(57) **ABSTRACT**

A communication method of a network entity for a network equipment includes the steps of: receiving a request message of entering a mobile initiated connection only (MICO) mode from a user equipment (UE); determining a time length of a delay timer of the MICO mode according to the request message; and paging the UE when the delay timer of the MICO expires.



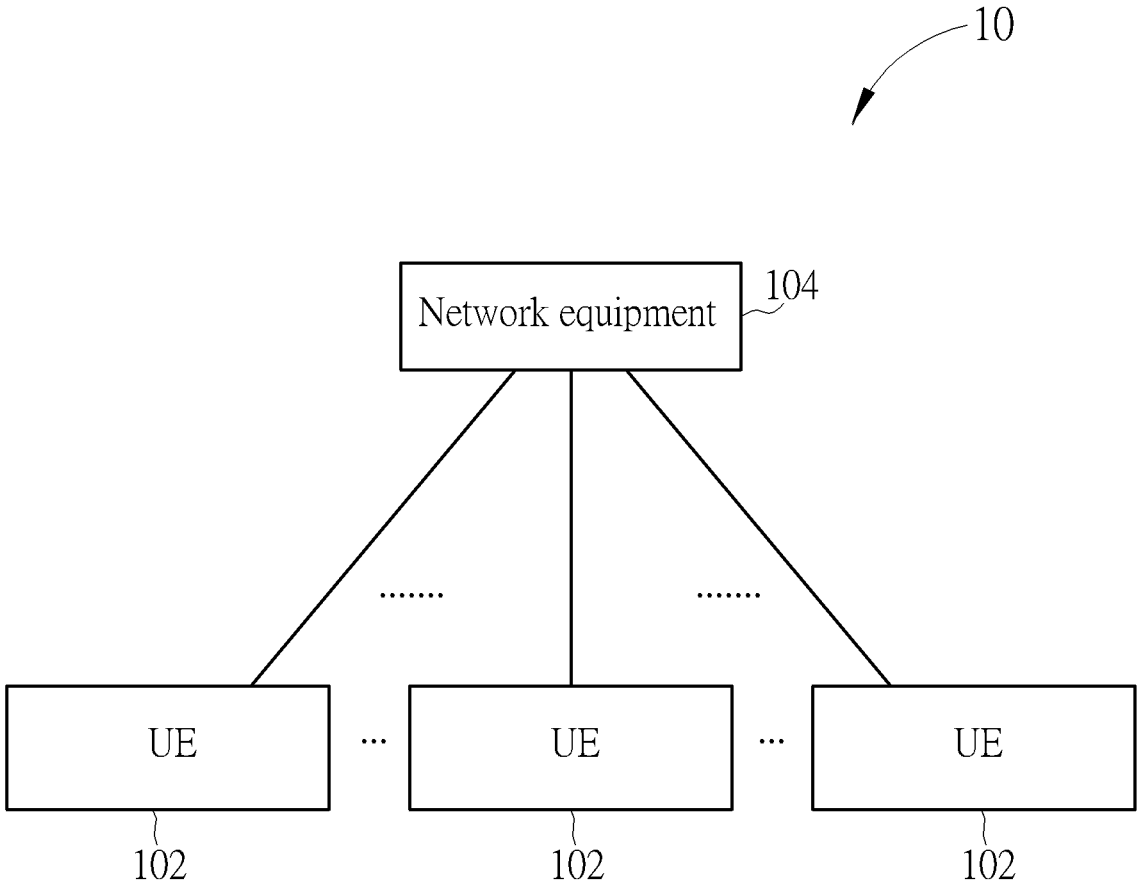


FIG. 1

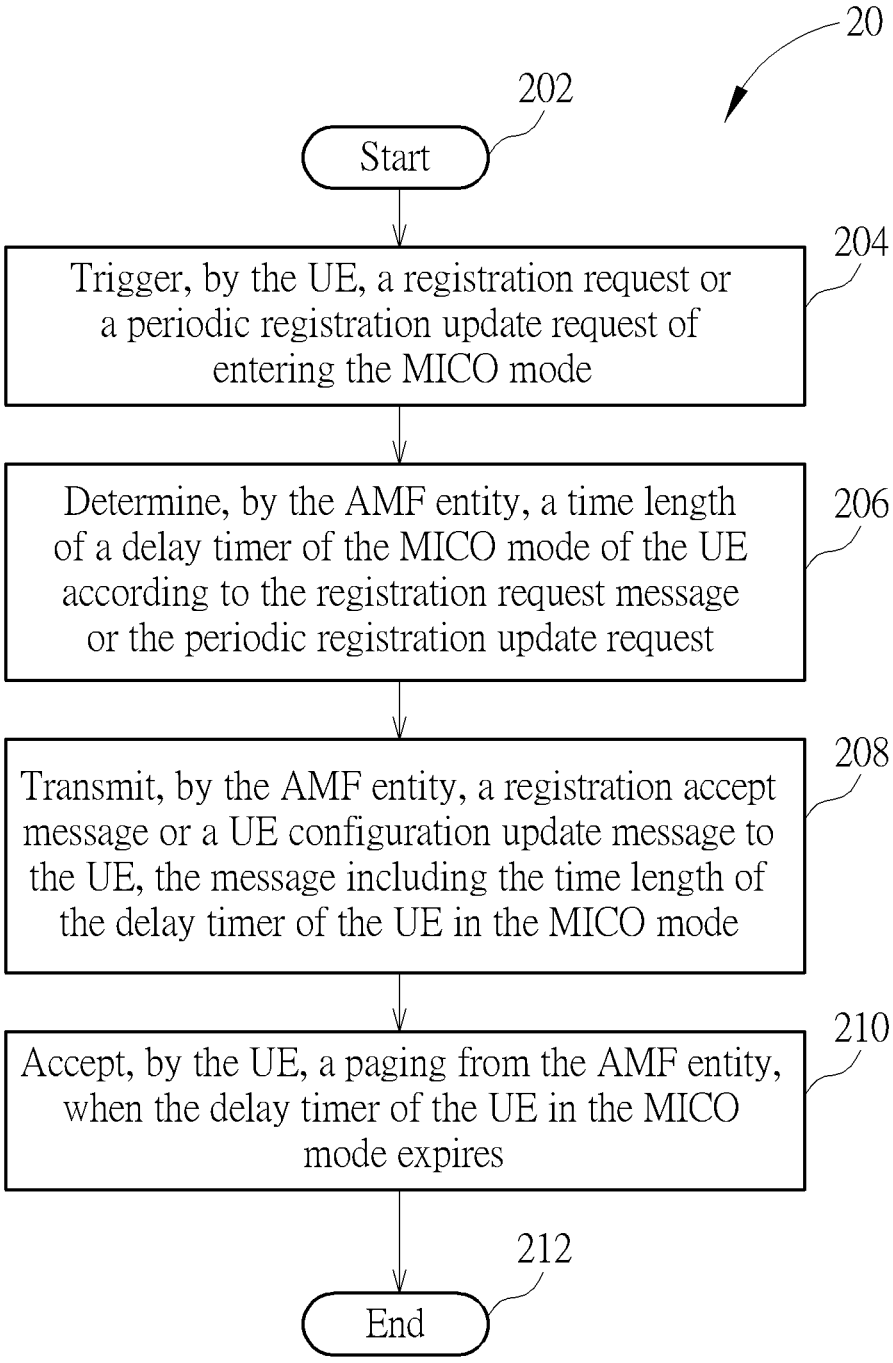

20
202
Start
204
Trigger, by the UE, a registration request or a periodic registration update request of entering the MICO mode
206
Determine, by the AMF entity, a time length of a delay timer of the MICO mode of the UE according to the registration request message or the periodic registration update request
208
Transmit, by the AMF entity, a registration accept message or a UE configuration update message to the UE, the message including the time length of the delay timer of the UE in the MICO mode
210
Accept, by the UE, a paging from the AMF entity, when the delay timer of the UE in the MICO mode expires
212
End

