A Comparison of Edge Discovery Solutions for 5G MEC Distributed System

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Abstract

Distributed Multi-access Edge Computing (MEC) is a key element in 5G technologies. It provides low latency and data localization for edge services. Edge applications normally have multiple instances deployed in distributed edge areas. Discovery of an optimal service instance and seamless routing of user traffic to that instance are important features that current traditional Domain Name System (DNS) cannot satisfy. In recent years, several network solutions including enhanced-DNS and other network protocol have been proposed. This work makes a short comparison of these new edge discovery proposals for 5G MEC Distributed System.

Ⅰ. INTRODUCTION

One of 5G network promised features is providing low latency service to users. The key element to enable this feature is distributed Multi-access Edge Computing. This deployment paradigm consists of multiple computing servers located at the edge of the network. As these servers are close to user equipment (UE), service applications deployed on these hosts have low service response time. To assist user mobility and mitigate the disadvantage of limited resources at the edge, each application is deployed as multiple instances across distributed areas. Currently, whenever UEs connect to a gNodeB, after establishing PDU Session, UEs need to use the Domain Name System to resolve the IP address of the MEC service instance to send traffic to it. However, when there are multiple instances across distributed areas, there are three challenges that the traditional Domain Name System cannot satisfy. These challenges are specified in ETSI white paper [1] about distributed MEC environment:

- First, MEC instance IP address should be resolved not only based on the service URL, but also UE location, resource availability, traffic type, performance requirements to optimize UE's quality of service
- Second, one service URL should be linked with multiple IP addresses of multiple instances instead of only one.
- Third, in case of drastic change caused by UE mobility, the MEC instance address update should be completed in real-time manner.

These challenges of selecting an optimal MEC service instance for a UE request and seamless routing to that instance has been formalized as edge Service Discovery problem in 3GPP test report and standard on enhancement of supporting for Edge Computing [2], [3]. These documents have proposed several enhanced-DNS solution to address the challenges.

Apart from enhanced-DNS, there are other candidate approaches based on Anycast address concept combined with different new networking protocol to support it. Anycast is the concept of using the same address for multiple MEC service instances. To support optimal instance finding and routing, IETF Computing Aware Networking (CAN) working group proposed the Dynamic Anycast approach [4] that relies on computing and network metrics embedded in network routers. Another anycast-based research work proposed a different approach based on Segment Routing IPv6 (SRv6) [5].

This paper provides a short analysis and comparison of current solutions for Edge Discovery in 5G MEC Distributed System.

Ⅱ. 5G DISTRIBTUED EDGE DISCOVERY SOLUTIONS

A. ENHANCED-DNS

These are solutions proposed in ETSI and 3GPP studies [1-3] on enhancement of support for Edge Computing in 5G Core Network. The key idea of Enhanced-DNS solutions is extending the current DNS query with other required parameters to support optimal MEC instance selection such as UE location, resource availability, network conditions, and performance indexes. Figure 1 shows the procedure.

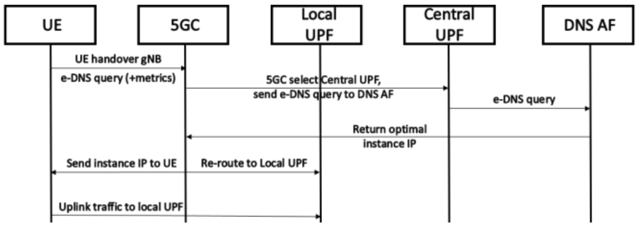

Figure 1. Enhanced-DNS procedure

First, when UE moves and connect to a new edge gNodeB, SMF function of the 5G core will select the Central UPF and forward the enhanced DNS query with attached metrics to the enhanced DNS server deployed as an 5G AF. This DNS server has service registration information, edge platform resources metrics from MEC platforms. Meanwhile, UE location can be fetched from the AMF function. Based on the attached metrics with the URL of the edge service, the DNS AF returns the optimal instance IP address to the SMF. SMF then re-routes the UE traffic to the Local UPF attached to the edge server that hosts the chosen instance and sends the instance IP to UE. The Central UPF and re-routing process might not be needed if the network operator pre-configured traffic to be handled by the local UPF at each edge area.

B. ANYCAST

Anycast approaches use the same IP address for multiple MEC instances of a single service.

The Dynamic Anycast approach proposed by the IETF CAN working group binds the anycasts address with to each instance's unicast address or the VPN tunnel to that instance. This will create a path from the ingress node of the network to each instance. Each path will be bound with computing and network resources metrics. These metrics are either distributed to all nodes in the network from the routers connecting to each edge server or centrally collected at a network controller. The path with the best metrics is chosen as the optimal path. When integrating the dynamic anycast concept to 5G, the ingress node is the gNodeB, while the edge router is the UPF PDU Session Anchor, In case of centralized deployment, decisions can be made at the SMF. In case of distributed deployment, gNodeB might decide then send the chosen path to SMF for configuring the corresponding UPF. Location Identifier Separation Protocol is one possible network protocol proposed for edge routing by the CAN working group [6].

SRv6 Edge Routing is another approach proposed by Oleg Berzin [5]. In this approach, all MEC server that can offer a specific upper latency budget is grouped as a MEC Domain. All UPF, gNodeB, Edge host and intermediate routers between them are assigned a SRv6 label. A optimal edge routing controller will decide the optimal service instance based on the collected metrics from the domain and configure the traffic path from UE to the instance by installing the SRv6 label stack to the routers. UE only need to send the traffic using the anycast service address, then the packets will be forwarded by SRv6.

III. COMPARISON AND EVALUATION

Table 1 shows our comparison and evaluation for the enhanced-DNS and Anycast solutions.

Criterias	Enhanced-DNS	Anycast
Support instance selection by other metrics	Yes, collect from 5GC and MEC Platform	Yes, collect from 5GC and MEC Platform
Support multiple addresses for a single service	Yes	Yes
Support real-time manner path update	Yes, but UE initiates IP resolution request. Time-to-live and DHCP lease should be short enough	Yes, update is performed by the new network layer
Seamless service continuity	Might not, service disruption caused by UE and instance's IP address change	No, routing is performed by new network protocol (LISP or SRv6), traffic source and destination address does not change
Changes made to the current network architecture	Only need to extend the DNS packet headers to include more information	Requires network nodes to support new network protocol

Table 1. Comparison of proposed edge discovery solutions for 5G MEC Distributed System

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