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# HOSTED SERVICES SUPPORT IN 5G NETWORKS

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## ABSTRACT

Techniques are presented herein that support configuring a User Equipment (UE) to initiate a new Protocol Data Unit (PDU) session with an optimized User Plane Function (UPF) selection for applications that are hosted in a specific Data Network Access Identifier (DNAI) that is away from the UE's location. Aspects of the presented techniques encompass an AM- Policy Control Function (PCF) including a subscription to a Unified Data Repository (UDR) for traffic influence data changes per application and altering the AF-provided Data Network Name (DNN) by appending DNAI information and providing the same to a UE in the UE Route Selection Policy (URSP) rules for an application identifier (AppId). Further aspects of the presented techniques encompass a Session Management Function (SMF) including support for decorated DNNs (e.g., the DNAI internet@realm may be decorated as internet.dnai-delhi@realm), extracting a DNAI from a received DNN and performing UPF selection based on the DNAI, and sending a DNAI to a SM-PCF during a SMPolicyContext Create on an N7 interface. Still further aspects of the presented techniques encompass a SM-PCF including a selection of an appropriate PDU session to handle the application policy rules based on the matching of an application's hosted DNAI and the DNAI of the PDU session that was received from a SMF. Use of the presented techniques yields a number of benefits including a separate PDU session with separate UPF in the DNAI where a service is hosted leading to an efficient transfer of data for an application with low latency. Further, the traffic for other applications continues to go through the other existing PDU sessions with a UPF that is closer to a UE's location thus preserving the quality of service (QoS) given for those edge applications during simultaneous use. Additionally, a SMF may select a UPF based on a DNAI and have a SM-PCF select a particular PDU session for all of the policies that are related to the applications that are hosted on the DNAI.

## DETAILED DESCRIPTION

Third Generation Partnership Project (3GPP) fifth-generation (5G) network deployments enable, among other things, operators to monetize new use cases. Hosted services, whether they are operator-specific or third-party, provide innovative revenue opportunities by leveraging new techniques such as support for a Local Area Data Network (LADN) and edge computing.

The 3GPP has studied several edge computing models (e.g., the 3GPP Technical Report 23.749 and Distributed Anchor Points, Session Breakout or Multiple sessions model) and techniques to provide hosted services in a dynamic fashion by defining how an Application Function (AF) may interact with a 5G core (e.g., a Network Exposure Function (NEF) and a Policy Control Function (PCF)). However, current techniques focus mainly on the session breakout model as well as hosted services that can be availed at the edge (i.e., that are closest to a User Equipment (UE)).

The session breakout model is complex to manage at the core. Traffic that is not terminated at the edge will go through both an Uplink Classifier (ULCL) User Plane Function (UPF) and an Anchor UPF, leading to a suboptimal utilization of resources.

There is a class of hosted services which may not terminate close to a UE, instead Edge Application Servers (EAS) should be selected from a Data Network Access Identifier (DNAI) and not based on UE location. One example could be multi-player augmented reality (AR) and virtual reality (VR) applications, which should reside on the same EAS but where users may be from different locations. Other examples may include teleconsultations, virtual games, and concerts that are hosted only on specific DNAIs but where users may connect from different locations.

Figure 1, below, presents elements of an exemplary arrangement.

