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(54) **OPTIMIZATION OF MTC DEVICE TRIGGER DELIVERY**

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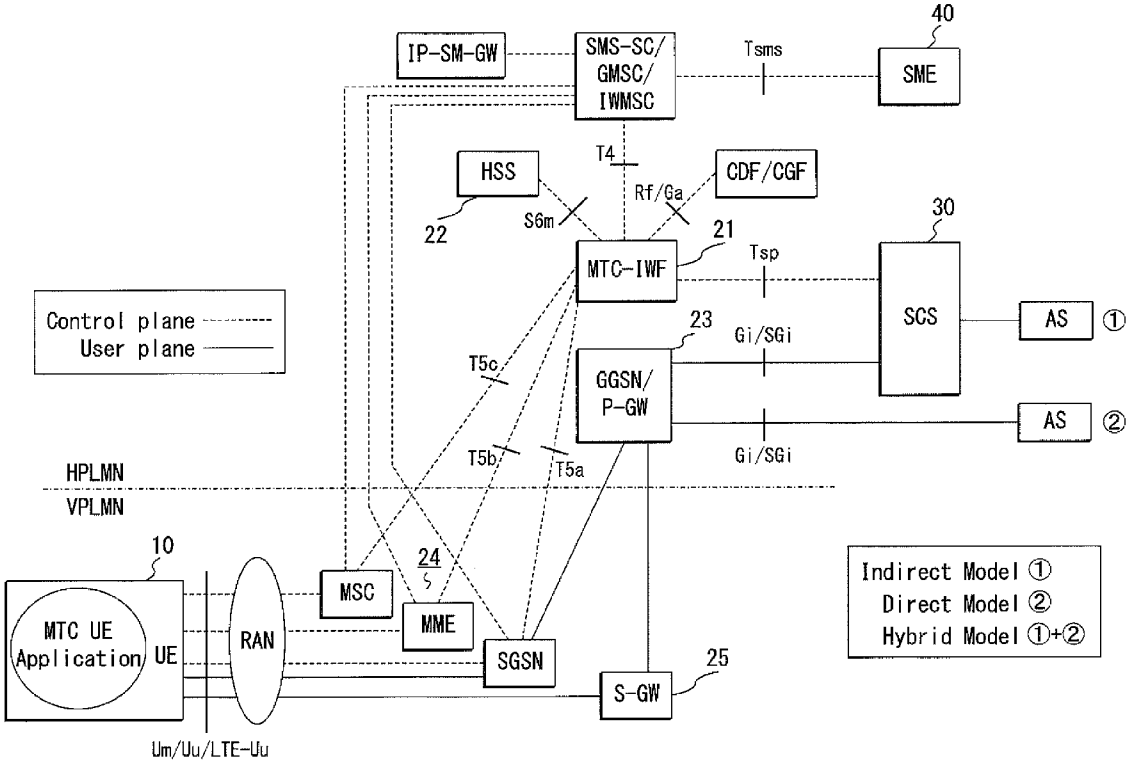
(57) **ABSTRACT**

A network node (**21**), which is placed within a core network, stores a list of network elements (**24**) capable of forwarding a trigger message to a MTC device (**10**). The network node (**21**) receives the trigger message from a transmission source (**30**, **40**) placed outside the core network, and then selects, based on the list, one of the network elements to forward the trigger message to the MTC device (**10**). The MTC device (**10**) validates the received trigger message, and then transmits, when the trigger message is not validated, to the network node (**21**) a reject message indicating that the trigger message is not accepted by the MTC device (**10**). Upon receiving the reject message, the network node (**21**) forwards the trigger message through a different one of the network elements, or forwards the reject message to transmission source (**30**, **40**) to send the trigger message through user plane.



