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NETWORK ASSISTED HANDOVER TO A PRIVATE 5G NETWORK

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ABSTRACT

An efficient handover mechanism is needed to facilitate seamless user equipment (UE) handover for public 5G to public 5G handover scenarios and also for public 5G to private 5G handover scenarios. The traditional approach for UE handovers can cause several minutes of delay when handing-over between public to private 5G networks. In order to address such issues, this submission proposes novel techniques that can be embedded within Third Generation Partnership Project (3GPP) call flows that will allow the network to query a UE about the available networks the UE can see in order to guide the UE to the best network to which to connect based on internal policies/logic. Having such an ability is highly desired by private 5G network operators. Accordingly, techniques herein facilitate efficient UE handovers for such public to private 5G handover scenarios.

DETAILED DESCRIPTION

Mobility is a core use-case for cellular connections and can enable a user equipment (UE) to move from one cell to the next as the user is on the move. During operation, a UE can request a list of neighboring radio nodes from a gNB and select one of the potential radio access networks (RANs) to which to connect. With this method, control of which cellular network to join is with the UE to select the next cell.

However, the development of private 5G (P5G) mobile networks presents a new difficulty. When a P5G user is connected to a public cellular network and moves in range of a private 5G network, the expectation is that the UE will immediately transition to the P5G network. However, in many cases, the UE is not at the edge of a cell at that point and has no reason to leave its current connection. Thus, a long time may elapse before the UE finally joins the private network, which can increase costs for P5G enterprise users.

Presented herein are novel techniques to facilitate assisted and deterministic handoff of a UE from a public 5G cellular network to a private 5G cellular network. Broadly, operations facilitated by the techniques of this proposal may be performed, as follows:

1. As per current implementations, a UE can scan for its possible hand-off RANs/radio nodes (e.g., gNBs) continuously and keep this list;
2. A Unified Data Management (UDM) entity maintains information about the subscriber and its association with a private 5G network;
3. At the time of the registration, the 5G core, such as an Access and Mobility Management Function (AMF) sends a special message to the UE that triggers the UE to share/update the list of scanned neighbors. Other parameters such as duration or on-scan event could be sent as part of this request message;
4. The UE processes this message and, as per the parameters in the initial request, the UE can update the core about the scanned neighbors; and
5. The 5G core selects a specific gNB and passes that information to the UE for priority handover or connection**.**

Figures 1 and 2, below, are call flows illustrating example details associated broad operations noted above, which may be utilized to facilitate P5G handovers in accordance with the techniques of this proposal.