FIG. 2

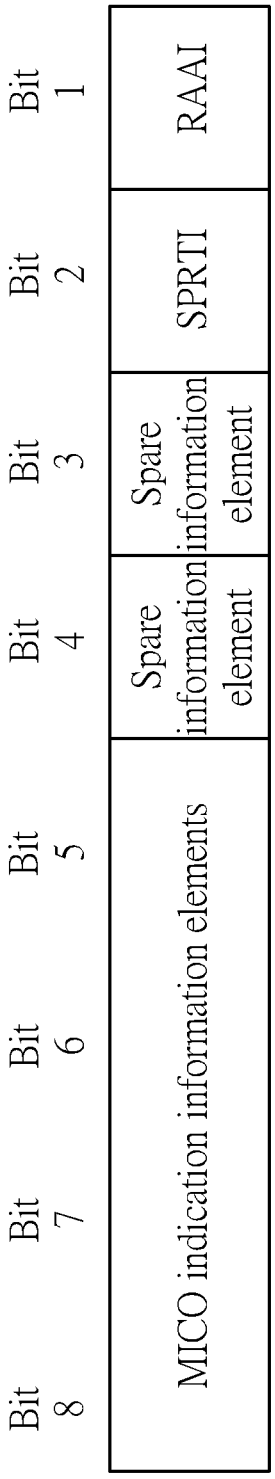

Bit 8
Bit 7
Bit 6
Bit 5
Bit 4
Bit 3
Bit 2
Bit 1
MICO indication information elements
Spare information element
Spare information element
SPRTI
RAAI

FIG. 3

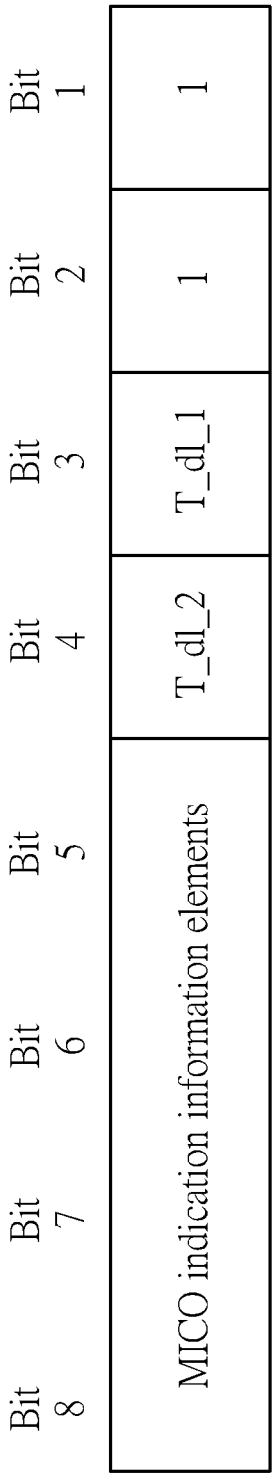

Bit 8
Bit 7
Bit 6
Bit 5
Bit 4
Bit 3
Bit 2
Bit 1
MICO indication information elements
T_dl_2
T_dl_1
1
1

FIG. 4

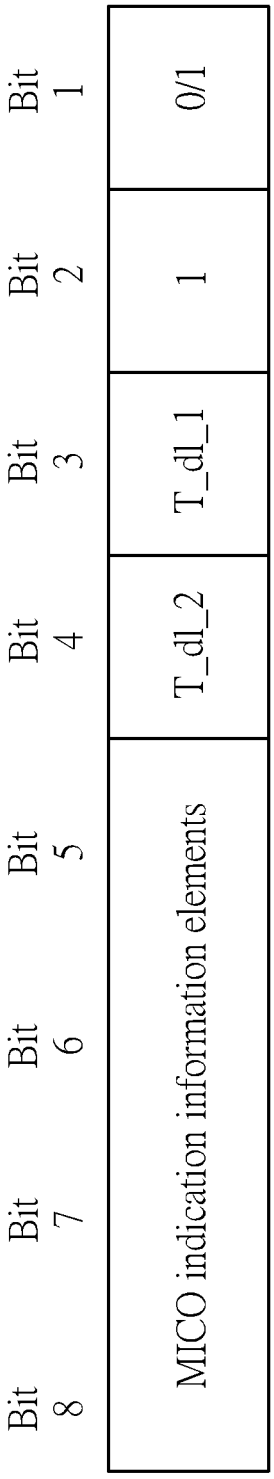

Bit 8
Bit 7
Bit 6
Bit 5
Bit 4
Bit 3
Bit 2
Bit 1
MICO indication information elements
T_dl_2
T_dl_1
1
0/1