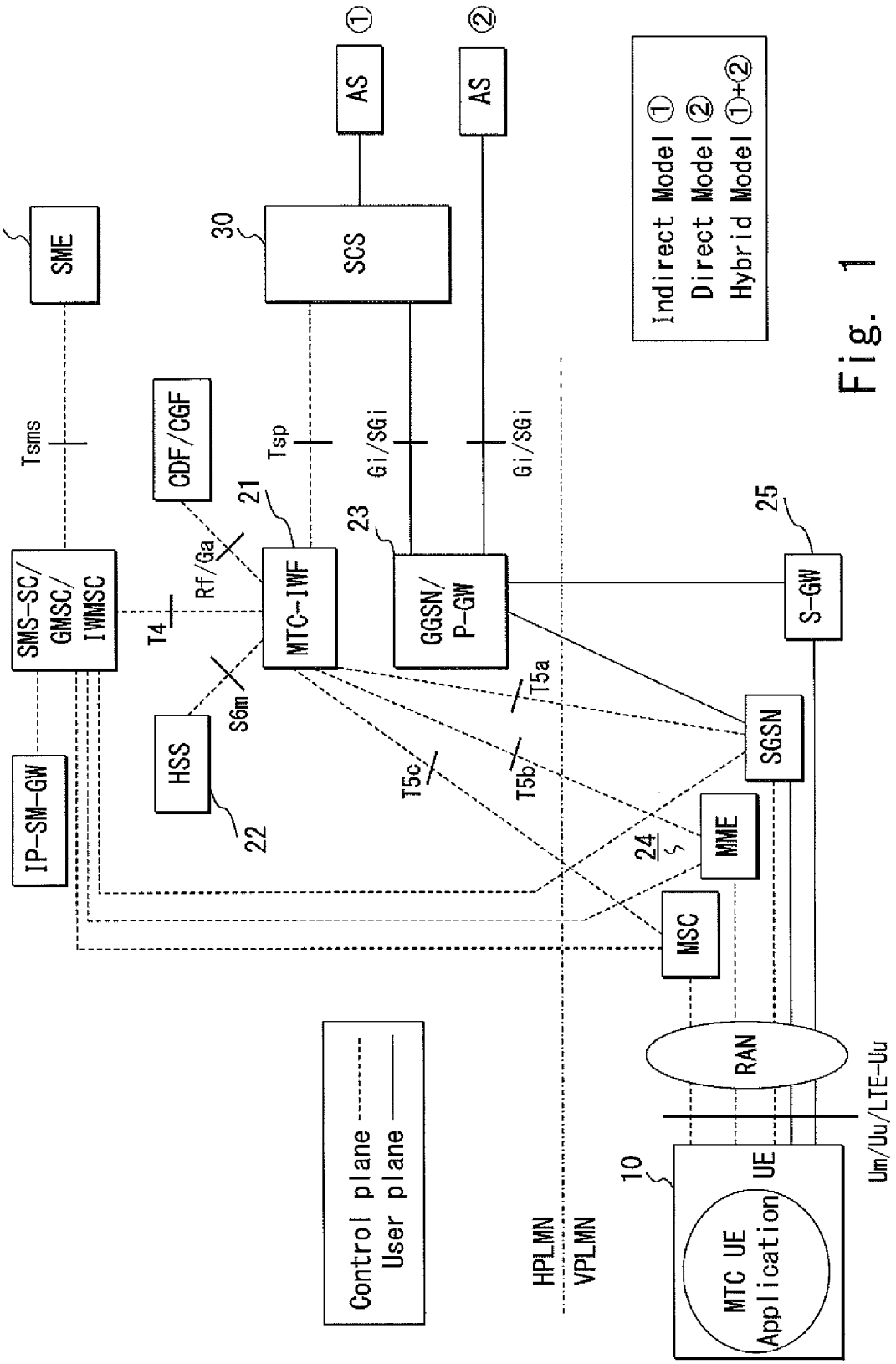

Indirect Model ①
Direct Model ②
Hybrid Model ①+②
AS
AS
SCS
SME
CDF/CGF
SMS-SC/
GMSC/
IWMSC
IP-SM-GW
HSS
MTC-IWF
GGSN/
P-GW
S-GW
SGSN
MME
MSC
RAN
MTC UE
Application
UE
Tsms
Tsp
Gi/SGi
Gi/SGi
Rf/Ga
T4
S6m
T5a
T5b
T5c
Control plane
User plane
HPLMN
VPLMN
Um/Uu/LTE-Uu
10
21
22
23
24
25
30
40

Fig. 1

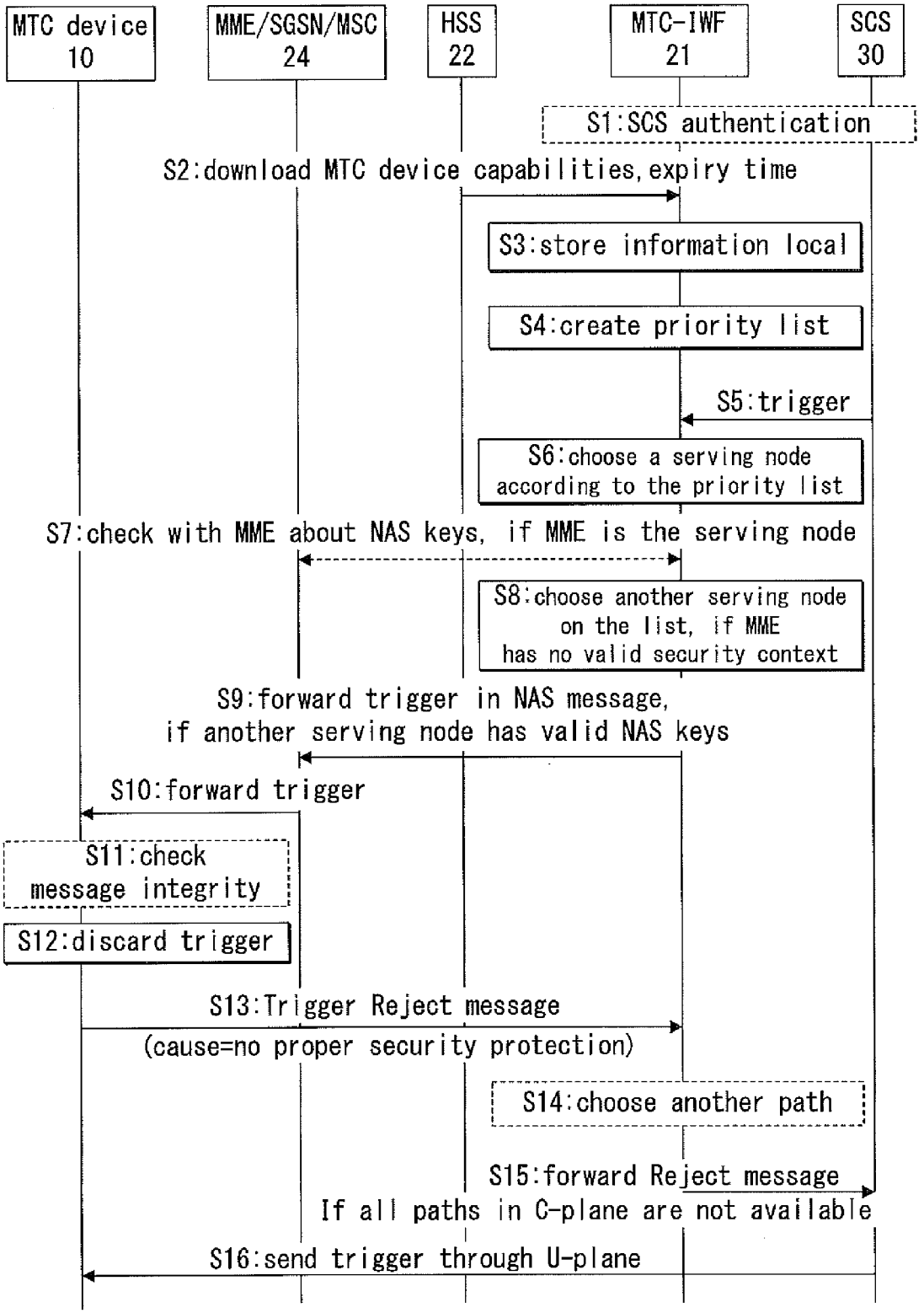

MTC device 10
MME/SGSN/MSC 24
HSS 22
MTC-IWF 21
SCS 30
S1:SCS authentication
S2:download MTC device capabilities, expiry time
S3:store information local
S4:create priority list
S5:trigger
S6:choose a serving node according to the priority list
S7:check with MME about NAS keys, if MME is the serving node
S8:choose another serving node on the list, if MME has no valid security context
S9:forward trigger in NAS message, if another serving node has valid NAS keys
S10:forward trigger
S11:check message integrity
S12:discard trigger
S13:Trigger Reject message
(cause=no proper security protection)
S14:choose another path
S15:forward Reject message
If all paths in C-plane are not available
S16:send trigger through U-plane