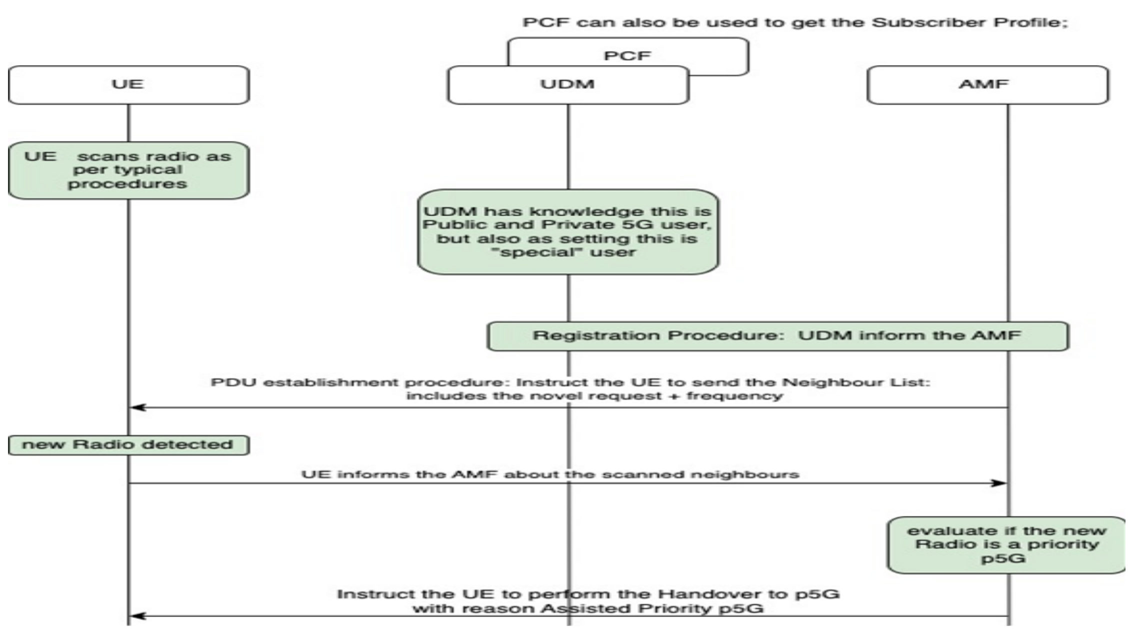

Figure 1: High-Level Call Flow of Proposed Techniques

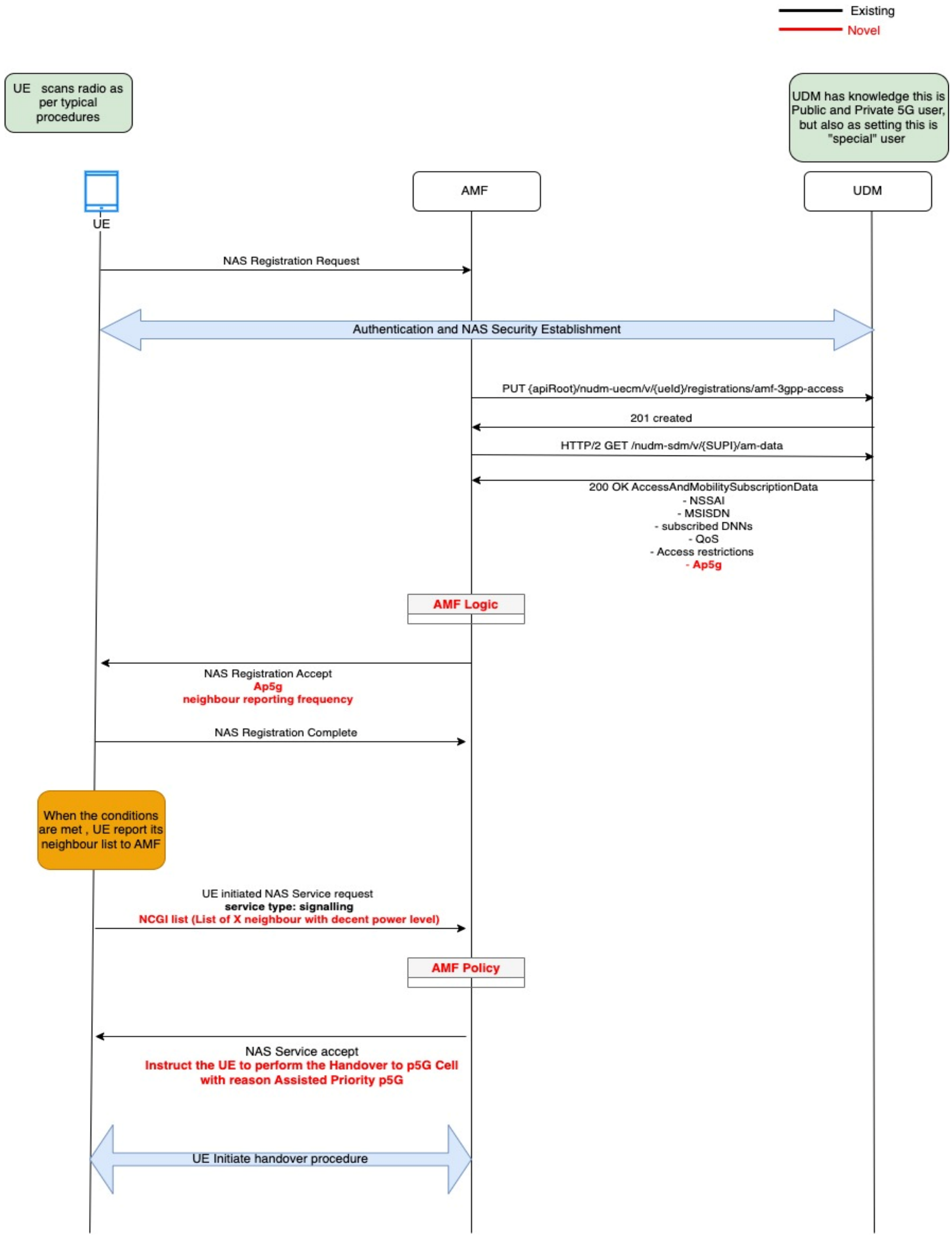

Figure 2: Example Call Flow Illustrating Handover Operations

Figure 3, below, is a more detailed call flow illustrating example operations that may be utilized to facilitate P5G handovers in accordance with the techniques of this proposal. For the call flow of Figure 3, it is assumed that the same AMF is responsible for private and public 5G network slices. Further, every AMF is to maintain a record of the Tracking Area Identifiers (TAIs) supported by each gNB and can learn this information during gNB initial setup procedures.