FIG. 5

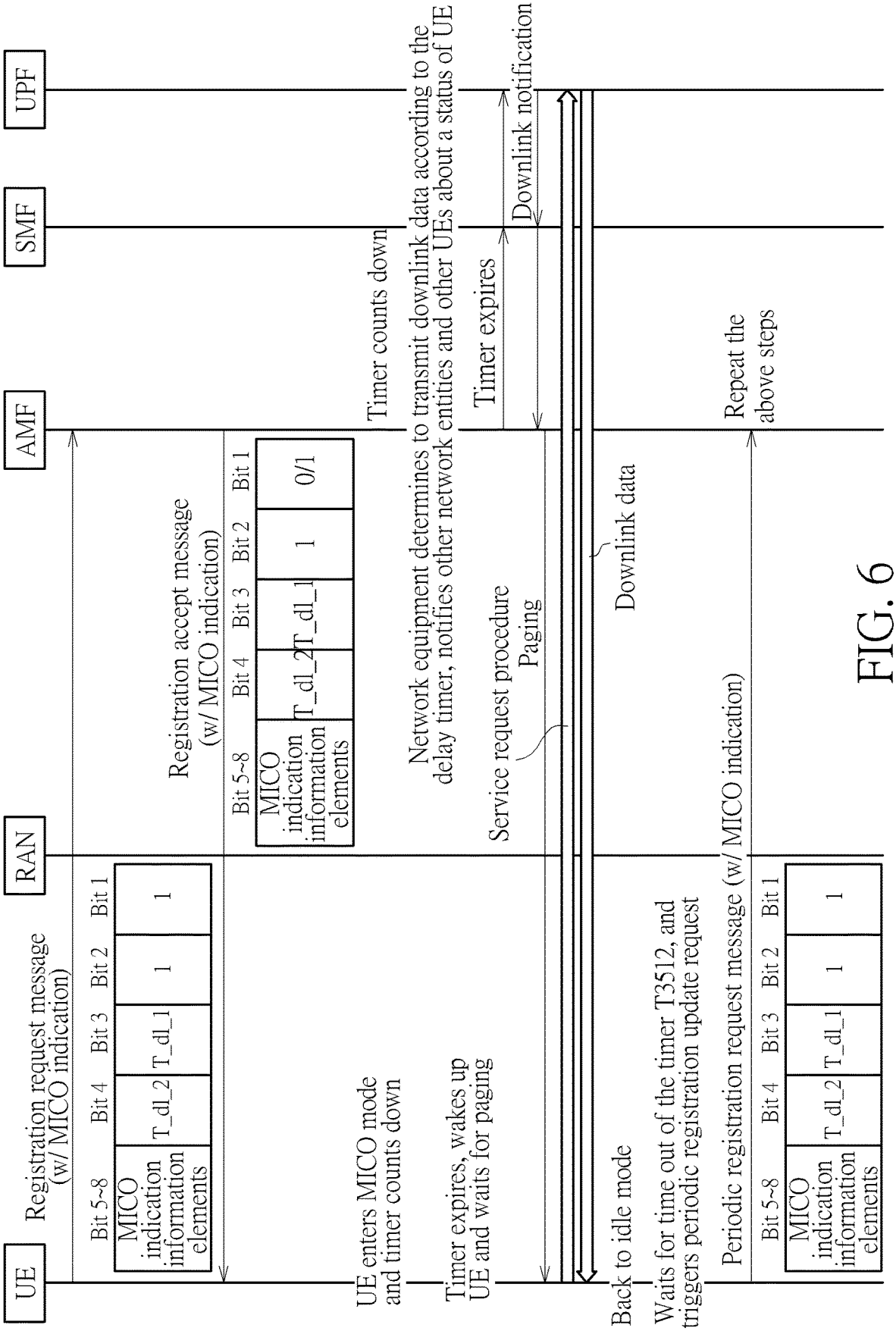

UE
RAN
AMF
SMF
UPF
Registration request message (w/ MICO indication)
Bit 5~8 Bit 4 Bit 3 Bit 2 Bit 1
MICO indication information elements
T_dl_2
T_dl_1
1
1
Registration accept message (w/ MICO indication)
Bit 5~8 Bit 4 Bit 3 Bit 2 Bit 1
MICO indication information elements
T_dl_2
T_dl_1
1
0/1
Timer counts down
UE enters MICO mode and timer counts down
Network equipment determines to transmit downlink data according to the delay timer, notifies other network entities and other UEs about a status of UE
Timer expires
Downlink notification
Timer expires, wakes up UE and waits for paging
Service request procedure
Paging
Downlink data
Back to idle mode
Waits for time out of the timer T3512, and triggers periodic registration update request
Repeat the above steps
Periodic registration request message (w/ MICO indication)
Bit 5~8 Bit 4 Bit 3 Bit 2 Bit 1
MICO indication information elements
T_dl_2
T_dl_1
1
1

FIG. 6

COMMUNICATION METHOD OF NETWORK ENTITY AND RELATED WIRELESS COMMUNICATION SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a communication method of a network entity and a related wireless communication system, and more particularly, to a communication method of a network entity and a related wireless communication system for user equipment (UE) in a mobile initiated connection only (MICO) mode.

2. Description of the Prior Art

[0002] Conventional wireless communication systems provide communication services, e.g. transmission of audio, video, data and messages. The wireless communication system may include multiple base stations (BS) where each of the base stations may support communications of multiple user equipment (UE). Base stations may communicate with user equipment via 5^{th} generation (5G) wireless systems.

[0003] In order to apply communication techniques in different regions, the 5G new radio (NR) access standard proposes a mobile initiated connection only (MICO) mode, which enables a UE to ignore messages from a network side when the UE enters the MICO mode and in an idle mode, wherein the UE may be an internet of things (IOT) equipment with low-mobility and power-saving type. When, however, the UE is in the MICO mode, timing of incoming data or messages is not predictable, and may be missed from the network side or other UEs. Therefore, improvements are necessary to the prior art.

SUMMARY OF THE INVENTION

[0004] The present invention provides a communication method of a network entity and a related wireless communication system which can avoid missing messages from a network side or other user equipment when a user equipment is in a MICO mode, thereby achieving a power saving effect.