Fig. 2

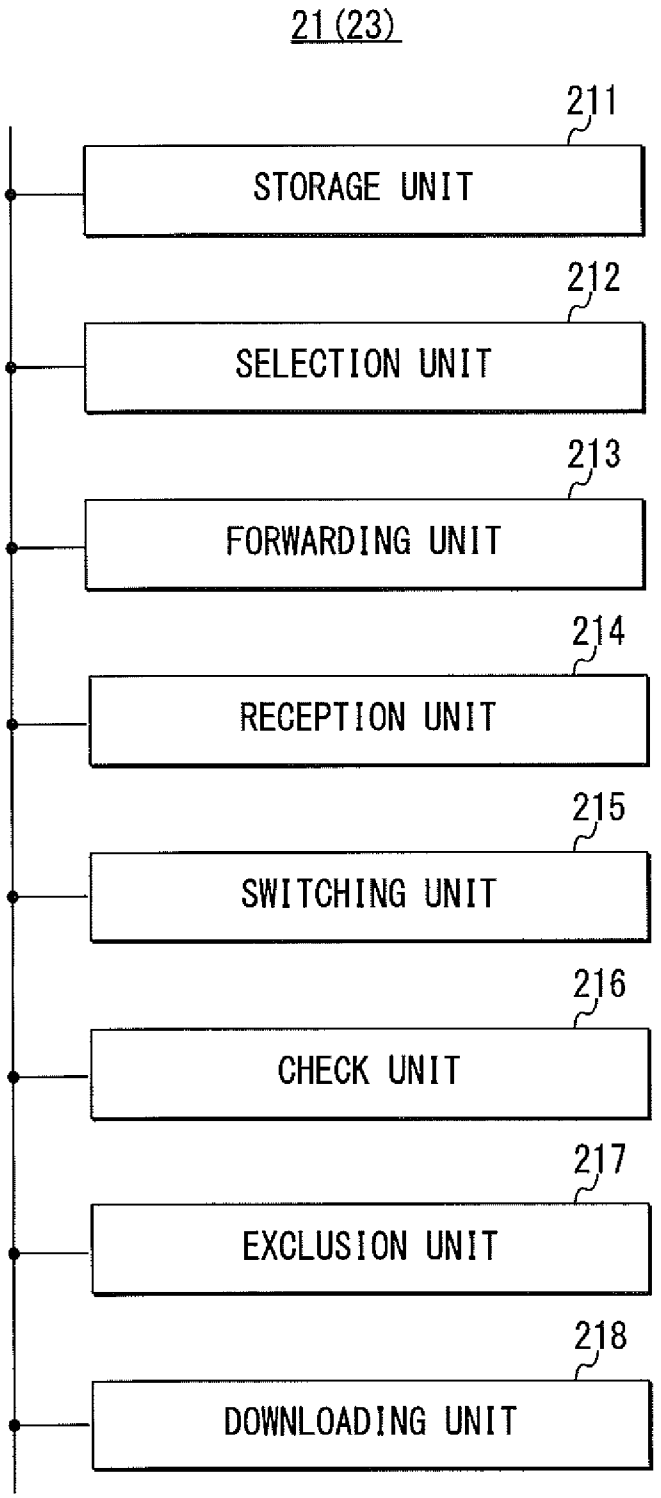

21(23)
211
STORAGE UNIT
212
SELECTION UNIT
213
FORWARDING UNIT
214
RECEPTION UNIT
215
SWITCHING UNIT
216
CHECK UNIT
217
EXCLUSION UNIT
218
DOWNLOADING UNIT

