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TECHNIQUES TO AVOID CALL DROP DUE TO COLLISIONS BETWEEN USER EQUIPMENT-INITIATED AND NETWORK-INITIATED SERVICE REQUESTS

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ABSTRACT

The user equipment (UE) -initiated service request procedure and the network-initiated service request procedure are the two most common procedures that occur in a Fifth Generation (5G) mobile network. Collisions between signaling for each of these procedures is common. With current Third Generation Partnership Project (3GPP) standards, such collisions often lead to the looping of these procedures and, eventually, to call drops. This submission proposes techniques to handle potential collisions involving the procedures and, thus, avoid the call loss that typically accompanies such collisions.

DETAILED DESCRIPTION

During operation in a 5G mobile network environment, the network or, more specifically, a Session Management Function (SMF), can trigger a service request (e.g., an N2 setup request) for a UE that is in an idle state (e.g., no N3 connection with the UE) when a User Plane Function (UPF) sends a notification (e.g., a Downlink Data Report (DLDR)) toward the UE to indicate a downlink data packet that is to be transmitted to the UE or when a Policy Control Function (PCF) sends a notification for bearer/flow creation.

In many instances, there can be a collision between a UE-initiated service request and an SMF-initiated service request that can occur at roughly the same time. Such collisions can cause several problems, as illustrated in Figure 1, below.