[0005] An embodiment of the present invention discloses a communication method of a network entity for a network equipment, comprising: receiving a request message of entering a mobile initiated connection only (MICO) mode from a user equipment (UE); determining a time length of a delay timer of the MICO mode according to the request message; and paging the UE when the delay timer of the MICO expires.

[0006] Another embodiment of the present invention discloses a communication method of a network entity for a user equipment (UE), comprising: triggering a request message of entering a mobile initiated connection only (MICO) mode; receiving a time length of a delay timer determined by a network equipment; and waking the UE to receive a paging from the network equipment when the delay timer of the MICO mode expires.

[0007] Another embodiment of the present invention discloses a wireless communication system, comprising: at least a user equipment (UE), configured to trigger a request message of entering a mobile initiated connection only (MICO) mode; a network equipment, configured to determine a time length of a delay timer of the MICO mode of the UE according to the request message, and transmit a registration accept message or a user equipment configuration update message to the UE, the message including the time length of the delay timer of the UE in the MICO mode; wherein the UE accepts a paging from the network equipment when the delay timer of the MICO mode expires.

[0008] These and other objectives of the present invention will no doubt become obvious to those of ordinary skill in the art after reading the following detailed description of the preferred embodiment that is illustrated in the various figures and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. **1** is a schematic diagram of a wireless communication system according to an embodiment of the present invention.

[0010] FIG. **2** is a schematic diagram of a communication method of a network entity according to an embodiment of the present invention.

[0011] FIG. **3** is a schematic diagram of a mobile initiated connection only indication according to an embodiment of the present invention.

[0012] FIG. **4** and FIG. **5** are schematic diagrams of a mobile initiated connection only indication according to an embodiment of the present invention.

[0013] FIG. **6** is a schematic diagram of a user equipment triggering a request of entering a mobile initiated connection only (MICO) mode to a network equipment according to an embodiment of the present invention.