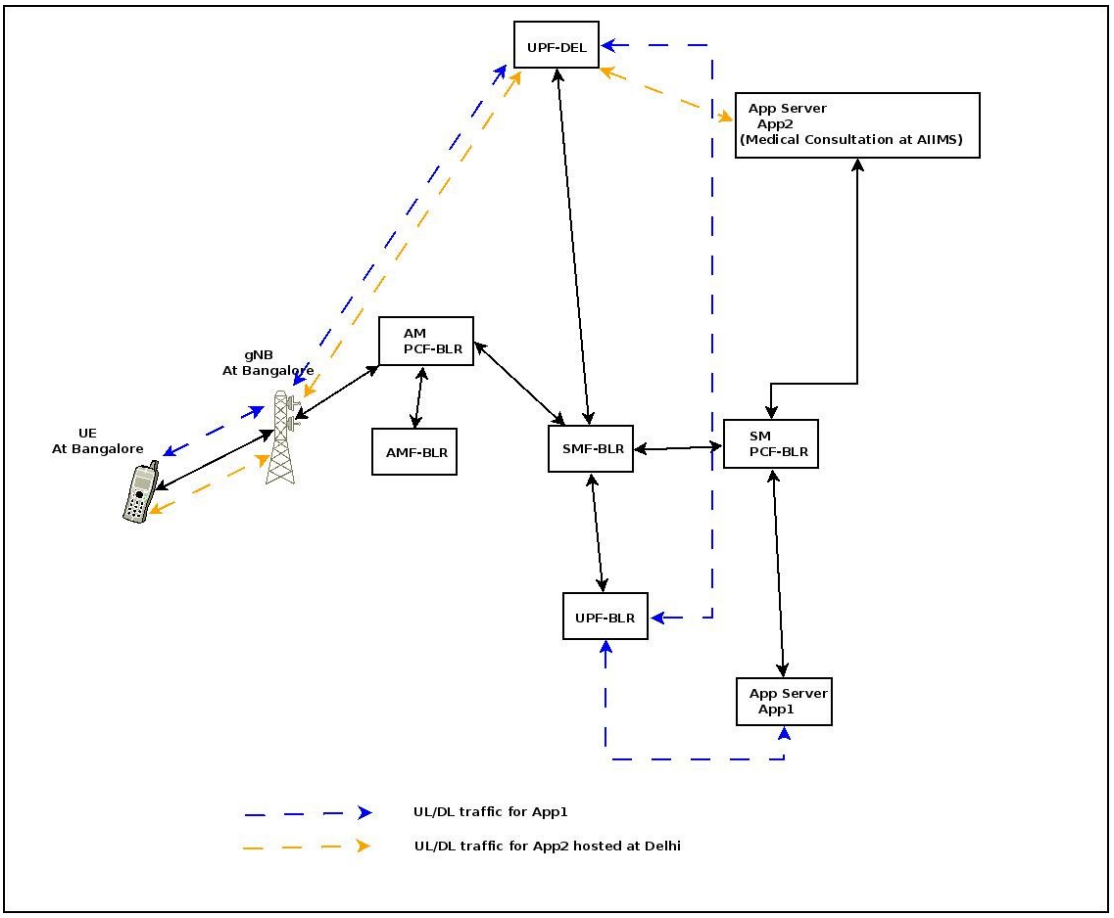


*Figure 1: Exemplary Arrangement*

As depicted in Figure 1, above, a UE in Bangalore attempts to access a medical consultation application (which is identified in the figure as App2) that is hosted in Delhi. The UPF in Delhi needs to be added as an Uplink (UL) Classifier and Intermediate UPF. Once this is done, the UL and downlink (DL) traffic to another application (which is identified in the figure as App1) begins being routed through the UPF in Delhi with an additional hop, thus making it inefficient.

Aspects of the techniques presented herein enable operators to support a class of hosted services (as described above) in a dynamic, scalable, and optimal fashion.

Figure 2, below, presents elements of an exemplary call flow that employs aspects of the arrangement that was depicted in Figure 1, above, to further illustrate the techniques presented herein. ~~The novel ideas of the proposal are highlighted in red.~~