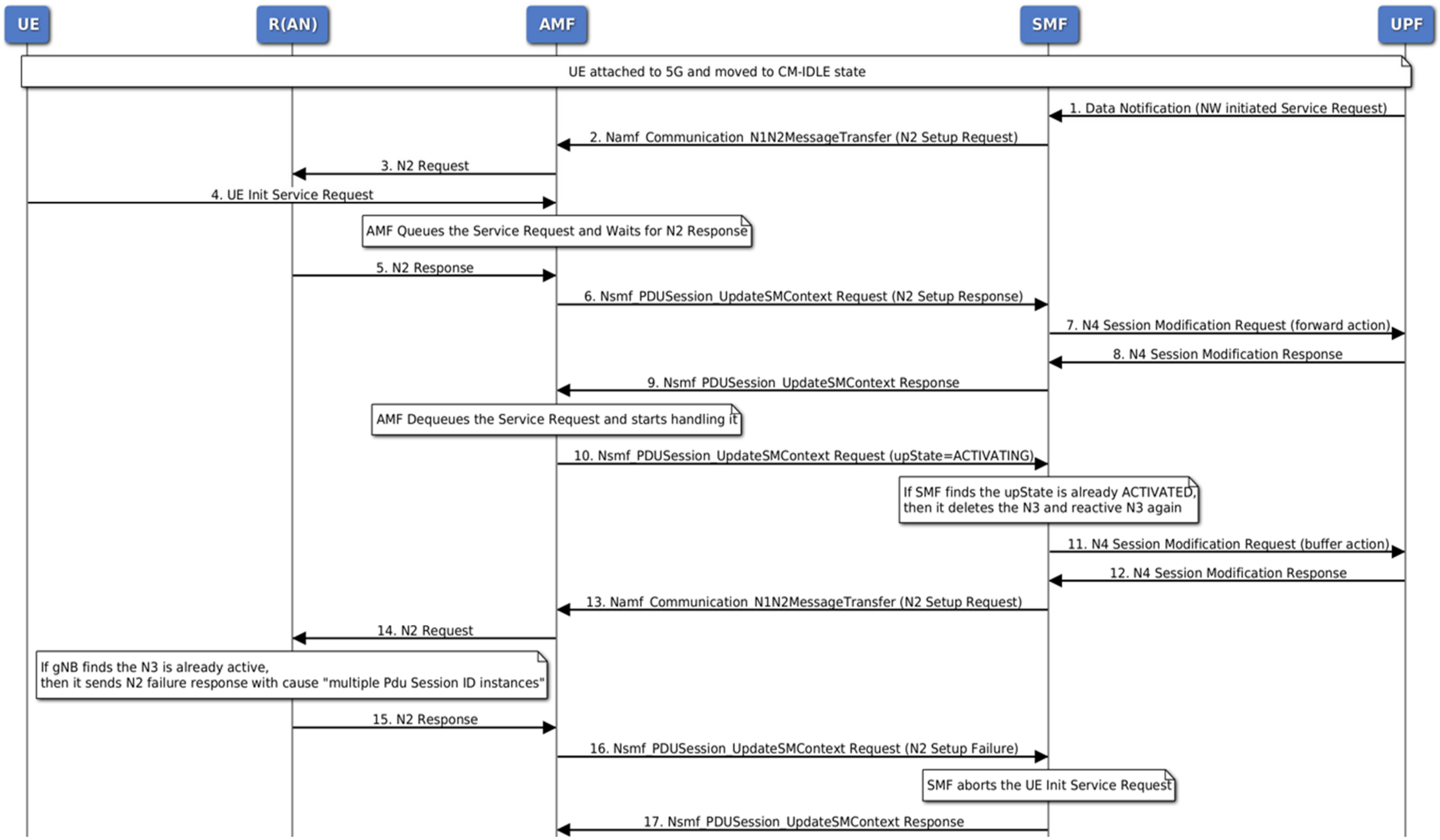

Figure 1: UE-Initiated Request and Network-Initiated Request Collision Scenario

Consider a scenario as shown in Figure 1, above, in which, upon receiving a paging trigger, the SMF triggers an N11 N1N2Transfer request with the N2 setup request. If the UE also triggers a service request at the same time, a collision can occur. If an Access and Mobility Management Function (AMF) receives the UE-initiated service request after forwarding the N2 setup request to a gNB, the AMF queues the UE-initiated service request. On receiving an N2 setup response from the gNB, the AMF sends an 'smContextUpdate' message to the SMF with the N2 setup response and awaits an 'smContextUpdate' response message from the SMF. Once the response is received, the AMF dequeues the UE-initiated service request and sends another 'smContextUpdate' message to the SMF with an "Activating" indication.

However, the AMF is not aware of the N3 status of the UE, so it cannot drop the service request and a collision may cause the SMF to send another N2 setup request, as shown in Figure 1, which can lead to several problems.

For example, if the SMF sends another N2 setup request and the gNB determines that the N3 connection with the UE is already active, the gNB can send an N2 setup failure response to the SMF with a cause "Multiple PDU Session ID." There is currently no mechanism defined in 3GPP specifications for recovering from such a scenario. In another example, if the UPF receives a Forwarding Action Rule (FAR) update with an action "buffer," the UPF will trigger another DLDR towards the UE, thus resulting in another collision. Such collisions can operate in a loop, with multiple N2 setup requests and/or DLDRs, which can result in the UE triggering a reattach to the network and call loss.

Some potential solutions have been proposed to address such issues, including delaying DLDR processing on the SMF, thereby providing an opportunity to process a UE-initiated service request, if received. However, such solutions do not address scenarios involving a network-initiated service request that may be triggered for bearer/flow creation and/or updates, which can lead to delayed voice call establishment.

In contrast, several techniques are presented herein to handle potential collisions that may be caused by UE-initiated and network-initiated service request collisions being initiated in close temporal proximity.

Figure 2A, below, is an example call flow illustrating example details for a first potential technique to address UE-initiated and network-initiates service request collisions.