DETAILED DESCRIPTION

[0014] Refer to FIG. **1**, which is a schematic diagram of a wireless communication system **10** according to an embodiment of the present invention. The wireless communication system **10** includes at least a user equipment (UE) **102** and a network equipment **104**. In FIG. **1**, the UE **102** and network equipment **104** are illustrated for briefly describing a structure of the wireless communication system **10**. In practice, a wireless network of the wireless communication system **10** may include multiple nodes B of a UMTS Terrestrial Radio Access Network (UTRAN) or multiple nodes B of a 5^{th} generation (5G) wireless system. The UE **102** may be an internet of things (IOT) equipment with low-mobility and of a power-saving type. The network equipment **104** may be a core network equipment of a 5G network, a Long Term Evolution (LTE) system or other wireless communication systems, which may include an access and management function (AMF) entity, a session management function (SMF) entity and a user plane function (UPF) entity. In an embodiment, the AMF entity of the network equipment **104** may be utilized for managing the access and mobility of the UE and performing authentication, handover, and location update of the UE; the SMF entity may be utilized for managing sessions, e.g. establishing, modifying or releasing packet data units (PDU) sessions; and the UPF entity may be utilized for forwarding data of the UE.

[0015] In conventional 5G New Radio (NR) standards, the UE cannot know timings to wake up for receiving data or messages when in a mobile initiated connection only (MICO) mode, and thus messages from the network equipment or other UEs (e.g. downlink data, packets or messages) may be missed. Therefore, a timer mechanism of the wireless communication system **10** according to an embodiment

of the present invention enables the UE **102** to download the data in a period allowed by the network equipment **104**, such that an amount of missing downlink data, packets or messages are reduced.

[0016] Refer to FIG. **2**, which is a schematic diagram of a communication method **20** of the network entity according to an embodiment of the present invention. The communication method **20** may be utilized in the wireless communication system **10** and includes the following steps:

[0017] Step **202**: Start.

[0018] Step **204**: Trigger, by the UE **102**, a registration request or a periodic registration update request of entering the MICO mode.

[0019] Step **206**: Determine, by the AMF entity, a time length of a delay timer of the MICO mode of the UE **102** according to the registration request message or the periodic registration update request.

[0020] Step **208**: Transmit, by the AMF entity, a registration accept message or a UE configuration update message to the UE **102**, the message including the time length of the delay timer of the UE **102** in the MICO mode.

[0021] Step **210**: Accept, by the UE **102**, a paging from the AMF entity, when the delay timer of the UE **102** in the MICO mode expires.

[0022] Step **212**: End.

[0023] According to the communication method **20**, in step **204**, the UE **102** triggers the registration request message or the periodic registration update request of entering the MICO mode. The registration request message or the periodic registration update request includes an MICO indication. When the UE **102** transmits the registration request message or the periodic registration update request to the AMF entity, the MICO indication is carried with the registration request message or the periodic registration update request.

[0024] The MICO indication defined by the 3rd Generation Partnership Project (3GPP) is shown in FIG. **3**: in an eight-bit MICO indication, bit **1** of the network equipment **104** is defined as a registration area allocation indication (RAAI); bit **2** of the network equipment **104** is defined as a strictly periodic registration timer indication (SPRTI), bits **3** and **4** are defined as spare information elements; and bits **5-8** are defined as the MICO indication information elements.

[0025] In a scenario from the UE **102** to the network equipment **104**, the MICO indication is shown in FIG. **4**: bit **1** represents that a preference value of the registration request message transmitted by the UE **102** in the MICO mode is **1**; bit **2** represents that the UE **102** supports a timer T3512; and T_d1_1, T_d1_2 in bits **3** and **4** represent an expected delay time length of the download of the UE **102**.

[0026] In the scenario from the network equipment **104** to the UE **102**, the MICO indication is shown in FIG. **5**: bit **2** represents that the network equipment **104** supports the timer T3512; and T_d1_1, T_d1_2 in bits **3** and **4** represent that the network equipment **104** allows the delay time length proposed by the UE **102**.

[0027] The T_d1_1, T_d1_2 of bits **3** and **4** in the MICO indication represent the time length for delaying the download, which may be binary bits corresponding to the time length. For example, when the T_d1_1, T_d1_2 are all 0, the time length of the delay timer is 0 hours; when the T_d1_1 is 1, T_d1_2 is 0, the time length of the delay timer is 1 hour; when the T_d1_1 is 0, T_d1_2 is 1, the time length of the delay timer is 2 hours; when both T_d1_1 and T_d1_2 are 1, the time length of the delay timer is 3 hours. In other words, a maximum delay time length of the UE **102** for downloading is 3 hours in this embodiment. Notably, the time length of the delay timer corresponding to the T_d1_1, T_d1_2 is not limited to the above embodiments, and other examples are all within the scope of the present invention.

