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Mobility Management based on Source Routing
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Abstract

This document explores how mobility management could be provided based on source routing like solutions and take SRv6 as an example for 5G LAN service.

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1 Introduction

The 5G network is designed aims at three scenarios which are eMBB (enhanced Mobile Broad Band), uRLLC (ultra-Reliable Low latency Communication), and mMTC (massive Machine Type Communication). The goal of 5G is to provide network services for various application scenarios not limited to traditional MBB service.

One of the promises of 5G is the convergence of fixed and mobile networks, and providing LAN (Local Area Network) services in 5G networks is a new communication requirement. 5G LAN has many potential application scenarios, for example, provide communication for home service in residential environment which will solve many coverage and QoS problems that home owners are suffering with the current solutions; provide enterprise communication service in enterprise environment to interwork with and enhance existing WLAN and fixed LANs in the enterprise and as a replacement LAN technology that eliminates the need for other WLAN and fixed LAN deployments and provide with a wider area coverage using the cellular radio and greater mobility for UEs.

Communication between UEs in a 5G LAN is a full mesh communication mode, and UEs that belong to the same LAN can communicate with each other, and the UE has mobility characteristics and may move between different network locations. The traditional GTP tunnel-based solution needs to establish a tunnel between network nodes in a full mesh manner in order to connect all the UEs in the same LAN, which will result in many tunnels. The maintenance process of the tunnels involves the process of establishing and deleting a tunnel through signaling, which is very complicated, especially when the UE moves, it may involve a large number of tunnel establishment and removal processes.

Source routing is an alternative method for packets routing, which allows a sender of a packet to partially or completely specify the route the packet takes through the network, source routing could be a

candidate for routing packets in 5G LAN. Currently there are different types of approach for source routing, and SRv6 is one of them. SRv6 (Segment Routing IPv6) [I-D. [draft-filsfils-spring-srv6-network-programming-05](#)] uses a source routing idea to forward packets in the network and provides flexible routing features for packet forwarding. SRv6 also defines a number of commands that provide more powerful additional functions based on data forwarding.

This document explores how mobility management could be provided based on source routing like solutions and take SRv6 as an example for 5G LAN service.

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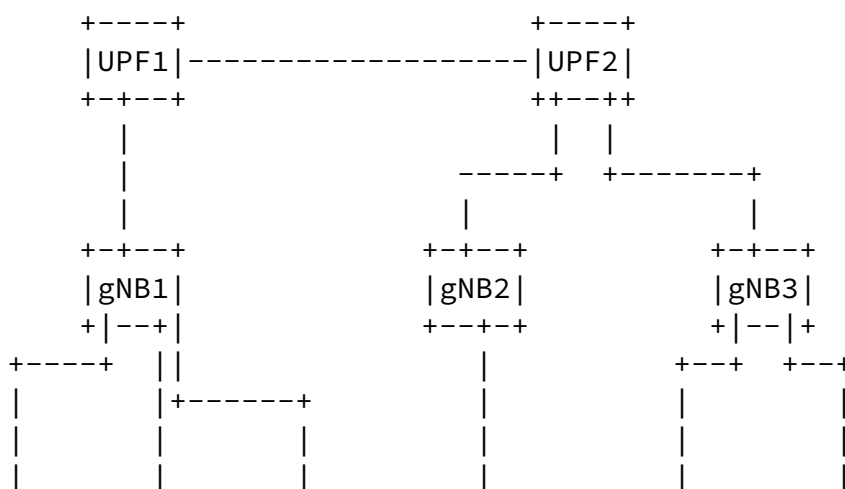
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2. Conventions and Terminology

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC 2119](#) [[RFC2119](#)].