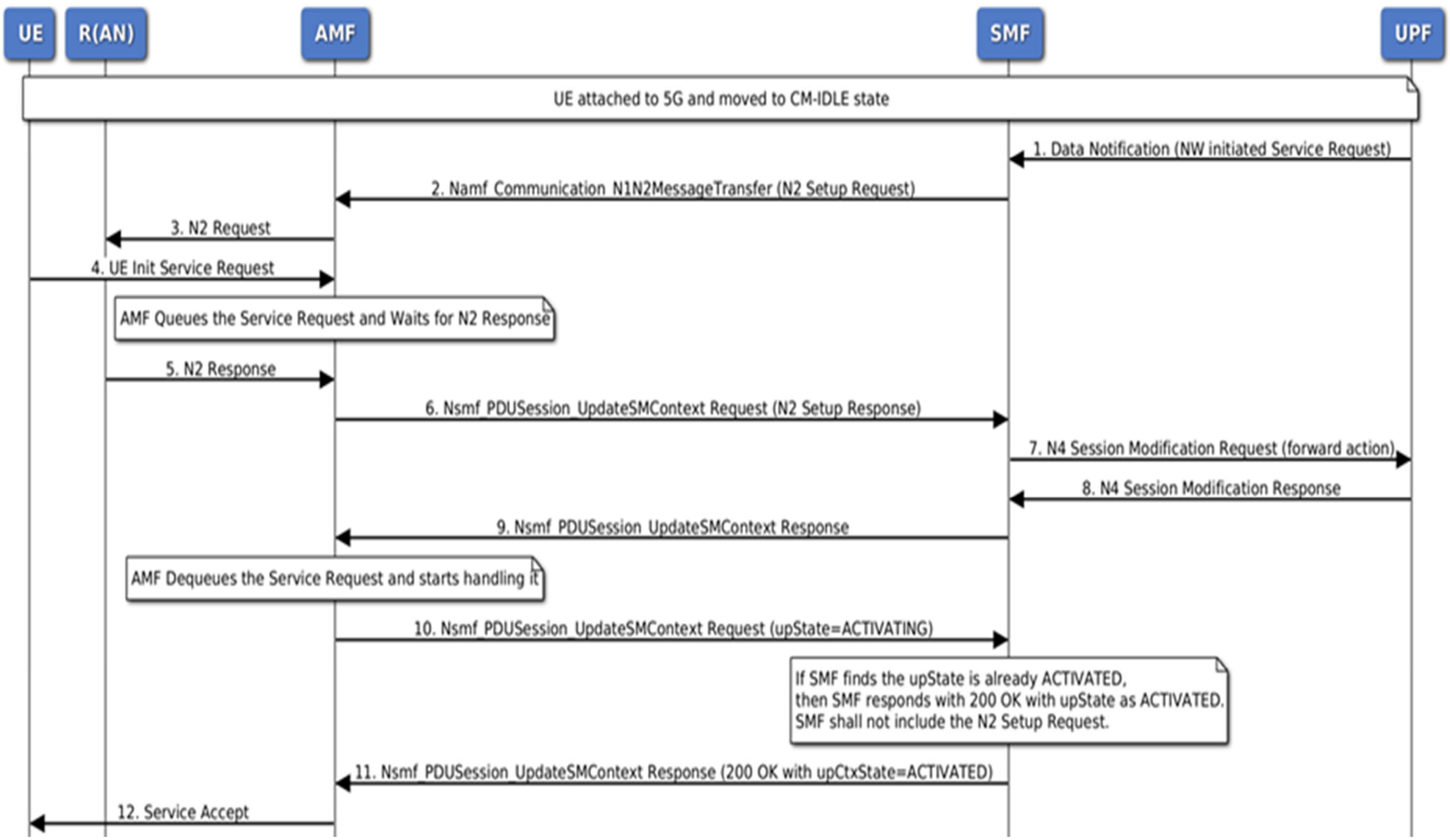

Figure 2A: First Technique to Address UE-Initiated and Network-Initiated Service Request Collisions

With reference to Figure 2A, to address UE-initiated and network-initiated service request collisions, consider various steps of the first technique that may be performed:

(1) On receiving a service request in an N3 activated state, the SMF can respond with a '200 OK' message that indicates 'upCnxState=activated' and the SMF will not include an N2 setup request in the response.

(2) If the SMF and gNB/UE are really out of sync, (1) would result in the gNB getting stuck in a deactivated state and SMF/UPF in an activated state. To resolve such a scenario in which the RAN/UE and SMF/UPF activation states are misaligned, the following operations can be performed, as illustrated in Figure 2B, shown below:

   a. The SMF can start a timer after responding to a service request without the N2 setup request being included.

   b. The SMF can stop this timer:

      On Receiving Handover;

      On Receiving path switch; or

      After sending an N2 setup request for any trigger.

   c. Any service request received while the timer is running, can be responded to with an N2 setup request. Essentially, if the SMF receives another service request after sending a response for the previous service request (without the N2 setup request), the indicates that the radio access and core network are really out of sync.

   d. The SMF responds as noted in step (1) if the timer is not running.