Fig. 3

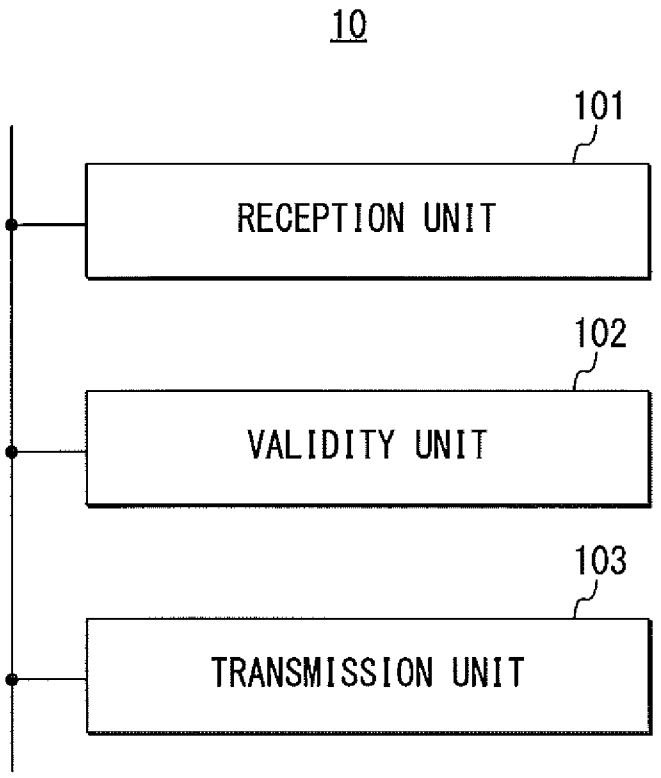

10
101
RECEPTION UNIT
102
VALIDITY UNIT
103
TRANSMISSION UNIT

Fig. 4

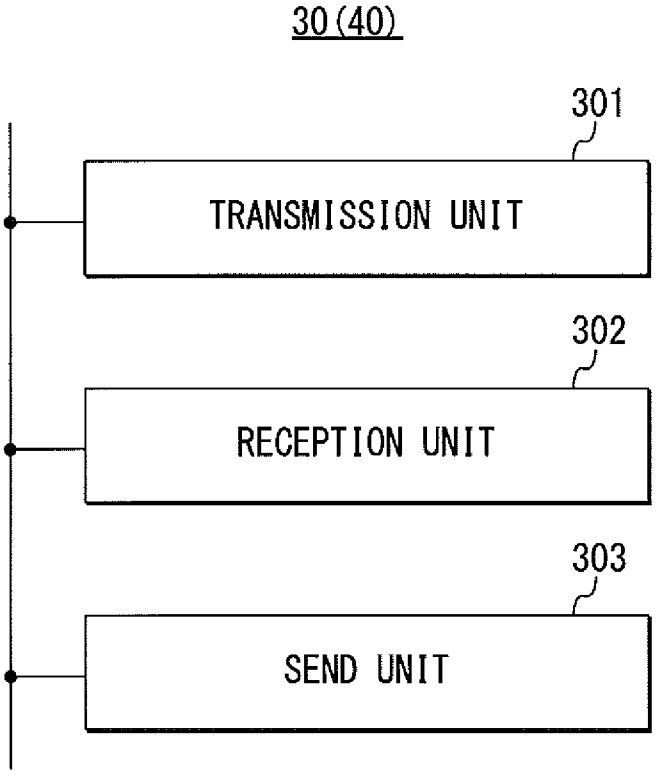

30(40)
301
TRANSMISSION UNIT
302
RECEPTION UNIT
303
SEND UNIT

Fig. 5

OPTIMIZATION OF MTC DEVICE TRIGGER DELIVERY

TECHNICAL FIELD

[0001] The present invention relates to new functions for UE (User Equipment)/MTC (Machine-Type-Communication) device and MTC-IWF (MTC-Interworking Function), in order to provide an efficient mechanism for MTC device trigger delivery.

BACKGROUND ART

[0002] MTC device triggering is a feature defined by the 3GPP's (Third Generation Partnership Project's) LTE-A (Long Term Evolution-Advanced) (see e.g. NPL 1). The MTC device triggering is sent from SCS (Services Capability Server) or SME (Short Message Entities) to network and terminated at MTC device. MTC device triggering message can be sent in NAS (Non-Access-Stratum) messages, SMS (Short Message Service), or user plane message.

[0003] MTC device trigger may not reach MTC device due to security protection check failure at UE. For example, it is described in NPL 2 that some NAS messages (e.g. Identity Request, Authentication Request, Detach Accept, etc.) with no protection can be processed by UE. If a fake MTC device trigger is embedded in such NAS messages, it can cause MTC device battery consumption, and potential mis-behaviour/mis-configuration of the MTC device.

[0004] When the secure exchange of NAS messages has not been established, UE discards the NAS messages which do not pass the integrity check (see e.g. NPL 3). When MTC device trigger is carried in such NAS messages and discarded, SCS will not have knowledge about it and may send the same trigger again. This will cause 1) overloading the network, 2) MTC device battery consumption. Another example is when trigger sent over user plane. The current 3GPP security mechanism requires confidential protection on user plane. Similarly problem should be considered that when the user plane message carrying trigger is not properly protected.

[0005] There is also considered an issue for SMS based trigger. In LTE where CSFB (CS (Circuit Switched) Fall Back) is in use, and SMS trigger is sent from SCS, without knowledge about if MTC device is IMS (IP (Internet Protocol) Multimedia Subsystem) support, MTC-IWF may forward the message to MME (Mobility Management Entity, assuming it is the serving node), then MME will decide what is the correct route. For example, if the UE is not IMS supported, MME will forward the SMS trigger to MSC (Mobile Switching Centre).

CITATION LIST

Non Patent Literature

[0006] NPL 1: 3GPP TS 23.682, "Architecture Enhancements to facilitate communications with packet data networks and applications (Release 11)", v11.1.0, 2012-06

[0007] NPL 2: 3GPP TS 24.301, "Non-Access-Stratum (NAS) protocol for Evolved Packet System (EPS); Stage 3 (Release 11)", v11.2.1, 2012-03

[0008] NPL 3: 3GPP TR 33.868, "Security aspects of Machine-Type Communications; (Release 11)", v0.8.0

SUMMARY OF INVENTION

Technical Problem

[0009] Assume that the trigger source (e.g. SCS or SME) is outside of 3GPP network domain. MTC device triggering can be sent in NAS message, user plane message or SMS message. Now, based on the background art given above, the issues to be solved include:

[0010] 1. Solution for receiving not properly protected message (e.g. NAS message) carrying trigger(s);

[0011] 2. Reducing network load and MTC device battery consumption; and

[0012] 3. Decision making on MTC device trigger delivery route by MTC-IWF.

[0013] Currently when MTC device receives a trigger without NAS protection or user plane message, it only discards the message.

[0014] There is no requirement for MTC-IWF storing MTC device capabilities, MTC device serving node information, and trigger message.

[0015] MTC-IWF only forwards the trigger to the serving node but there is no mechanism for an optimization of path selection.

[0016] As mentioned above, currently if MTC device does not support IMS, for a network which supports CSFB, MME can forward the SMS trigger to MSC. However, the inventors of this application have found that if MTC-IWF has knowledge in the early stage, a shorter route can be taken that MTC-IWF directly forwards the SMS trigger directly to MSC.

[0017] Accordingly, an exemplary object of the present invention is to provide solutions to the above described issues such that MTC device trigger can be delivered efficiently.

Solution to Problem

[0018] In order to achieve the above-mentioned object, one exemplary aspect of this invention first considers MTC device triggering carried in unprotected NAS or user plane message. When such messages carry MTC device trigger, MTC device can discard the trigger and send a Trigger Reject message to MTC-IWF or GGSN (Gateway GPRS General Packet Radio Service) Support Node)/P-GW (PDN (Packet data network) Gateway). MTC-IWF or GGSN/P-GW will hold this trigger message and forward it via a different path like SGSN (Serving GPRS Support Node) in case of NAS message or S-GW (Serving Gateway) in case of user plane message. In case of NAS message,

[0019] MTC-IWF can alternatively check the security status with MME and SGSN beforehand, and wrap the trigger in NAS message only when MME has valid NAS security context. The route in which the MTC device trigger is delivered, can be decided by a priority list of MTC device trigger delivery. The priority can be decided by UE capabilities and serving node information. The list can be either created in HSS (Home Subscriber Server) or MTC-IWF.

[0020] When the SMS trigger is in use and MTC device does not support IMS, without knowledge about MTC device capability, MTC-IWF may still forward the SMS trigger message to MME, if it was indicated that the MME is the current serving node by HSS. When MME finds out MTC device does not support IMS, it will forward the trigger to MSC to make it reach MTC device. This will delay the trigger delivery. While MTC-IWF can access HSS for some of MTC

device information, it is proposed that MTC-IWF also requests MTC device capabilities of IMS support or not. When the MTC-IWF receives a SMS trigger, it will check its local stored MTC device capability, if the MTC device does not support IMS, it can directly forward the trigger to MSC.