Consider, for example, at Step 1 of Figure 3 that, as a part of initial UE registration, the UE send a Non-Access Stratum (NAS) Registration request to the AMF, which triggers the AMF, as shown at Step 2, to proceed with normal authentication and NAS Security establishment for the UE.

At Step 3, the AMF send registration to the UDM that includes subscriber's Subscription Permanent Identifier (SUPI) along with "Amf3GppAccessRegistration" information, which informs the UDM that the particular AMF is responsible for the subscriber at this time. At Step 4, the UDM responds with a "201 Created" response.

At Step 5, once AMF is registered against the subscriber, the AMF will request the subscriber profile from the UDM via an HTTP/2 GET /nudm-ssdm/v/{SUPI}/am-data. This request will contain subscriber's identity (SUPI) and the type of requested information, which is Access Management data (am-data). At Step 6, the UDM can respond with a "200 OK" that includes the AccessAndMobilitySubscriptionData. The AccessAndMobilitySubscriptionData is defined in 3GPP Technical Specification (TS) 29.503, Table 6.1.6.2.4-1.

When the UDM supports the assisted private 5G feature as provided by this proposal, then it is to indicate this capability to the AMF via a "supportedFeatures" Information Element (IE) that can be included inside an "AccessAndMobilitySubscriptionData" IE. When the UE is provisioned with the assisted private 5G feature, then the UDM should send an "Ap5g" flag together with other information in the AccessAndMobilitySubscriptionData IE. Current data types defined in 3GPP TS 29.502 Table 6.1.6.3.2-1 and would need to be updated to include the new proposed IE.

