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HANDLING REJECT CAUSE ON ROAMING NETWORK

Abstract

A wireless multiple-access communications system may provide various types of wireless communication content such as voice, video, messaging, etc. The wireless multiple-access communications system may be a public land mobile network (PLMN). The PLMN may support various radio access technologies (RATs), for example, fourth generation (4G), such as Long-Term Evolution (LTE), LTE-Advanced (LTE-A) or LTE-A Pro system. The PLMN may also include network devices, such as a mobility management entity (MME), a serving gateway, a packet data network, etc. Each of these network devices may support communication for a communication device, which may be otherwise known as a user equipment (UE). The UE may be registered with a PLMN to receive the various types of wireless communication content. The UE may, in some examples, roam out of the PLMN and attempt to register with a roaming network (e.g., another PLMN) via a registration procedure (e.g., an attach procedure), to continue receiving the various types of wireless communication content.

Background

As part of roaming, many network devices may exchange messages with a UE roaming across one or more roaming networks (e.g., PLMNs). For example, when the UE is outside of a home network (e.g., a home public land mobile network (HPLMN)) and has roamed into another operator's service area, such as another PLMN (e.g., a visited public land mobile network (VPLMN)), the other PLMN may exchange messages with the roaming UE to register the UE to the other PLMN. The UE may attempt to register with the other PLMN via a registration procedure (e.g., an attach procedure), to continue receiving the various types of wireless communication content. For example, the UE may transmit a registration request message (e.g.,

an attach request message) to a network device (e.g., an MME) associated with the roaming network. The network device may receive the registration request message and respond with a registration response message (e.g., an attach response message).

The registration response message may provide an indication of whether the roaming network accepted or rejected the registration request message from the UE. In some examples, the registration response message may provide one or more cause indications, which may signal reasons for the acceptance or rejection of the UE's registration request. A cause indication may be a permanent reject cause, which may have adverse effects for the UE, such as providing limited service for the UE or forcing a universal subscriber identity module (USIM) as invalid. In addition, the permanent reject cause may trigger the UE to operate in a lower RAT (e.g., operate in third generation (3G) versus 4G).

Description

Figure 1 shows a flowchart illustrating a method for mitigating reject causes in a roaming network. A UE may mitigate permanent reject causes in a roaming network according to the operations of the method as shown in Figure 1. For example, the UE may mitigate permanent reject causes using a rejection counter with a preset threshold. The rejection counter and the preset threshold may offer additional attempts for the UE to register with other PLMNs or RATs. In some examples, the UE may be configured with one overall rejection counter for all permanent reject causes. Alternatively, the UE may be configured with multiple rejection counters. Each rejection counter may correspond to a specific permanent reject cause (e.g., an unknown international mobile subscriber identity (IMSI) home location register (HLR), an illegal UE, an illegal mobile equipment (ME), an evolved-packet switch (EPS) service and non-EPS service not allowed). The UE may also be configured to mitigate permanent reject causes

using a forbidden list of blocking PLMNs. The forbidden list may include a list of blocked PLMNs to prevent the UE access to the PLMN again. The UE may, additionally or alternatively, be configured to mitigate permanent reject causes using a timer to record a time taken to remove a blocked PLMN from the forbidden list. Thus, the UE may be configured to use a timer or timestamp to record some periods to remove blocked PLMNs from the forbidden list, thereby allowing the UE to access them again.