[0028] In step **206**, the AMF entity determines the time length of the delay timer of the UE **102** in the MICO mode according to the registration request message or the periodic registration update request from the UE **102**. Then, in step **208**, the AMF entity transmits the registration accept message or the UE configuration update message to the UE **102**, the message including the time length of the delay timer of the UE **102** in the MICO mode. The AMF entity determines the time length of the delay timer of the UE **102** in the MICO mode in step **206**, such that the corresponding MICO indication is transmitted to the UE **102** in step **208**.

[0029] When the UE **102** receives the time length of the delay timer determined from the AMF entity, the UE **102** checks the registration accept message or the UE configuration update message to determine whether the AMF entity allows the UE **102** to enter the MICO mode or not. In an embodiment, when the registration accept message or the UE configuration update message received by the UE **102** carries the MICO indication, the AMF entity allows the UE **102** to enter the MICO mode. In contrast, when the registration accept message or the UE configuration update message received by the UE **102** does not carry the MICO indication, the AMF entity does not allow the UE **102** to enter the MICO mode. Notably, in an example, when the registration accept message or the UE configuration update message transmitted by the AMF entity carries the MICO indication, and bits **3** and **4** of the MICO indication are 0, the network equipment **104** allows the UE **102** to enter the MICO mode, but setting the time length of the delay timer is not allowed.

[0030] Therefore, when the AMF entity allows the UE **102** to enter the MICO mode, the delay timer of the UE **102** and the AMF entity are triggered to count down at the same time. Meanwhile, the AMF entity determines a period of the UE **102** of downloading downlink data according to the time length of the delay timer and notifies other network entities (i.e. the SMF entity and the UPF entity) and other UEs about a status (e.g. whether the UE **102** is in the MICO mode or a wake-up time) of the UE.

[0031] Then, in step **210**, when the delay timer of the UE **102** in the MICO mode expires, the UE **102** accepts the paging from the AMF entity. In addition, since the network equipment **104** knows that the delay timer expires, other network entities (i.e. the SMF entity and the UPF entity) may trigger a service request procedure to transmit the downlink data to the UE **102**. The UE **102** enters an idle mode after the UE **102** receives the downlink data, waits for the next expiration of the timer T3512, and triggers the periodic registration update request to repeat the steps in the communication method **20** of the network entity.

[0032] Therefore, the UE **102** according to an embodiment of the present invention is awakened to receive the downlink data from the network equipment **104** based on the time length of the delay timer. Since the delay timer of the UE **102** is synchronized with that of the network equipment **104**, a download timing of the UE **102** is synchronized with the downlink data, such that circumstances of missing packets, data or messages are avoided, and signaling between the UE

102 and the network equipment for executing download procedures are reduced to achieve the power-saving effect.

[0033] The above communication method of the UE 102 proposing the request to the network equipment 104 for entering the MICO mode may be summarized by the flowchart shown in FIG. 6. Further details of operations are provided in the communication method 20 of the network entity and therefore not narrated here for brevity.

[0034] In summary, the communication method of a network entity and a related wireless communication system according to an embodiment of the present invention synchronizes the download timing of the UE and the network equipment via a timer mechanism, which can prevent missing packets, data or messages, such that signaling between the UE and the network equipment are reduced, thereby achieving a power-saving effect.

[0035] Those skilled in the art will readily observe that numerous modifications and alterations of the device and method may be made while retaining the teachings of the invention. Accordingly, the above disclosure should be construed as limited only by the metes and bounds of the appended claims.

1. A communication method of a network entity for a network equipment, comprising:
- receiving a request message of entering a mobile initiated connection only (MICO) mode from a user equipment (UE);
- determining a time length of a delay timer of the MICO mode according to the request message; and
- paging the UE when the delay timer of the MICO expires.

2. The communication method of a network entity of claim 1, wherein the request message includes a registration request message or a periodic registration update request.