Advantageous Effects of Invention

[0021] According to the present invention, it is possible to solve one or more of the above-described issues. For example, it is possible to achieve at least a part or one of the following effects 1 to 3.

[0022] 1. The network node (MTC-IWF or GGSN/P-GW) which forwards trigger or trigger source can have knowledge of the trigger discarding. It can find another path to deliver the trigger such that 1) the trigger can reach MTC device, 2) the trigger will not be re-sent on the same path thus unnecessary network traffic can be reduced and MTC device battery consumption will not be wasted.

[0023] 2. MTC-IWF can decide a right path for MTC device trigger delivery in an early stage so that the trigger delivery time can be shorten and network traffic will not be wasted.

[0024] 3. A priority list of MTC device trigger delivery path provides a route selection optimization such that MTC-IWF will be able to choose a proper route in an early stage and will not send the trigger through a failed path.

BRIEF DESCRIPTION OF DRAWINGS

[FIG. 1]

[0025] FIG. **1** is a block diagram showing an example of system architecture according to an exemplary embodiment of the present invention.

[FIG. 2]

[0026] FIG. **2** is a sequence diagram showing an example of message sequence (trigger carried in NAS message) in a system according to the exemplary embodiment of the present invention.

[FIG. 3]

[0027] FIG. **3** is a block diagram showing a configuration example of a network node placed within a core network in the system according to the exemplary embodiment of the present invention.

[FIG. 4]

[0028] FIG. **4** is a block diagram showing a configuration example of a MTC device in the system according to the exemplary embodiment of the present invention.

[FIG. 5]

[0029] FIG. **5** is a block diagram showing a configuration example of a network node placed outside the core network in the system according to the exemplary embodiment of the present invention.

DESCRIPTION OF EMBODIMENTS

[0030] Hereinafter, an exemplary embodiment of the present invention will be described with reference to FIGS. **1** to **5**.

[0031] As mentioned above, when the trigger message is send over NAS, it is described in NPL 3 that trigger without NAS security protection should be discarded by MTC device. The trigger source or network node such as MTC-IWF will not know about the discard and repeatedly send the same trigger again, which may be discarded by the MTC device again. This can cause a few problems: 1) the trigger will not reach MTC device; 2) MTC device (power sensitive) will consume and waste battery; 3) network traffic waste.

[0032] In order to address these problems, as shown in FIG. **1**, a system according to this exemplary embodiment includes a core network (3GPP network), one or more MTC devices **10** which connect to the core network through a RAN (Radio Access Network), and an SCS **30** and an SME **40**, each of which is placed outside the core network and serves as a transmission source of a trigger message.

[0033] Among them, each MTC device **10** is a UE for MTC communication with the core network via the Um/Uu/LTE-Uu interface. The UE can host one or multiple MTC Applications. The corresponding MTC Applications in the external network are hosted on one or multiple ASs (Application Servers).

[0034] Further, the SCS **30** and the SME **40** connect to the core network to communicate with the MTC device **10**.

[0035] Furthermore, the core network includes an MTC-IWF **21**, an HSS **22**, and GGSN/P-GW **23** in the HPLMN (Home Public Land Mobile Network), and includes MME/SGSN/MSC **24** and an S-GW **25** in the VPLMN (Visited PLMN). In the core network, each of the MTC-IWF **21** and the GGSN/P-GW **23** serves as a network node which receives a trigger message from its transmission source, each of the MME/SGSN/MSC **24** and the S-GW **25** serves as a network element which forwards the trigger message to the MTC device **10**, and the HSS **22** (or e.g. HLR (Home Location Register)) serves as a server which provides various information to the network node. Typically, in a case of NAS message, the MTC-IWF **21** receives a trigger message from the SCS **30** via Tsp interface, and then forwards the trigger message to the MME via T5b interface. On the other hand, in a case of SMS message, the MTC-IWF **21** receives a trigger message from the SME **40** via T4 and Tsms interfaces (i.e. through SMS-SC/GMSC/IWMSC) or from the SCS **30** via Tsp interface, and then forwards the trigger message to the MME/SGSN/MSC **24** via T5b/T5a/T5c interface. Thus, the trigger message can be routed by the MME/SGSN/MSC **24** to the MTC device **10**. The HSS **22** stores MTC device capabilities and serving node information which will be described later, and notifies them to the MTC-IWF **21** via S6m interface. The GGSN/P-GW **23** receives a trigger message from the SCS **30** or directly from the AS via Gi/SGi interface, and then forwards the trigger message to the SGSN or the S-GW **25** through user plane, so that the trigger message can be also routed to the MTC device **10**.

[0036] Next, operation examples of this exemplary embodiment will be described in detail with reference to FIG. **2**.

[0037] In this exemplary embodiment, assume that the trigger source (i.e. SCS **30** or SME **40**) is properly authenticated to the network (Step S**1**). Mutual authentication between the MTC device **10** and the network is also performed.

(1) Optimization of MTC Device Trigger Delivery

[0038] 1) MTC-IWF **21** downloads UE capabilities from HSS **22** via interface S6m (Step S**2**). This can be a new

message or the same message that MTC-IWF **21** retrieves UE's serving node information from HSS **22**. The UE capabilities can include, for example, information on which communication system (e.g. SAE (System Architecture Evolution)/LTE or 3G) the MTC device **10** supports. Preferably, as will be described in the following (2), the UE capabilities may include information as to whether or not the MTC device **10** supports IMS. On the other hand, the serving node information includes usage rates of the MME/SGSN/MSC **24**. Additionally, routing information can be downloaded from the HSS **22** or the HLR. Data of routing information, serving node information can be pushed or downloaded from HSS/HLR and saved locally in SMSC/SMS-GMSC.

[0039] The downloading can happen when:

[0040] (A) MTC-IWF **21** receives the first trigger; or

[0041] (B) MTC device **10** is attached to the network and HSS **22** pushes the information to MTC-IWF **21**.

[0042] 2) MTC-IWF **21** stores the UE capabilities and serving node information locally, for a given period (Step S**3**).