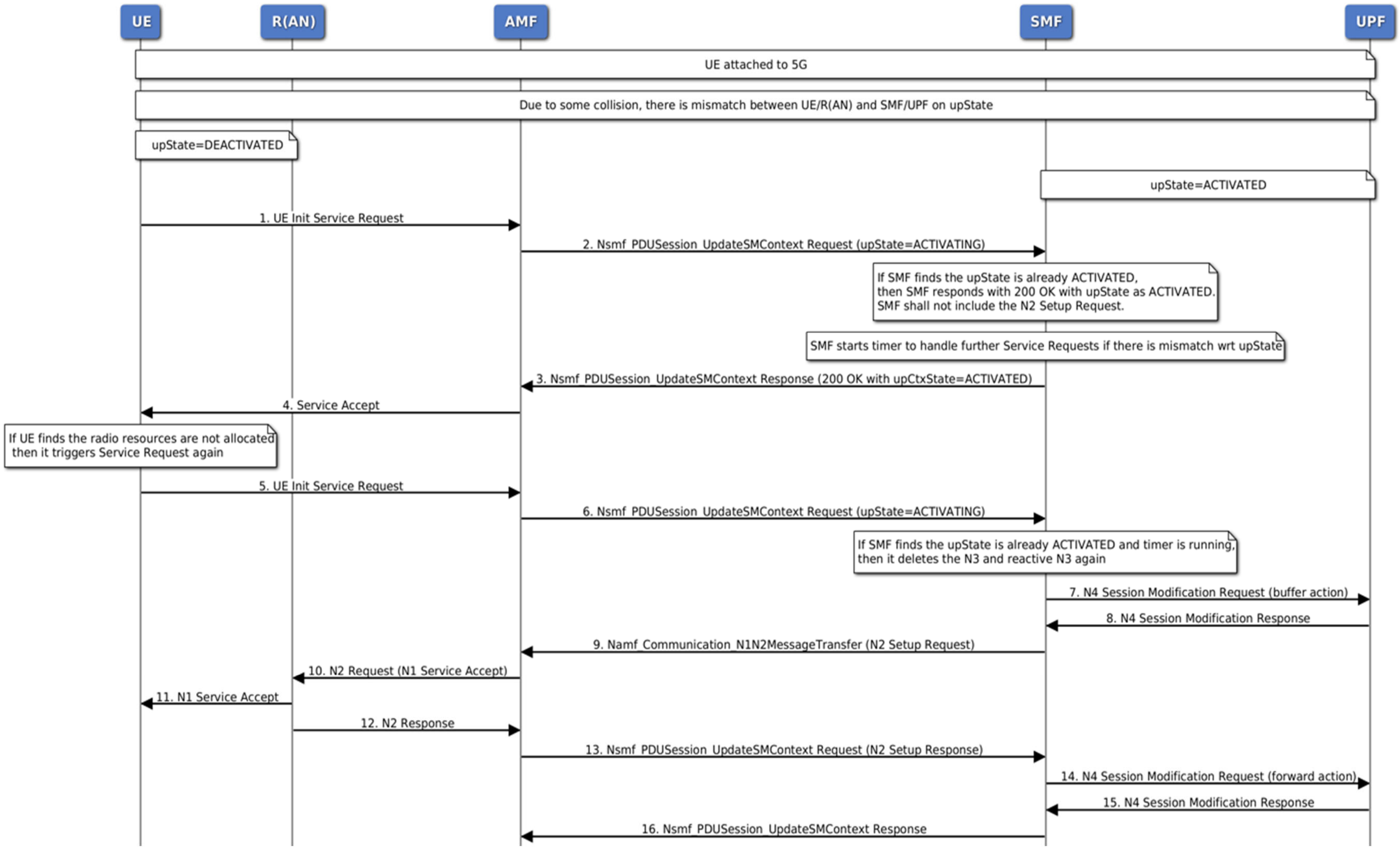

Figure 2B: Example Operations to Address RAN/UE and SMF/UPF State Issues

In some scenarios, if the AMF receives a UE-initiated service request before network triggered service request, the AMF can send an 'smContextUpdate' message with an indication of "Activating" to the SMF and can queue a network-initiated service request. The SMF, while awaiting an N2 setup request receives the UE-initiated service request from AMF, however, since an N3 connection is not yet established, the SMF is expected to respond with an N2 setup request in an 'smContextUpdate' response for the AMF to forward to the gNB for N3 establishment.

Once the UE-initiated service request procedure handling is completed, the AMF can dequeue the network-initiated service request and can send an N2 setup request to the gNB, however, this can result in a "Multiple PDU session ID" error being sent from the gNB.

A second technique is proposed herein which several approaches may be utilized in order to address such issues.

For example, in one approach, upon receiving the UE-initiated service request while waiting for the N2 setup response, the SMF can respond with a "204 no content" message. The AMF can then send a service accept to the UE. Thereafter, network-initiated service request processing can bring the N3 connection to an activated state.

In another approach, the SMF can abort the network-initiated service request procedure upon receiving the UE-initiated service request. The SMF can then continue processing the UE-initiated service request and send N2 setup request in an 'smContextUpdate' response message.

The N3 connection can be activated by the UE-initiated service request. Thereafter when the gNB sends a "Multiple PDU Session ID" error with regard to the network-initiated service request, the SMF can ignores the error as it has already aborted the network-initiated service request procedure.

Accordingly, various techniques are proposed herein that may be utilized to handle potential collisions involving the procedures and, thus, may help to avoid the call loss that typically accompanies such collisions.