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5G CORE REDUNDANCY FROM EVOLVED PACKET CORE

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ABSTRACT

Presented herein is a technique to provide Fifth Generation (5G) core (5GC) redundancy from a Fourth Generation (4G) Evolved Packet Core (EPC). In particular, for a 4G-5G interworking scenario, if a Session Management Function (SMF) set is implemented, the technique presented herein provides that an initial combined SMF and control plane Packet Data Network (PDN) Gateway (PGW-C) [referred to herein as SMF+PGW-C] can provide to a Serving Gateway (SGW), at session creation time, address information of all the SMF+PGW-Cs belonging to the same SMF set. The SGW can use the address information to facilitate failover to an alternate SMF+PGW-C belonging to the SMF set, in case the initial SMF+PGW-C does not respond to the SGW.

DETAILED DESCRIPTION

Referring to Third Generation Partnership Project (3GPP) Technical Specification (TS) 23.501, interworking between a 5G core system (5GS) and an EPC/Evolved Universal Mobile Telecommunication System (UMTS) Terrestrial Radio Access Network (E-UTRAN) is supported. This allows an SGW in the EPC to connect to an SMF+PGW-C via the S5-C/S8-C interfaces and to a combined User Plane Function (UPF) and user plane PGW (PGW-U) [referred to herein as UPF+PGW-U] via the S5-U/S8-U interfaces. Figure 1, below, illustrates the reference diagram for the non-roaming case where the SGW connects to the 5GC using S5-C/S5-U.

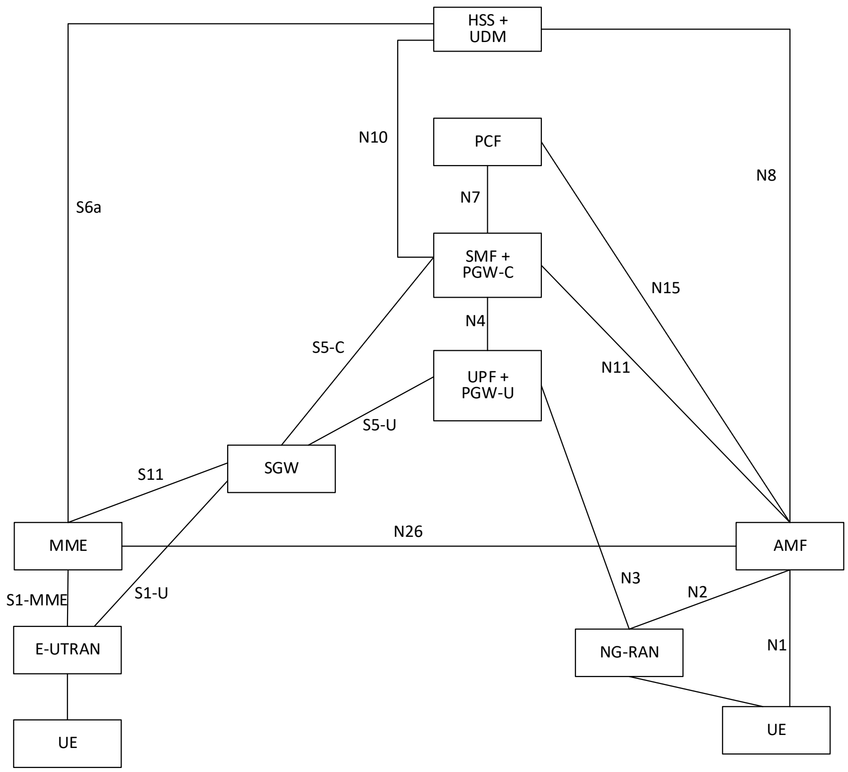

Figure 1: 3GPP Non-Roaming Reference Diagram

3GPP Release 15 does not support the Network Function (NF) Set concept. Rather, Release 16 introduces the concept of NF Set (and NF Service Set). An NF Set allows a number of NF instances (e.g. SMF+PGW-C, Policy Control Function (PCF), etc.) to share user equipment (UE) Context Data and thus belong to the same NF Set. The NFs belonging to the same NF Set share the same data related to a UE and, therefore, can be used to provide service for a UE.

To exemplify this NF Set concept, assume SMF Set 1 consists of 3 SMF+PGW-C NFs (SMF+PGW-C(1), SMF+PGW-C(2), and SMF+PGW-C(3)). A Service-based Interface (SBI) based 5GC NF, such as a PCF may have a session association with SMF+PGW-C(1) to start with for a UE session. However, during the course of the UE session, SMF+PGW-C(1) may not be accessible from the PCF (e.g. because the SMF+PGW-C (1) may be down). In this case, the PCF can continue with either SMF+PGW-C (2) or SMF+PGW-C (3), since all SMF+PGW-Cs in the NF Set share the UE Context and can serve the UE.