[0043] 3) HSS **22** or MTC-IWF **21** creates a priority list of MTC device trigger delivery route, with an expiry timer (Step S**4**). The priority could be simply a random selection, or decided by operator policy of network usage, or based on the serving node information and UE capabilities. Taking as an example the case where the serving node information includes the usage rates, priority list includes records in which the MME/SGSN/MSC **24** are stored in association with their respective usage rates. Further, in the case where the list is created by the HSS **22**, the MTC-IWF **21** downloads the list from the HSS **22**. The downloading and/or creation are performed before the MTC-IWF **21** receives the trigger from the SCS **30**. Note that the list should be removed if MTC-IWF **21** is informed the MTC device **10** is detached or when it is expired.

[0044] 4) MTC-IWF **21** receives the trigger from the SCS **30** (Step S**5**).

[0045] 5) MTC-IWF **21** performs authorization to SCS **30**, to see whether it can send trigger message.

[0046] 6) MTC-IWF **21** checks security context at a given network element, e.g. MME (Steps S**6** and S**7**), which can be done by:

[0047] (A) Pinging given network element for information or by analyzing the information received from the HSS; or

[0048] (B) Check with the information that provided by HSS **22** when MTC-IWF **21** downloaded the serving node information, or pushed from HSS **22** e.g. when UE changed its location.

[0049] 7) If MME responds that it has no valid security context for the UE, MTC-IWF **21** will send the trigger message to the next serving node in the priority list, e.g. SGSN (Steps S**8** and S**9**). Then, SGSN forwards the trigger message to MTC device **10** (Step S**10**). MTC-IWF **21** should ensure that it does not choose the same route, by marking the failed path invalid. Thus, it is possible to prevent the trigger message from being redundantly re-forwarded through the failed path, so that the trigger message can more rapidly reach the MTC device **10**. The route can be valid if MTC-IWF **21** receives information from HSS **22** or MME that security context is established.

[0050] Thus, in this exemplary embodiment, it is possible to ensure that the trigger message can securely reach the MTC device **10**, by deciding the network element which should transfer the trigger message based on the list. In the case where the MTC-IWF **21** creates the list, it is possible to rapidly select the valid path. This is because that the MTC-IWF **21** operates as an entrance into the core network.

[0051] Further, in the case where the list includes records in which the MME/SGSN/MSC **24** are stored in association with their respective usage rates, the MTC-IWF **21** can select the MME/SGSN/MSC **24** in ascending order of usage rate. Therefore, it is possible to reduce congestion of the core network.

[0052] 8) UE (MTC device **10**) checks validity of the message carrying the trigger (this follows the current 3GPP specification security requirements) (Step S**11**).

[0053] 9) If message is not validated correctly then MTC device **10** discards the trigger message (Step S**12**) and sends a Reject message to MTC-IWF **21** indicating the reject cause (e.g. no proper security protection) (Step S**13**), otherwise accepts the trigger.

[0054] 10) After received the Reject message, MTC-IWF **21** can do as follows:

[0055] (A) Choose the next path which is not marked as invalid from propriety list, and then forward the trigger through the chosen path (Step S**14**);

[0056] (B) When there is no any control plane path available, MTC-IWF **21** can forward the Reject message to SCS **30** such that SCS **30** can send the trigger through user plane (Steps S**15** and S**16**);

[0057] (C) Request MME to initiate AKA (Authentication and Key Agreement) and SMC (Short Message Control) procedure to establish security context such that it can forward the trigger message.

[0058] Thus, in this exemplary embodiment, it is also possible to prevent the trigger message from being redundantly re-forwarded by use of the Reject message. Therefore, it is possible to reduce congestion of the core network and battery consumption of the MTC device **10**. For example, it can be ensured that an emergent trigger message or the like reaches the MTC device **10**.

[0059] Although the illustration is omitted, with respect to user plane, the GGSN/P-GW **23** performs similar processing with that of the MTC-IWF **21**. Specifically, the GGSN/P-GW **23** receives from the MTC device **10** a Reject message with a cause indicating there was no proper user plane confidentiality protection, finds another path to deliver the trigger. For example, if a path via the SGSN is not protected, the GGSN/P-GW **23** chooses a protected path via the S-GW **25** to forward the trigger message.

(2) Consideration of SMS Based Trigger for Non-IMS Support MTC Device

[0060] When the trigger message is sent as SMS, MTC devices which do not support IMS should also be considered. An SMS trigger message carried in NAS message to a MTC device which does not support IMS, CSFB may be initiated such that MME will forward the message to MSC. This will cause unnecessary traffic and delay the trigger delivery.

[0061] In order to avoid them, the operation of this exemplary embodiment is performed as follows.

[0062] 1) MTC-IWF **21** can download MTC device capability of support IMS from HSS **22** as described in (1). When an SMS trigger is to be forwarded, MTC-IWF **21** should check the local stored information to see whether MTC device **10** supports IMS or not.

[0063] 2) If the MTC device **10** does not support IMS, MTC-IWF **21** should forward the trigger directly to MSC, not MME.

[0064] In this way, the SMS trigger message is directly forwarded to the MMC not through the MME. Therefore, it is possible to avoid causing unnecessary traffic from the MME to the MSC, and thus to prevent the SMS trigger message from being delayed due to the redundant routing through both of the MME and the MSC.

[0065] As shown in FIG. **3**, the MTC-IWF **21** includes at least a part or all of a storage unit **211**, a selection unit **212**, a forwarding unit **213**, a reception unit **214**, a switching unit **215**, a check unit **216**, an exclusion unit **217**, and a downloading unit **218**. These units **211** to **218** are mutually connected with each other through a bus or the like. The storage unit **211** stores the priority list. The selection unit **212** selects one of the MME/SGSN/MSC **24** based on the priority list. The forwarding unit **213** forwards the trigger message to the MTC device **10** through the selected one of the MME/SGSN/MSC **24**. The reception unit **214** receives the trigger message from the SCS **30** or the SME **40**, and receives the Reject message from the MTC device **10** through the selected one of the MME/SGSN/MSC **24**. The switching unit **215** causes the forwarding unit **213** to forward the trigger message through a different one of the MME/SGSN/MSC **24**, when the Reject message is received by the reception unit **214**. The check unit **216** checks whether or not the selected one of the MME/SGSN/MSC **24** can securely forward the trigger message to the MTC device **10**. The exclusion unit **217** instructs the forwarding unit **213** to exclude the selected one of the MME/SGSN/MSC **24** upon the subsequent forwarding, when the check unit **216** determines that the selected one of the MME/SGSN/MSC **24** cannot securely forward the trigger message. The downloading unit **218** can download from the HSS **22** the priority list to be stored in the storage unit **211**. Further, the downloading unit **218** downloads the MTC device capability from the HSS **22**. When the MTC device capability indicates that the MTC device **10** does not support IMS, the forwarding unit **213** forwards the trigger message directly to the MSC.