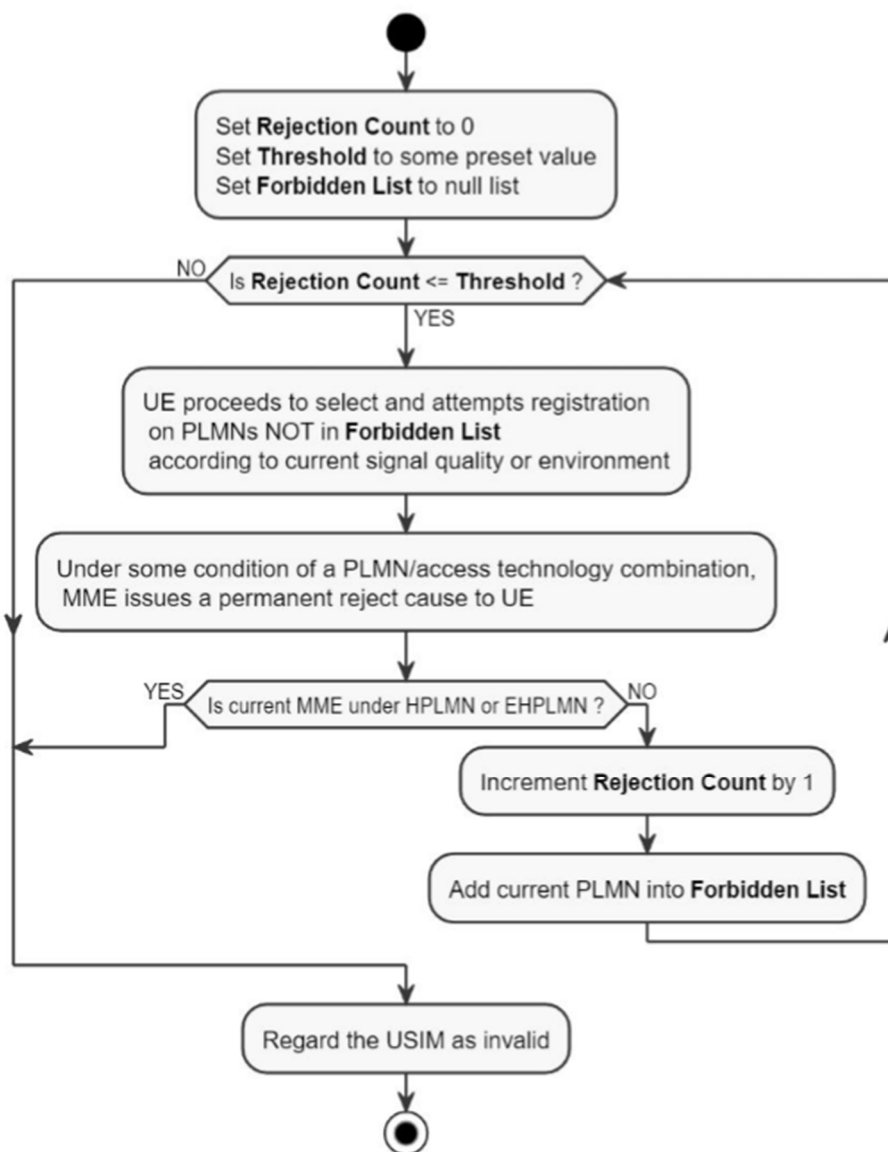


FIG. 1

The method may commence with the UE setting a rejection counter to a null value, setting a threshold value to a preconfigured value, and nulling a forbidden list. The UE may proceed to determine whether a rejection counter value is greater than the set threshold value. If the UE determines that the rejection counter value is greater than the set threshold value, the UE may consider a USIM as invalid. Otherwise, if the UE determines that the rejection counter value is greater than the set threshold value, the UE may proceed to select a PLMN and attempt to register with the PLMN. The PLMN may be a PLMN that is not part of the forbidden list. The UE's selection of the PLMN may, in some cases, depend on a signal quality (e.g., a reference signal received power (RSRP), a reference signal received quality (RSRQ)) or some other environmental condition.

As part of the attempt to register with the PLMN, the UE may transmit a registration request message to an MME associated with the PLMN. The MME may respond with a registration response message. In some examples, the MME may issue a permanent reject cause to the UE based in part on one or more conditions. The one or more conditions may include an attach reject message issued from the PLMN (e.g., the MME), a detach request message issued from the PLMN (e.g. the MME), or a tracking area update (TAU) reject message issued from the network (e.g., the PLMN), or some combination thereof. Additionally, or alternatively, the MME may issue a permanent reject cause to the UE based in part on an access technology condition. In some examples, the access technology condition may be that the PLMN (e.g., the roaming network) supports global system for mobile communications (GSM) and general packet radio service (GPRS). In some other examples, the access technology condition may be that the PLMN (e.g., the roaming network) supports universal mobile telecommunications system (UMTS). In

other examples, the access technology condition may be that the PLMN (e.g., the roaming network) supports LTE or fifth generation systems (5GS).

The method may continue with the UE determining whether the MME is under the UE's HPLMN or equivalent HPLMN (EHPLMN). If the UE determines that the MME is under the UE's HPLMN or EHPLMN, the UE may consider the USIM as invalid. Otherwise, if the UE determines that the MME is not under the UE's HPLMN or EHPLMN, the UE may increment the rejection counter by a predefined value (e.g., by 1) and may add the PLMN to the forbidden list. This PLMN may now be referred to as a blocking PLMN. The UE may repeat the above operations to attempt to register with a PLMN that is not in the forbidden list based on current signal quality or environment until the rejection counter does not exceed the preset threshold value. If the rejection counter exceeds the preset threshold value, the UE may regard the USIM as invalid.

References

1. 3GPP TS 23.122, v 9.5.0, Release 9, the entire content of which is hereby incorporated by reference.
2. U.S. Patent Publication No. 2014/0378129 A1, the entire content of which is hereby incorporated by reference.
3. U.S. Patent Publication No. 2010/0190497 A1, the entire content of which is hereby incorporated by reference.