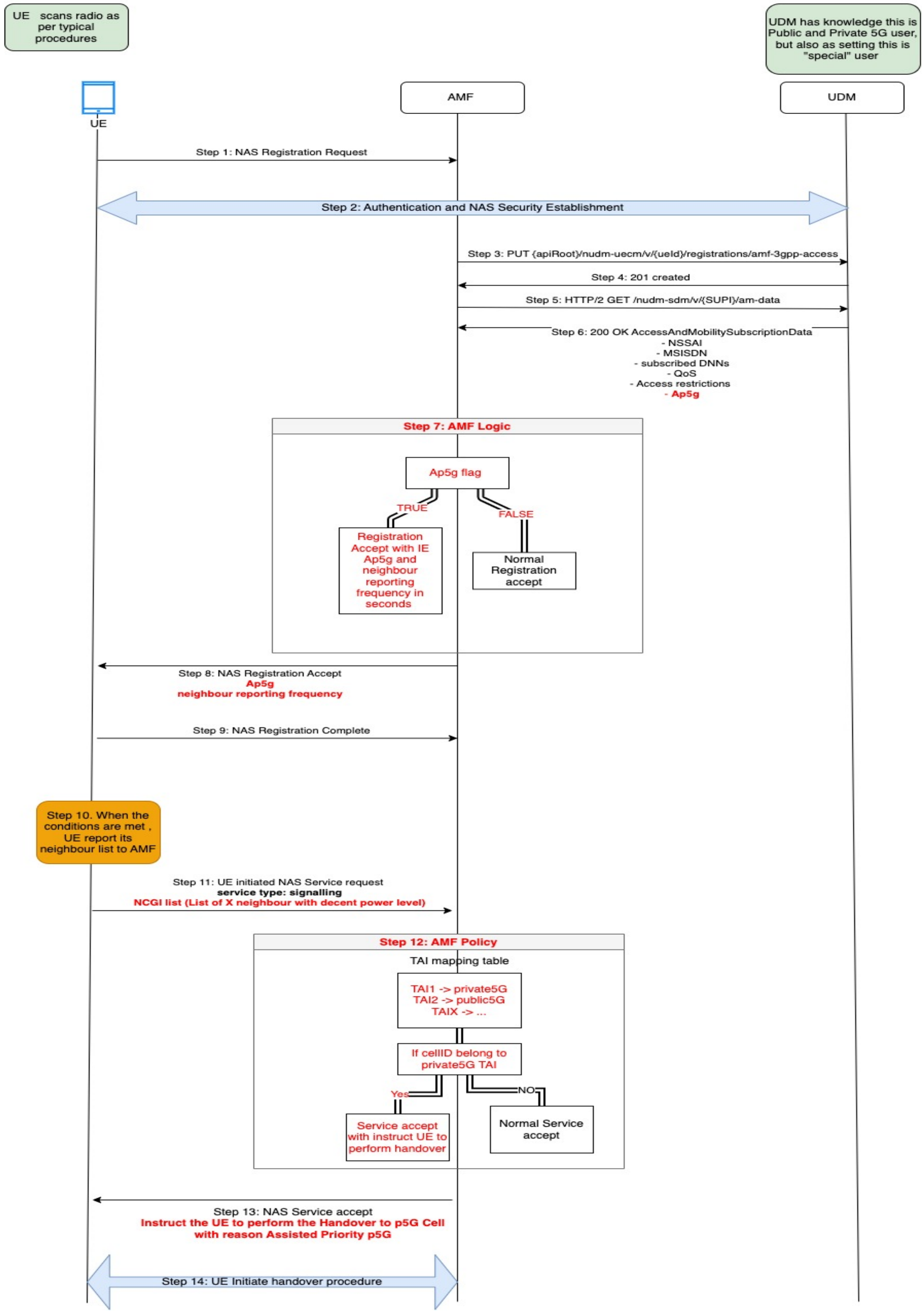

Figure 3: Detailed Call Flow

With regard to Step 7 of the call flow shown in Figure 3, if the subscriber profile within the UDM includes the Ap5g feature then this will be indicated in the AccessAndMobilitySubscriptionData, which can trigger internal logic/configuration options provided for the AMF to send a Registration Accept message to the UE that includes two additional IEs, an "Ap5G" IE that includes an Ap5g flag and a "Neighbor Reporting Frequency" IE that indicates how frequently the UE is to report its detected neighbors to the AMF.

The new Ap5g IE will instruct the UE to report its neighbor list with neighbors that are detected at satisfactory power levels. The AMF could request the neighbor list to be sent using the following (but not limited) techniques:

- Whenever a new neighbor with a satisfactory power level is detected, which can potentially increase the signaling load but could facilitate faster handover; and/or
- At the expiry of a “Neighbor list reporting duration” provided by the AMF, such as:
    - After every “X” seconds, which could be provided by the AMF via the “Neighbor Reporting Frequency” IE; and/or
    - If the UE learned more than a certain number of new cells.

In some instances, the AMF could have option to choose the reporting method based on subscriber groups. If the UE is allowed to report to the AMF during every new neighbor, signaling load may increase.

Continuing to Step 8 involving the Registration Accept Procedure the two new IEs can be added in the Registration Accept message. The message content is defined in 3GPP TS 24.501 Table 8.2.7.1.1. The message can be updated with an IE identifier (IEI) of 51 for the Ap5G assisted p5g indication utilizing a format as shown below in Figure 4.

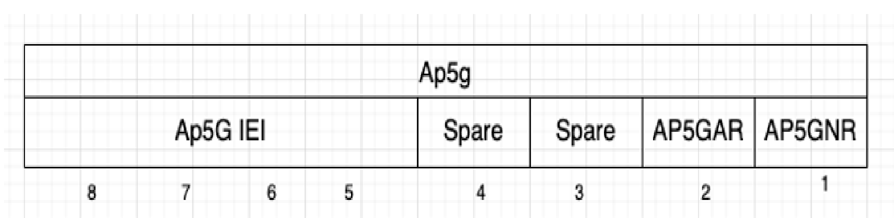

Figure 4: Ap5g IE format

With regard to the example Ap5G IE format as shown in Figure 4, above, an "AP5GAR" bit can be set to signal an "Always Report" feature. Setting this bit indicates that the UE has to report its neighbor list whenever a new neighbor is detected. When this bit is set then the AMF will not include the “neighbor reporting frequency” IE in the registration accept messaging.

Conversely, an "AP5GNR" bit can be set to signal a "Normal Reporting" such that, when this bit is set, the UE is to report its neighbors if one of the below conditions are met:

a. At every “X” seconds. This reporting duration can be provided by the AMF via the “Neighbor Reporting Frequency” IE.
b. If the UE learned more than a certain number of new cells

Figure 5, below illustrates an example format the "Neighbor Reporting Frequency" (IEI 52) in which the frequency can be provided in seconds, in one example.