[0066] These units **211** to **218** can be configured by, for example, transceivers which respectively conduct communication with the HSS **22**, the MME/SGSN/MSC **24**, the SCS **30** and the SME **40**, and a controller which controls these transceivers to execute the processes shown at Steps **S1** to **S9** and **S13** to **S15** in FIG. **2** or processes equivalent thereto. The GGSN/P-GW **23** can be also configured as with the MTC-IWF **21**, except conducting communication with the SGSN, the S-GW **25**, the SCS **30** and the AS through the user plane.

[0067] Further, as shown in FIG. **4**, the MTC device **10** includes at least a reception unit **101**, a validity unit **102**, and a transmission unit **103**. These units **101** to **103** are mutually connected with each other thorough a bus or the like. The reception unit **102** receives the trigger message from the core network. The validity unit **102** validates the trigger message. The transmission unit **103** transmits the Reject message to the core network, when the trigger message is not validated by the validity unit **102**. These units **101** to **103** can be configured by, for example, a transceiver which wirelessly conducts communication with the core network through the RAN, and a controller which controls this transceiver to execute the processes shown at Steps **S10** to **S13** and **S16** in FIG. **2** or processes equivalent thereto.

[0068] Furthermore, as shown in FIG. **5**, the SCS **30** includes at least a transmission unit **301**, a reception unit **302**, and a send unit **303**. These units **301** to **303** are mutually connected with each other thorough a bus or the like. The transmission unit **301** transmits the trigger message to the core network through control plane (i.e. transmits the trigger message to the MTC-IWF **21** via Tsp interface). The reception unit **302** receives the Reject message from the MTC-IWF **21**. The send unit **303** sends the trigger message through user plane (i.e. sends the trigger message to the GGSN/P-GW **23** via Gi/SGi interface), when the Reject message is received by the reception unit **302**. These units **301** to **303** can be configured by, for example, transceivers which respectively conduct communication with the MTC-IWF **21** and the GGSN/P-GW **23**, and a controller which controls these transceivers to execute the processes shown at Steps **S1**, **S5**, **S15** and **S16** in FIG. **2** or processes equivalent thereto. The SME **40** can be also configured as with the SCS **30**, except transmitting the trigger message to the MSC-IWF **21** via the SMS-SC/GMSC/IWMSC.

[0069] Note that the present invention is not limited to the above-mentioned exemplary embodiment, and it is obvious that various modifications can be made by those of ordinary skill in the art based on the recitation of the claims.

[0070] For example, the MTC-IWF **21** or the GGSN/P-GW **23** may transfer the trigger message through a different network element, when a response to the trigger message is not received within a predetermined period of time. Specifically, the reception unit **214** receives the response from the MTC device **10**. If the response is not received by the reception unit **214** within the period of time, the switching unit **215** causes the forwarding unit **213** to forward the trigger message through a network element different from the selected network element. Note that the period of time can be measured by use of a timer, a counter or the like. Thus, it can be also ensured that the trigger message reaches the MTC device **10**. In this case, it may not be required for the MTC device **10** to sends the Reject message, so that modification to the MTC device **10** can be reduced compared with the above-mentioned exemplary embodiment.

[0071] The whole or part of the exemplary embodiment disclosed above can be described as, but not limited to, the following supplementary notes.

(Supplementary Note 1)

[0072] MTC-IWF downloads (requesting or being pushed) MTC device capabilities from HSS via interface S6m including for example if MTC device supports IMS. This can be a new message or a new field in the message which MTC-IWF retrieves MTC device serving node information.

(Supplementary Note 2)

[0073] MTC device trigger delivery route priority list. This list is created based on the operator policy of network usage and/or by UE capability. The list can be created in HSS then pushed to MTC-IWF, or created by MTC-IWF after it downloaded the necessary information from HSS. The list can be stored in MTC-IWF locally.

(Supplementary Note 3)

[0074] If a MME is the serving node, MTC-IWF checks with MME to see if it has valid NAS security context. When MME does not have valid security context, MTC-IWF should forward the trigger to other entities like SGSN/MSC according to the delivery route priority.

(Supplementary Note 4)

[0075] When MTC device receives a trigger embedded in an unprotected NAS or user plane message, it sends a Trigger Reject message with cause indication to network node: MTC-IWF or GGSN/P-GW.

(Supplementary Note 5)

[0076] MTC-IWF, which receives a reject message with a cause indicating there was no proper NAS protection, finds another path to deliver the trigger. When all the control plane paths are not available, MTC-IWF can initiate AKA and SMC procedure. It also can forward the Reject message to SCS, such that SCS can send the trigger message via user plane.

(Supplementary Note 6)

[0077] GGSN/P-GW which receives a reject message with a cause indicating there was no proper user plane confidentiality protection, finds another path to deliver the trigger.

2. Discussion

[0078] There are two issues discussed in this document.

[0079] First, SA2 TS 23.682 considers roaming in the architecture. In this case, the visited network may not be trusted by the MTC device and the triggers forwarded from such network should not be trusted and taken as valid either.

[0080] Thus MTC device should:

[0081] verify if the MTC-IWF it communicates with is authorized.

[0082] be able to verify if the trigger is from a authorized MTC-IWF. If it is from an invalid MTC-IWF, MTC device should inform MME such that MME will suspend the communication with MTC-IWF and may have a further action.

[0083] Second, when the MTC device receives a trigger without NAS integrity protection, the MTC device (as described in TR 33.868) "could discard the trigger or alternatively look deeper into the trigger if end-to-end protection was applied".

[0084] A few things are concerned:

[0085] The trigger cannot be received and MTC server or MTC user has no knowledge about the discard.

[0086] It wastes network traffic and MTC device's battery, that if MME sends a trigger which will not be received.

[0087] In order to solve the above described issue:

[0088] MME should not send the trigger without protection in the first place

[0089] If such trigger is received, MTC device should send Reject message to MME/MTC-IWF/SCS with a cause of reject such that network can act accordingly:

[0090] MME can Initiate AKA procedure to establish security context

[0091] MTC-IWF can send the trigger from another path (i.e. via another network node), for example, SGSN. This can depend on operator policy and/or MTC device capabilities.