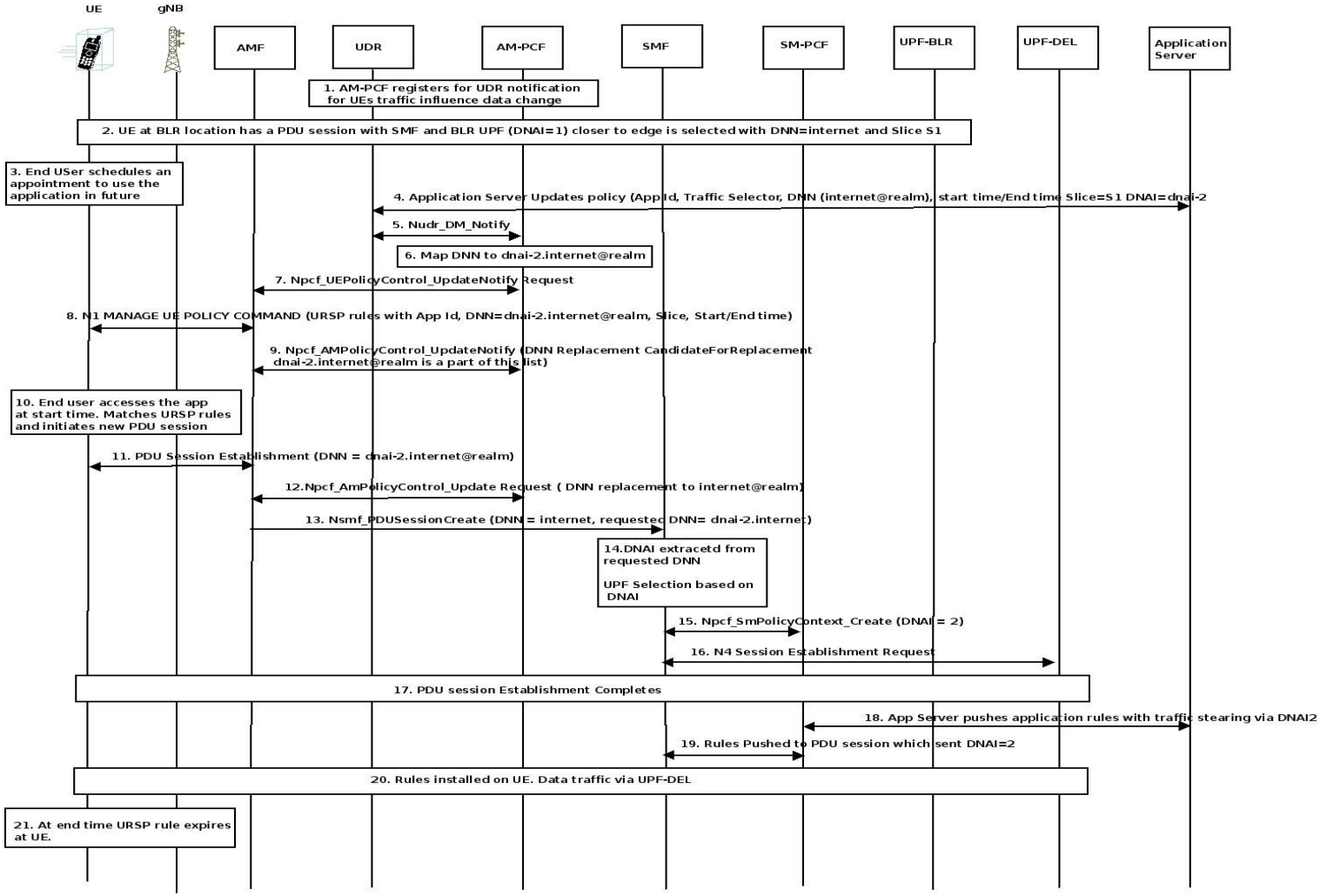


*Figure 2: Exemplary Call Flow*

The sequence diagram that is presented in Figure 2, above, identifies a series of steps. Those steps, which are labeled 1 through 21 in the figure, will be described below.

During Step 1, an AM-Policy Control Function (PCF) registers with a Unified Data Repository (UDR) to obtain a per-application UE traffic influence data change notification.