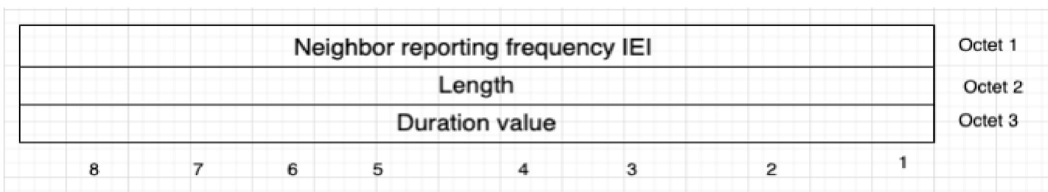

Figure 5: Neighbor Reporting Frequency IE Format

Continuing to Step 9, the NAS registration completes (per standards-based procedures). As shown at Step 10, the UE will wait for the conditions to be met to report the neighbor list to the AMF. In one example, the logic shown below in Figure 6 can be applied by the UE based on the IE(s) included in the Registration Accept response message.

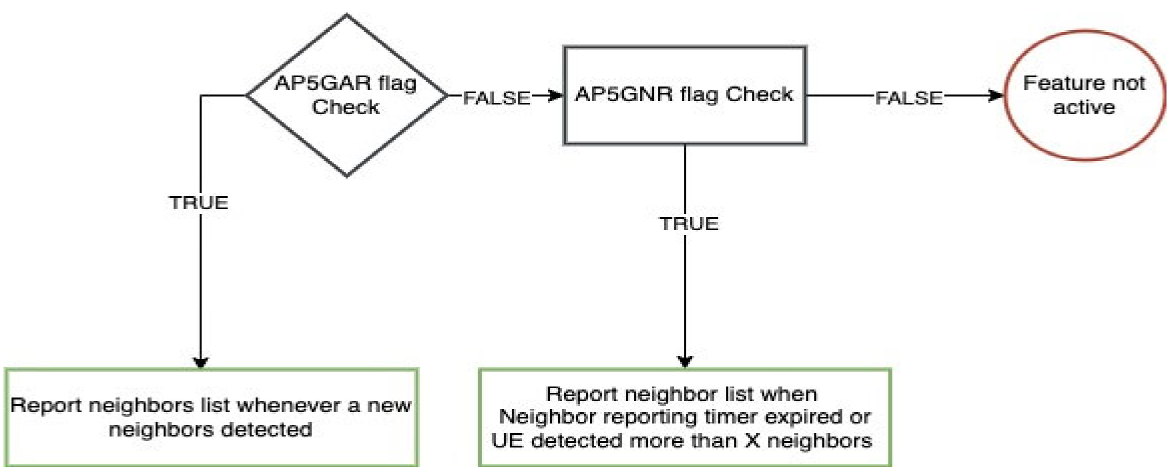

Figure 6: Example Logic to Trigger UE Reporting

At Step 11, when the conditions are met for the logic as shown in Figure 6, a NAS Service request message is triggered for the UE to send to the AMF that can include a new New Radio Cell Global Identifier (NCGI) list IE. Service type will be signaled as the Protocol Data Unit (PDU) sessions for the UE are not modified. The Service Request message is defined in 3GPP TS 24.501, Table 8.2.16.1.1. The Service Request message content can be updated to reflect the new NCGI list IE, which could be tagged with an IEI of 55. Figures 7A, 7B, and 7C, shown below, illustrate various example details of the NCGI list IE.

New IE in SERVICE REQUEST message					
IEI	Information Element	Type/Reference	Presence	Format	Length
55	Neighbor list	5G NCGI list	O	TV	9-114