Handling for an NF Set and usage of an NF Set in failover scenarios for the SBI interfaces are specified 3GPP Release 16 specifications. It can be noted that a UPF+PGW-U does not support the NF Set concept, however, 3GP specifications allow, on the N4 interface, a UPF+PGW-U to use an SMF+PGW-C Set to support failover to an alternate SMF+PGW-C for failover.

Still, there is currently no mechanism today to support failover from an SGW to an alternate SMF+PGW-C belonging to the same Set. The General Packet Radio Service (GPRS) Tunneling Protocol (GTP) based S5-C/S5-8 interfaces cannot take advantage of the NF Set concept introduced in 5GC. For example, if, at the beginning of Session setup for a UE, the SGW is connected to SMF+PGW-C(1) (as in the above example), then if the SMF+PGW-C (1) goes down during the session, the SGW cannot continue the UE session with SMF+PGW-C (2) or SMF+PGW-C (3) and the UE session will be terminated, resulting in bad user experience.

Figure 2, below, is an architecture diagram illustrating SGW connectivity to a SMF Set in 5GC. In this example, consider that three SMFs (with IP addresses 10:10:10:01..03) belong to the SMF Set.

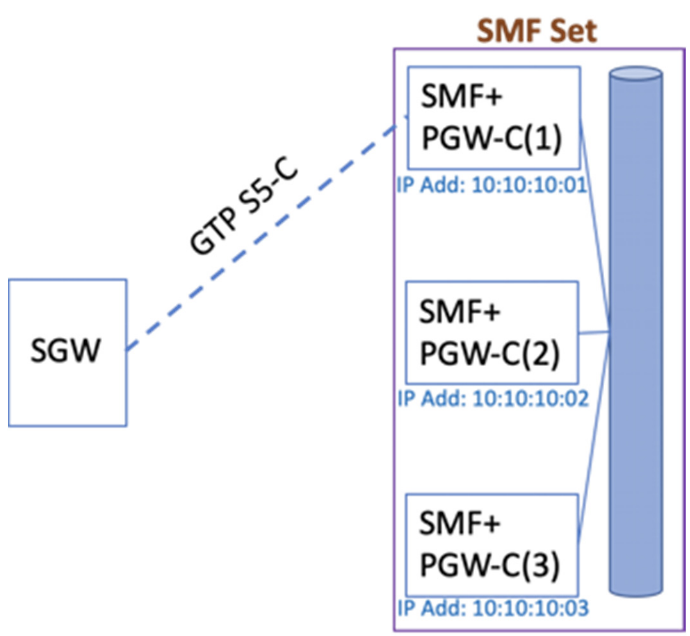

Figure 2: Example SGW Connectivity to SMF Set

Figure 3, below, is a message sequence diagram illustrating an example call flow highlighting example details for the transfer of SMF address information to the SGW of Figure 1.

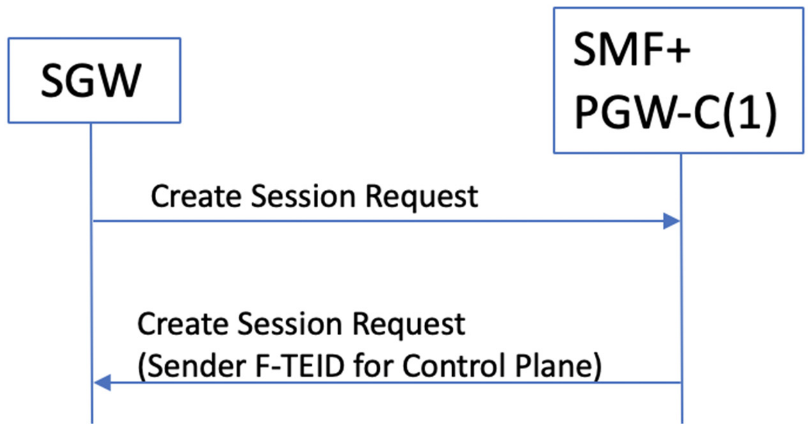

Figure 3: Transfer of SMF Address Information to SGW

As shown in Figure 3, a new Session Request from the SGW to SMF+PGW-C(1) is performed by sending from the SGW a "Create Session Request" General Packet Radio Service (GPRS) Tunneling Protocol (GTP) message to the SMF+PGW-C(1). The SMF+PGW-C(1) responds with a "Create Session Response" message that carries its address information in an Attribute Value Pair (AVP) "Sender F-TEID for Control Plane." Among other fields, the "Sender F-TEID for Control Plane" AVP, contains a Tunnel Identifier (=x) and an IP Address (=10:10:10:01), as follows:

"Sender F-TEID for Control Plane" AVP : (TEID = x, IP Address = 10:10:10:01)

Since only one SMF+PGW-C address information can be transferred to the SGW under current standards, the SGW cannot perform a failover to an alternate SMF+PGW-C belonging to the same SMF Set. For example, if a subsequent message (e.g., "Modify Bearer Request") is sent to the SMF+PGW-C(1) and no response is received, the SMF can only retry to the same SMF+PGW-C(1), which is likely down and, thus, the session is terminated even though the session could have continued with SMF+PGW-C(2) or SMF+PGW-C(3).

Techniques herein provide a solution to such issues involving by providing for the ability to include alternate SMF+PGW-C address information (for all SMF+PGW-Cs belonging to the same SMF Set) in a "Create Session Response" message carrying a new AVP "Alternate Sender F-TEID(s) for Control Plane." This is new AVP may be carried in addition to the existing AVP "Sender F-TEID for Control Plane".

For example, the AVPs could be provided as:

"Sender F-TEID for Control Plane" AVP : (TEID = x, IP Address = 10:10:10:01)

"Alternate Sender F-TEID(s) for Control Plane" AVP : {(TEID = x, IP Address = 10:10:10:02), (TEID = x, IP Address = 10:10:10:03)}

To facilitate this solution, an SMF+PGW-C is to send the new AVP Alternate Sender F-TEID(s) to the control plane network function(s). For example, the SMF+PGW-C(1) can determine the other SMF+PGW-C(s) belonging to the same SMF Set either via configuration or by performing a Network Repository Function (NRF) Discovery [the NRF Discovery mechanism is already defined in 5GC]. The SGW is to process and store the information contained in the "Alternate Sender F-TEID(s) for Control Plane" AVP.

Once address information is obtained for all SMF+PGW-Cs belonging to the same SMF set, failover handling in the SGW could be performed as shown below in the call flow of Figure 4.

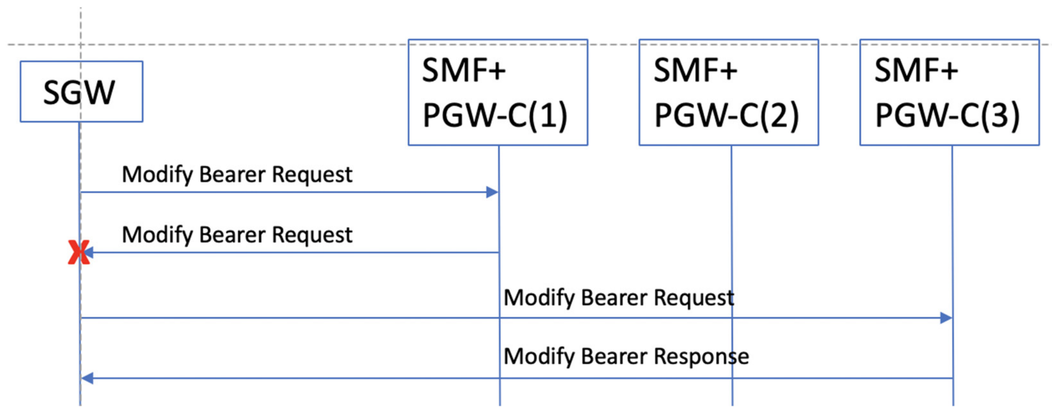

Figure 4: Proposed SGW Failover Handling

As shown in Figure 4, now that SGW is armed with address information for all three SMF+PGW-Cs belonging to the same SMF set, the SGW can failover to an alternate SMF+PGW-C. Thus, in accordance with the techniques of this proposal, an SGW is to use, for a failover, an alternate SMF+PGW-C whose address was obtained via the "Alternate Sender F-TEID(s) for Control Plane" AVP.

In summary, the techniques herein facilitate 5GC redundancy from a 4G EPC. In particular, for a 4G-5G interworking scenario in which an SMF set is implemented, the technique presented herein provides that an initial SMF+PGW-C can provide to an SGW, at session creation time, address information of all the SMF+PGW-Cs belonging to the same SMF set. The SGW can use the address information to facilitate failover to an alternate SMF+PGW-C belonging to the SMF set if the initial SMF+PGW-C does not respond to the SGW.