Under Step 2, a Protocol Data Unit (PDU) session with a Data Network Name (DNN) that is equal to internet@realm is already established for the UE to access other applications (e.g., the application App1 in Figure 1, above). Importantly, the current UPF (i.e., UPF-BLR) is closer to the UE's location in Bangalore.

During Step 3, the end user schedules an appointment at a predefined timeslot through the application App2 (e.g., a medical consultation application that is hosted in Delhi, as depicted in Figure 1, above) where that application is best served by the UPF-DEL with a DNAI that is equal to dnai-2.

At Step 4, an application server updates the policy in the UDR with an application identifier (AppId), traffic selectors, a DNN that is equal to internet@realm, and a preferred DNAI that is equal to dnai-2.

During Step 5, the UDR initiates a Nudr_DM_Notify towards the AM-PCF to update the application policy information at the AM-PCF. Under Step 6, the AM-PCF creates a decorated DNN by appending the DNAI information for the application, which in the instant example results in the creation of a DNN that is equal to dnai-2.internet@realm.

During Step 7, the AM-PCF initiates a Npcf_UEPolicyControl_UpdteNotify request towards an Access and Mobility Management Function (AMF). That message includes the UE Route Selection Policy (URSP) rules that were received from the UDR. The DNN in the URSP rules is set to the decorated DNN value of dnai-2.internet@realm.

Under Step 8, the AMF sends an N1 MANAGE UE POLICY COMMAND message to the UE through a gNodeB (gNB). That message contains the URSP rules with the AppID, the decorated DNN, and the start and stop times for the URSP rule validity. At Step 9, the AM-PCF also sends a Npcf_AMPolicyControl_UpdateNotify to the AMF to update the AMF with a CandidateForReplacement list indicating that the PCF should request a DNN replacement when a DNN from the list is received from UE. The decorated DNN value of dnai-2.internet@realm is a part of that list.

At Step 10, after the start time that is indicated in the URSP rules, the end user begins using the medical consultation application. The UE matches the URSP rules and determines that there is no session with a DNN that is equal to dnai-2.internet@realm. Consequently, the establishment of a new PDU session is triggered. Next, during Step 11, the UE initiates a new PDU session setup for a DNN with the value dnai-2.internet@realm. Then, under Step 12, the AMF matches this DNN with the DNN replacement candidate list and initiates a Npcf_AMPolicyControl_Update Request towards the PCF to ask for a replacement DNN. The AM-PCF then provides internet@realm as the replacement DNN.

During Step 13, the AMF initiates a Nsmf_PDUSessionCreate towards the Session Management Function (SMF) with both the replaced DNN of internet@realm and the requested DNN of dnai-2.internet@realm. At Step 14, the SMF extracts the DNAI information from the requested DNN (that is received from the AMF) and performs a UPF selection based on the DNAI for this session. In the instant example, the UPF-DEL with a DNAI that is equal to dnai-2 is selected.

Under Step 15, the SMF sends a Npcf_SMPolicyContext_Create towards the SM-PCF including the DNAI (that is equal to dnai-2) information to the PCF in a new attribute that is supported by aspects of the techniques presented herein. During Step 16, the SMF also triggers a N4 Session Establishment towards the UPF that is equal to UPF-DEL which was selected based on the extracted DNAI value of dnai-2.

During Step 17, the balance of the PDU session establishment steps are followed to complete the PDU session setup.

At Step 18, the application server pushes the application rules to the SM-PCF and indicates the preferred DNAI of dnai-2 for traffic routing. The SM-PCF then selects between the two available sessions. The session that is created for the application that is hosted in Delhi is selected since the SMF previously sent the DNAI to the SM-PCF.

During Step 19, the SM-PCF pushes the rules to the second PDU session that was specially created for this application. Then, during Step 20, the balance of the steps are followed to install the rules on the UE and the UPF-DEL.

Under Step 21, at a later point in time when the pre-set end time for the URSP rules is reached, the rules become invalid for this application. Any subsequent usage of the application will not result in the creation of a new PDU session.

