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SPRING Use cases for IP Flow Mobility
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Abstract

The ability for a node to specify a forwarding path, other than the normal shortest path, that a particular packet will traverse, benefits a number of network functions. Source-based routing mechanisms have previously been specified for network protocols, but have not seen widespread adoption. In this context, the term ‘source’ means ’the point at which the explicit route is imposed’.

The objective of this document is to illustrate some use cases that need to be taken into account by the Source Packet Routing in Networking (SPRING) architecture.

Status of this Memo

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1. Introduction

Source Packet Routing in Networking (SPRING) architecture leverages the source routing paradigm. An ingress node steers a packet through a controlled set of instructions, called segments, by prepending the packet with SPRING header. A segment can represent any instruction, topological or service-based. A segment can represent a local semantic on the SPRING node, or a global semantic within the SPRING domain. SPRING allows one to enforce a flow through any topological path and service chain while maintaining per-flow state only at the ingress node to the SPRING domain.

The SPRING architecture is described in [I-D.filsfils-rtgwg-segment-routing]. The SPRING control plane is agnostic to the dataplane, thus it can be applied to both MPLS and IPv6. In case of MPLS the (list of) segment identifiers are carried in the MPLS label stack, while for the IPv6 dataplane, a new type of routing extension header is required.

The scope of this document is to study the use cases for UEs with multiple interfaces which will simultaneously connect to 3GPP access and non-3GPP WLAN access. In this use cases, the forwarding paths can be explicitly specified by taking into account the Source Packet Routing in Networking (SPRING) architecture.

1.1. Terminology and abbreviations

Much of the terminology used in this document has been defined by the 3rd Generation Partnership Project (3GPP), which defines standards for mobile service provider networks. Although a few terms are defined here for convenience, further terms can be found in [RFC6459].

AS   Access Switch

AR   Aggregation Router

CE   Customer Edge Router

ER   Edge Router

UE   User equipment like tablets or smartphones

eNB   enhanced NodeB, radio access part of the LTE system

S-GW Serving Gateway, primary function is user plane mobility

P-GW Packet Gateway, actual service creation point, terminates 3GPP mobile network, interface to Packet Data Networks (PDN)

PE   Provider Edge Router

HSS   Home Subscriber System (control plane element)

MME   Mobility Management Entity (control plane element)

GTP   GPRS (General Packet Radio Service) Tunnel Protocol

S-IP Source IP address

D-IP Destination IP address

IMSI The International Mobile Subscriber Identity that identifies a mobile subscriber

(S)Gi Egress termination point of the mobile network (SGi in case of LTE, Gi in case of UMTS/HSPA). The internal data structure of this interface is not standardized by 3GPP

PCRF 3GPP standardized Policy and Charging Rules Function

2. Mobile network overview

For simplicity we only describe IP flow mobility in the context of LTE (Long Term Evolution), which aims to provide seamless Internet Protocol (IP) connectivity between user equipment (UE) and the packet data network (PDN). But indeed IP flow mobility also applies to earlier generations of mobile networks, such as purely UMTS-based mobile networks.

An IP packet for a UE is encapsulated in an EPC-specific protocol and tunneled between the P-GW and the eNodeB for transmission to the UE. Different tunneling protocols are used across different interfaces. A 3GPP-specific tunneling protocol called the GPRS Tunneling Protocol (GTP) is used over the CN interfaces, S1 and S5/S8.

2.1. Building blocks of 3GPP mobile networks

The major functional components of a LTE network are shown in Figure 2 and include user equipment (UE) like smartphones or tablets, the LTE radio unit named enhanced NodeB (eNB), the serving gateway (S-GW) which together with the mobility management entity (MME) takes care of mobility and the packet gateway (P-GW), which finally terminates the actual mobile service. These elements are described in detail in [TS.23.401]. Other important components are the home subscriber system (HSS) and the policy and charging rule function (PCRF), which are described in [TS.23.203]. The P-GW interface towards the SGi-LAN is called the SGi-interface, which is described in [TS.29.061]. Finally, the SGi-LAN is the home of service function chains (SFC), which are not standardized by 3GPP.

The radio-based IP traffic between the UE and the eNB is encrypted according 3GPP standards. Between the eNB, S-GW, and P-GW user plane IP packets are encapsulated in 3GPP-specific tunnels. In some mobile carrier networks the 3GPP specific tunnels between eNB and S-GW are even additionally IPSec-encrypted. More precisely, IPSec originates/terminates at the eNB and on the other side at an IPSec-GW often placed just in front of the S-GW. For more details see [TS.29.281], [TS.29.274] and [TS.33.210].

```
+----------------------------------------+
| Mobile Network       [HSS]             |    [OTT Appl. Platform]
|                        |               |              |
|           +--------- [MME]  [PCRF]-----+--------+     |
|           |            |      |        |        |     |
|           +         [S-GW]  [P-GW]     |        |  Internet
|           |            |      |        |        |     |
| [UE] -- [eNB]          +------+        |        |     |
|           |                   |        |        |     |
+===========|===================|========+  +-----+-----+-------+
|           |                   |        |  |                   |
|         [AS] - [AR(PE)] == [ER(PE)] == +--+----[SGi-LAN]      |
|                                        |  |        |          |
|                                        |  |        |          |
|                                        |  | [Appl. Platform]  |
| IP Network                             |  |                   |
```

```
+----------------------------------------+  +-------------------+
```