[0092] Based on the discussion above, we propose to have the following change to TR 33.868.

[0093] Solution 1: Triggering via NAS Signaling

[0094] The main Device triggering mechanisms currently being considered in SA2 TR 23.888 [10] are triggering via NAS signalling (e.g. a new information element in an existing NAS message or a new NAS message) and triggering via SMS. The SMS trigger may possibly also be sent from the network to the MTC Device using NAS as a transport. In this case, current NAS security mechanisms can be used to solve the security issue. After NAS SMC, NAS security is activated. All NAS signaling messages should be integrity-protected according to TS 33.401 [13], and therefore current LTE security mechanisms ensure that the trigger indication is not tampered with. In this case the SMS trigger will also benefit from the integrity protection of NAS signalling in LTE.

[0095] Source verification needs to be considered which in this context is understood to mean that the MTC Device can verify that the source of the trigger is a valid MTC server. This could be achieved in the following way.

[0096] MTC Device trusts the 3GPP network sending the NAS integrity protected trigger. In this case the MTC Device could be configured with identities of trusted 3GPP networks. (Somewhat analogically as trusted non3GPP access networks can be configured in the UE in TS 33.402.) In this context trusted 3GPP network would mean networks which have a secured interface from the MTC server to the 3GPP network, and which are trusted to ensure that only trigger indications received from authorized MTC Servers will lead to triggering of MTC Devices "belonging" to that MTC server.

[0097] The network may not be trusted for example when MTC device is roaming in the visited network, or when there is a strict security requirement for MTC. The MTC device should verify if the trigger is forwarded from a valid MTC-IWF.

[0098] When the MTC Device then receives a NAS integrity protected trigger, it can, after verifying NAS integrity protection, verify the 3GPP network in the sense as described above. If both can be verified, the trigger can be accepted.

[0099] MME should not send the trigger in a NAS message without integrity protection. If there is no NAS integrity protection of the trigger or if the 3GPP network is not trusted, the MTC Device could discard the trigger and send a Reject message to MME and MTC-IWF with a proper cause or alternatively look deeper into the trigger if end-to-end protection was applied.

[0100] When MME receives a reject response from MTC device with a cause indicating no integrity protection or integrity check failure, MME can

[0101] Initiate 3GPP AKA procedure towards MTC device so that when there is security context shared between them MME can forward the trigger;

[0102] Or forward the reject message to MTC-IWF, so that MTC-IWF can choose another route to send the trigger.

[0103] This application is based upon and claims the benefit of priority from Japanese patent application No. 2012-147982, filed on Jun. 29, 2012, and Japanese patent application No. 2012-209393, filed on Sep. 24, 2012, the disclosures of which are incorporated herein in their entirety by reference.

REFERENCE SIGNS LIST

[0104] **10** MTC DEVICE

[0105] **21** MTC-IWF

[0106] **22** HSS

[0107] **23** GGSN/P-GW

[0108] **24** MME/SGSN/MSC

[0109] **25** S-GW

[0110] **30** SCS

[0111] **40** SME
[0112] **101**, **214**, **302** RECEPTION UNIT
[0113] **102** VALIDITY UNIT
[0114] **103**, **301** TRANSMISSION UNIT
[0115] **211** STORAGE UNIT
[0116] **212** SELECTION UNIT
[0117] **213** FORWARDING UNIT
[0118] **215** SWITCHING UNIT
[0119] **216** CHECK UNIT
[0120] **217** EXCLUSION UNIT
[0121] **218** DOWNLOADING UNIT
[0122] **303** SEND UNIT

1. A network node placed within a core network, comprising:
a storage unit that stores a list of network elements capable of forwarding a trigger message to a MTC (Machine-Type-Communication) device attached to the core network, the trigger message being received from a transmission source placed outside the core network; and
a selection unit that selects, based on the list, one network element to which a path is not marked as invalid to securely forward the trigger message to the MTC device.

2. The network node according to claim **1**,
wherein the storage unit is configured to:
download information of the network elements from a server; and
create the list by use of the downloaded information,
wherein the downloading and the creation are performed prior to a reception of the trigger message.

3. The network node according to claim **1**,
wherein the list is created by a server based on information of the network elements, and
wherein the storage unit is configured to download the list from the server, and
wherein the downloading is performed prior to a reception of the trigger message.

4. The network node according to claim **1**,
wherein in the list, the network elements are stored in association with their respective usage rates, and
wherein the selection unit is configured to select, as said one network element, the network elements in ascending order of usage rate.

5. The network node according to claim **1**, wherein the selection unit is configured to check whether or not said one network element can securely forward the trigger message to the MTC device, by pinging said one network element or analyzing information on said one network element received from a server.

6. The network node according to claim **1**, wherein the network node comprises an MTC-IWF (MTC-Interworking Function), a GGSN (Gateway GPRS (General Packet Radio Service) Support Node), or a P-GW (PDN (Packet data network) Gateway).

7. A MTC (Machine-Type-Communication) device attached to a core network, and configured to receive a trigger message forwarded by the network node according to claim **1**.

8. A network node placed outside a core network, and configured to transmit a trigger message to the network node according to claim **1**.

9. The network node according to claim **8**, wherein the network node placed outside the core network comprises an SCS (Services Capability Server) or an SME (Short Message Entity).

10. A method of controlling a network node that is placed within a core network and that forwards a trigger message to a MTC (Machine-Type-Communication) device attached to the core network, a transmission source of the trigger message being placed outside the core network, the method comprising:
storing a list of network elements capable of forwarding the trigger message to the MTC device; and
selecting, based on the list, one network element to which a path is not marked as invalid to securely forward the trigger message to the MTC device.

11-44. (canceled)

45. The method according to claim **10**, further comprising:
downloading information of the network elements from a server; and
creating the list by use of the downloaded information,
wherein the downloading and the creation are performed prior to a reception of the trigger message.

46. The method according to claim **10**, further comprising:
downloading the list from a server, the list being created by the server based on information of the network elements,
wherein the downloading is performed prior to a reception of the trigger message.

47. The method according to claim **10**,
wherein in the list, the network elements are stored in association with their respective usage rates, and
wherein the selection is performed by selecting, as said one network element, the network elements in ascending order of usage rate.

48. The method according to claim **10**,
wherein the selection includes checking whether or not said one network element can securely forward the trigger message to the MTC device, by pinging said one network element or analyzing information on said one network element received from a server.

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