Figure 7A: NCGI List IE Details

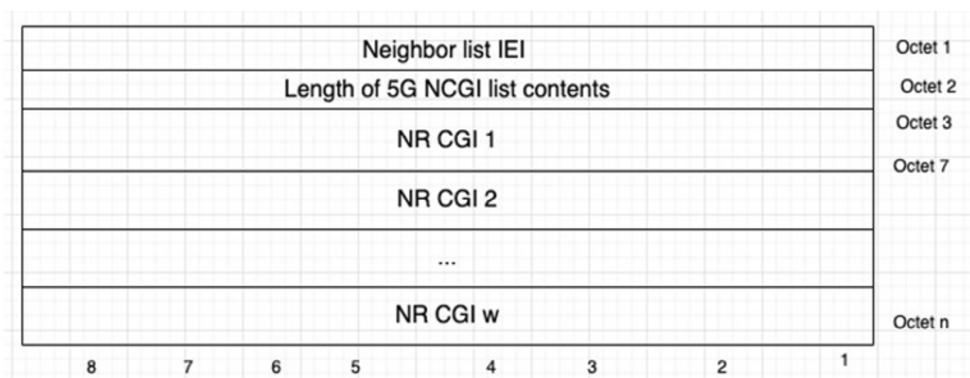

Figure 7B: NCGI List IE Format

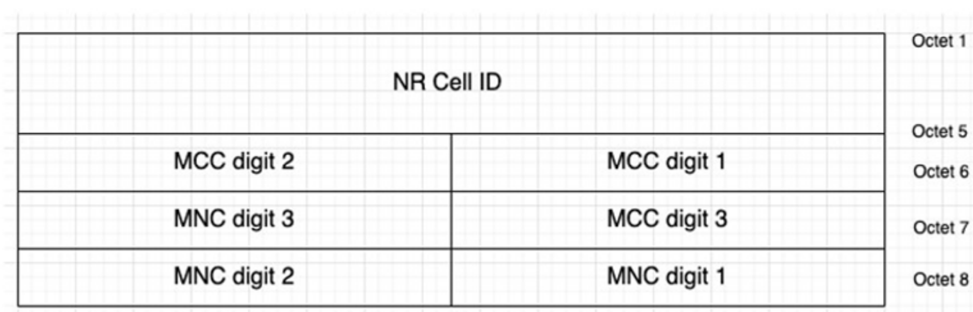

Figure 7C: NCGI List NR Cell ID Format

At Step 12, when the AMF receives the NCGI list, it will extract the TAI of each NR-CGI. The AMF will have the TAI information of each gNB that is connected to the AMF. The AMF be configured with a policy that can be used to check whether any of the reported New Radio (NR) CGIs in the reported list belong to private 5G TAI(s).

At Step 13, if any of the NR-CGI's belong to private 5G TAI(s), the AMF will send a Service Accept message to the that includes a forced handover trigger to the private 5G NR cell ID with a cause code indicating "Assisted Priority p5G." Consequently, the Service Accept message (as defined in 3GPP TS 24.501, Section 8.2.17.1.1) would need to be enriched with two additional IEs, as follows:

- IEI 56 - Assisted Handover - Assisted private 5G handover trigger flag that would instruct the UE to initiate the handover procedure to a suggested cell ID; and
- IEI 57 - Priority NR Cell ID

Upon receiving the message, the UE will initiate the handover procedure to the provided Priority private NR Cell ID, as shown at Step 14.

Thus, broadly, operations proposed through the techniques of this submission may facilitate public to private 5G handovers under conditions in which private and public 5G slices are handled by the same AMF and different TAI(s) are used for private 5G coverage areas. Whenever a new gNB connects to the AMF, it is to send its supported TAIs and cell IDs; thus, the AMF can maintain a TAI to cell ID mapping for all connected gNBs. The AMF can define a TAI mapping table that classifies private 5G TAI(s) and public 5G TAI(s).

A UE/subscriber can be defined Subscriber Data Management (SDM)/UDM functionality to indicate whether the UE/subscriber supports neighbor report feature of this proposal. (e.g., an indication that the subscriber prefers "fast handover" to P5G when available). It should be noted that techniques proposed herein do not involve changes related to SDM/UDM functionality as SDM/UDM functionality as such functionality is not intended to maintain/store neighbor list information nor participate in mobility management. Mobility management is performed by an AMF, whereas SDM/UDM functionality is used to maintain subscriber data (i.e., user profiles, subscription, and security functions). The SDM/UDM functionality is responsible for user authentication when trying to connect to the network and authorization of access to selected and does not maintain data about cells.

During operation, when a UE is provisioned with the neighbor reporting feature, the AMF can instruct the UE to report its neighbors as cell IDs. Per current 3GPP standards, the AMF is not aware of the neighbor list identified by a UE. Thus, techniques herein involving a UE sending a neighbor list to the AMF represents a novel feature in comparison to 3GPP standards.

When the UE report its neighbor list, the AMF will check its TAI mapping table and determine whether any of the reported cell IDs belong to private 5G TAIs. If so, then the AMF can trigger the UE to handover to a corresponding private 5G cell ID from the reported list.

Accordingly, a variety of techniques are provided herein that can be used to facilitate public to private 5G handovers for user equipment in a mobile networking environment.