Figure 1 Mobile and IP network in case of 3GPP access

Mobile network consists of some LTE components in 3GPP access and GTP connections between eNB and S-GW, and between S-GW and P-GW are established, as shown in Figure 1. The LTE components are connected to MPLS components such as AS, AR and ER in IP network. The interactions between LTE components occur through MPLS components.

```
+----------------------------------------+
| Mobile Network       [HSS]             |    [OTT Appl. Platform]
|                        |               |              |
|           +--------- [AAA]  [PCRF]-----+--------+     |
|           |            |      |        |        |     |
|           +         [ePDG]  [P-GW]     |        |  Internet
|           |            |      |        |        |     |
| [UE] -- [AP/APC]       +------+        |        |     |
|           |                   |        |        |     |
+===========|===================|========+  +-----+-----+-------+
|           |                   |        |  |                   |
|         [AS] - [AR(PE)] == [ER(PE)] == +--+----[SGi-LAN]      |
|                                        |  |        |          |
|                                        |  |        |          |
|                                        |  | [Appl. Platform]  |
| IP Network                             |  |                   |
+----------------------------------------+  +-------------------+
```

Figure 2 Mobile and IP network in case of Non-3GPP access

Mobile network consists of some LTE components in non-3GPP access (WLAN) and GTP connections or IPsec between AP/APC and ePDG, and between ePDG and P-GW are established, as shown in Figure 2. The WLAN components are connected to MPLS components such as AS, AR and ER in IP network. The interactions between WLAN components occur through MPLS components.

3. Use case

With an explosive increase of data traffic, cellular networks are likely to be operating at their capacity limits and hence. Data offload is regarded as one of solutions that can avoid overload and improve the overall end user experience by redirection.

3.1. High level use case

This sub-clause describes a use case where the UE is connected to the EPS via different accesses simultaneously, sending and receiving different IP flows through different accesses.

Michael is in an outdoor area and the 3GPP accesses are only available. Michael is accessing different services with different characteristics in terms of QoS requirements and bandwidth:

- a Video Telephony call: IP Flow 1 and 5

- a p2p download: IP Flow 2

- a media file synchronization (e.g. a podcast and downloading of a TV series): IP Flow 3

- a non-conversational video streaming (e.g. IPTV): IP Flow 4

The scenario is depicted in Figure 3.

```
     +----------------------+    +------------------------+
     | 3GPP Access          |    | EPC/WLAN               |
```

```
     |                      |    |                       |
     |                      |    |                       |
     |          +-----------|----|-----------------------|----IP Flow 1
     |          | +---------|----|-----------------------|----IP Flow 2
     |          | | +-------|----|-----------------------|----IP Flow 3
     |          | | | +-----|----|-----------------------|----IP Flow 4
     |          | | | | +---|----|-----------------------|----IP Flow 5
     |          | | | | |   |    |                       |
     |          +--------+  |    |                       |
+===============|   UE   |  |    |                       |
|               +--------+  |    |                       |
|                      |----+    |                       |
|                      |         |                       |
|                      |         |                       |
|                      |         |                       |
| Non-3GPP Access      |         |                       |
+======================+         +-----------------------+
```

Figure 3 Routing of different IP flows through 3GPP access

After a while Michael comes back home where both 3GPP access and a trusted or untrusted non-3GPP access are available. As an example, the non-3GPP access may be a domestic WiFi hotspot. Some of these flows may be from the same application (e.g. the Video Telephony may be via a virtual private network tunnel). Based on operator’s policies, the user’s preferences and the characteristics of the application and the accesses, the IP flows are routed differently; as an example, the audio media (conversational voice) of the VT call and the video streaming are routed via 3GPP access, while the video media (conversational video (live streaming)) of the VT, the p2p download (best effort) and media file synchronization are routed through the non-3GPP access. The scenario is depicted in Figure 4.

```
     +----------------------+    +-----------------------+
     | 3GPP Access          |    | EPC/WLAN              |
     |                      |    |                       |
     |                      |    |                       |
     |                      |    |                       |
     |                      |    |                       |
```

```
     |                      |    |                       |
     |                +-----|----|-----------------------|----IP Flow 4
     |                | +---|----|-----------------------|----IP Flow 5
     |                | |   |    |                       |
     |          +--------+  |    |                       |
+===============|   UE   |  |    |                       |
|               +--------+  |    |                       |
|                | | | |----+    |                       |
|                | | +-|---------|-----------------------|----IP Flow 1
|                | +---|---------|-----------------------|----IP Flow 2
|                +-----|---------|-----------------------|----IP Flow 3
| Non-3GPP Access      |         |                       |
+======================+         +-----------------------+
```

Figure 4 Routing of different IP flows through different accesses

3.2. SPRING use case

Devices with multiple wireless interfaces (e.g. 3GPP, WLAN, etc.) are becoming commonly available and the set of applications running in the mobile devices is diversifying with some applications suited to run over 3GPP access systems and other applications well suited to run over non-3GPP WLAN access systems. It is called IP flow mobility to allow a telecom operator to seamlessly and selectively switch over a single IP flow (e.g., user application) to a different radio access, while keeping all other ongoing connections for this and the rest of the users on both radio accesses untouched. However IP flow mobility (e.g., traffic redirection) always introduces some kind of delay, due to processing, forwarding, and the difference in round-trip time (RTT) between the different accesses.

With segment routing, the paths between PEs that connect LTE components (e.g., eNB and S-GE, AP/APC and ePDG, S-GE and P-GW, and ePDG and P-GW) can be explicitly specified instead of RSVP or LDP. When data over 3GPP access are redirected to non-3GPP access, the path of data over non-3GPP access can be specified in the similar way of data over 3GPP access in order to reduce the redirection delay. When the PEs connecting the relevant LTE components is same, then the paths can be exactly same. Therefore redirection delay could be significantly reduced.

4. Security Considerations

TBD

5. IANA Considerations

TBD

6. References

6.1. Normative References

None

6.2. Informative References

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7. Acknowledgments

TBD

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