3. The communication method of a network entity of claim 1, further comprising:
- in response to allowing the UE to enter the MICO mode by the network equipment, simultaneously triggering a delay timer of the UE and the delay timer of the network equipment to count down;
- wherein the delay timer is of an access and management function (AMF) entity of the network equipment.

4. The communication method of a network entity of claim 3, further comprising:
- determining a period of the UE of downloading downlink data according to the delay timer and notifying other network entities of the network equipment and/or other user equipment about a status of the UE.

5. The communication method of a network entity of claim 4, wherein other network entities includes at least one of a session management function (SMF) entity and a user plane function (UPF) entity.

6. The communication method of a network entity of claim 5, further comprising:
- triggering a service request procedure by the other network entities when the delay timer of the network equipment expires, and transmitting the downlink data to the UE.

7. The communication method of a network entity of claim 5, further comprising:
- in response to allowing the UE to enter the MICO mode, transmitting a registration accept message or a user equipment configuration update message including a mobile initiated connection only indication.

8. The communication method of a network entity of claim 7, wherein the mobile initiated connection only indication includes at least a spare bit to indicate the time length of the delay timer.

9. A communication method of a network entity for a user equipment (UE), comprising:
- triggering a request message of entering a mobile initiated connection only (MICO) mode;
- receiving a time length of a delay timer determined by a network equipment; and
- waking the UE to receive a paging from the network equipment when the delay timer of the MICO mode expires.

10. The communication method of a network entity of claim 9, further comprising:
- checking a registration accept message or a user equipment configuration update message from the network equipment; and
- determining whether the UE is allowed to enter the MICO mode by the network equipment.

11. The communication method of a network entity of claim 10, further comprising:
- entering the MICO mode when the received registration accept message or the received UE configuration update message includes a mobile initiated connection only indication; and
- not allowing to enter the MICO mode when the received registration accept message or the received UE configuration update message does not include the mobile initiated connection only indication.

12. The communication method of a network entity of claim 11, wherein the mobile initiated connection only indication includes at least a spare bit to indicate the time length of the delay timer.

13. A wireless communication system, comprising:
- at least a user equipment (UE), configured to trigger a request message of entering a mobile initiated connection only (MICO) mode; and
- a network equipment, configured to determine a time length of a delay timer of the MICO mode of the UE according to the request message, and to transmit a registration accept message or a user equipment configuration update message to the UE, the message including the time length of the delay timer of the UE in the MICO mode;
- wherein the UE accepts a paging from the network equipment when the delay timer of the MICO mode expires.

14. The wireless communication system of claim 13, wherein the request message includes a registration request message or a periodic registration update request.

15. The wireless communication system of claim 13, wherein the registration request message or the periodic registration update request includes a mobile initiated connection only indication.

16. The wireless communication system of claim 15, wherein the delay timer is of an access and management function (AMF) entity of the network equipment, and the UE is configured to check the registration accept message or a user equipment configuration update message to determine whether the AMF entity allows the UE to enter the MICO mode or not; and the delay timer of the UE and the AMF entity are simultaneously triggered to count down when the AMF entity allows the UE to enter the MICO mode.

17. The wireless communication system of claim **16**, wherein the AMF entity determines a period of the UE of downloading downlink data according to the delay timer and notifies other network entities of the network equipment and/or other user equipment about a status of the UE.

18. The wireless communication system of claim **17**, wherein the other network entities include at least one of a session management function (SMF) entity and a user plane function (UPF) entity.

19. The wireless communication system of claim **16**, wherein when the UE receives the registration accept message or the user equipment configuration update message which includes a mobile initiated connection only indication from the AMF entity, the AMF entity allows the UE to enter the MICO mode; and when the UE receives the registration accept message or the user equipment configuration update message which does not include a mobile initiated connection only indication from the AMF entity, the AMF entity does not allow the UE to enter the MICO mode.

20. The wireless communication system of claim **15**, wherein the mobile initiated connection only indication includes at least a spare bit to indicate the time length of the delay timer.

21. The communication method of a network entity of claim **5**, further comprising:

in response to not allowing the UE to enter the MICO mode, transmitting the registration accept message or a user equipment configuration update message without the mobile initiated connection only indication.

* * * * *