Elements of the exemplary call flow that was illustrated and described above employed a UPF selection that was based on Access Point Name (APN) decoration. While such a capability is known, aspects of the techniques presented herein extend that capability in innovative ways. Specifically, DNN decoration from an AMF is usually driven by a subscription (similar to a virtual Access Point Name (APN) in a 3GPP fourth-generation (4G) network) for mobile virtual network operator (MVNO) use cases and it is static. In contrast, the techniques presented herein are controlling an AMF's DNN decoration from AF-influenced traffic, it is dynamic, and it is applied for a specific time of day or duration. Further, an SMF employs two DNNs (as opposed to just one which is decorated) for its operations, one which is decorated (e.g., internet@dnai) for UPF selection and another (e.g., the Internet) on the rest of the interfaces. Such an approach eliminates the need to change a subscription or a policy where it is necessary to define additional DNNs for a Unified Data Management (UDM) or a PCF.

From a Multi-access Edge Computing (MEC) point of view, the standards mainly discuss two solutions – a LADN and an AF influencing traffic routing. A LADN caters to only those use cases where services are at the edge and it depends upon the UE's location. An AF influencing traffic also expects hosted services to be closer to a UE's location and provide a mechanism for UPF insertion.

There is a prominent set of 5G use cases where hosted service may not be at the location of a UE. However, when combined with MEC use cases, the current approaches become inefficient. Aspects of the techniques presented herein support an end-to-end solution to address this issue and offer many innovative aspects. Examples of the above may include telemedicine, virtual concerts, online undergraduate and graduate programs that are not hosted close to a UE's location, however, basic internet connectivity can be terminated at the edge. LADN or a current definition of an AF influence of traffic cannot solve this set of use cases.

Further, aspects of the techniques presented herein attend to a number of areas that the current standards do not address. For example, the current standards do not address the alteration of URSP rules based on AF influence. Additionally, when there are two PDUs for the same DNN the ways in which a PCF may apply AF-influenced traffic routing related PCC rules to those PDUs are not defined in the current standards.

As described and illustrated in the above narrative, the techniques presented herein provide an end-to-end solution which is triggered by the AF influence on both an AM-PCF (UE-policy PCF) and a SM-PCF to trigger updates to both the URSP rules and the use of appropriate PCC rules in the SM-PCF. Additionally, aspects of the presented techniques use existing information elements (IEs) and mechanisms (e.g., DNN replacement in an AMF) which results in similar behavior but improves the possibility of deployment without impacting too many interfaces.

In summary, techniques have been presented that support configuring a UE to initiate a new PDU session with an optimized UPF selection for applications that are hosted in a specific DNAI that is away from the UE's location. Aspects of the presented techniques encompass an AM- PCF including a subscription to a UDR for traffic influence data changes per application and altering the AF-provided DNN by appending DNAI information and providing the same to a UE in the URSP rules for an AppId. Further aspects of the presented techniques encompass a SMF including support for decorated DNNs (e.g., the DNAI internet@realm may be decorated as internet.dnai-delhi@realm), extracting a DNAI from a received DNN and performing UPF selection based on the DNAI, and sending a DNAI to a SM-PCF during a SMPolicyContext Create on an N7 interface. Still further aspects of the presented techniques encompass a SM-PCF including a selection of an appropriate PDU session to handle the application policy rules based on the matching of an application's hosted DNAI and the DNAI of the PDU session that was received from a SMF. Use of the presented techniques yields a number of benefits including a separate PDU session with separate UPF in the DNAI where a service is hosted leading to an efficient transfer of data for an application with low latency. Further, the traffic for other applications continues to go through the other existing PDU sessions with a UPF that is closer to a UE's location thus preserving the QoS given for those edge applications during simultaneous use. Additionally, a SMF may select a UPF based on a DNAI and have a SM-PCF select a particular PDU session for all of the policies that are related to the applications that are hosted on the DNAI.