3. 5G LAN Network Model

This section provides a more detailed description of 5G LAN network. (for simplicity, the control plane entities of 5G core network is eliminated, for more information about 5G core architecture, please refer to [TS 23.501])



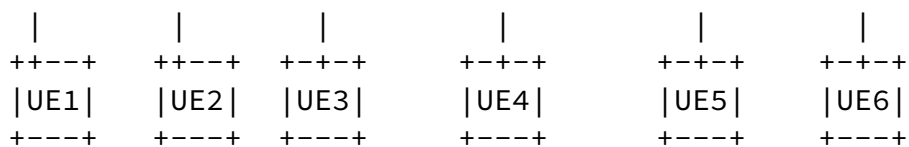


Figure 1: 5G LAN Network Model

UE: User Equipment.

gNB: RAN node of 5G system.

UPF: User Plane Function.

Multiple UEs can be included in the same LAN and different UEs can access the same LAN through different network access point. The data frame can be unicasted, multicasted or broadcasted among UEs as in the traditional layer 2 LAN except that data frames are carried over a 5G network. The UEs may move between different network locations while maintaining continuity of UE services.

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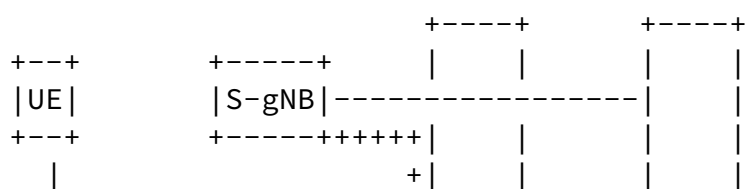
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[4. SRv6-based mobility management for 5G LAN](#)

[4.1 UE Handover](#)

The solution of 5G LAN based on SRv6 instead of tunnel can make full use of SRv6 flexibility, and avoid the complexity of tunnel maintenance while meeting the mobility requirements.

The UE in the LAN handover from one gNB to another gNB due to reasons such as UE's movement or radio signal quality change. The network side needs to ensure that no packets are lost during the handover process, and no packets re-ordering happens to ensure service continuity. Several requirements that the handover scheme needs to meet: the switching of the forwarding context from S-gNB to T-gNB and distinguish between normal traffic and in-transit traffic.



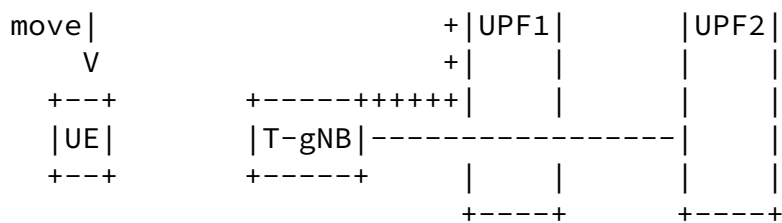


Figure 2: UE Handover

4.2 SRv6-based Handover

When using SRv6 to carry data packets, SRv6 not only needs to identify the transmission path for packets, but also needs to distinguish the in-transit data packets during the handover process, so as to avoid the packets re-ordering received by the UE. The in-transit packets are packets that should be sent to T-gNB but sent to S-gNB for transit after handover.

Before the handover occurs, the service flow of the UE is transmitted between the anchor UPF, the S-gNB and the UE based on the SRv6, the data packet is carried between the network entities through SRv6 encapsulation, and the S-gNB and the anchor UPF are respectively responsible for adding SRv6 header for the uplink data packets and the downlink data packets. The SRv6 header encapsulated on the data packet sent by the anchor UPF to the UE

carries the "Forward" flag to indicate that the data packet is a data packet from the anchor UPF.

The UE periodically sends a channel measurement report to the S-gNB for S-gNB to make decision whether a handover to new gNB is needed. Once the S-gNB decides to initiate the handover procedure, the S-gNB will interact with the target T-gNB so that the T-gNB is ready for UE access.

After receiving the handover notification, the Anchor UPF will stop to transmit data on the path used before the handover. At this time, the Anchor UPF will set the "End" flag in the SRv6 header of the packet sent on the path before the handover. The "End" flag is used to indicate that the anchor UPF will stop transmitting data packets to the path used before the handover,

and then the anchor UPF will transmit the data packet to the T-gNB through the new path established after handover, and in order to avoid packets re-ordering, the packets from the anchor UPF are first cached by T-gNB.

The outer layer of the packets that anchor UPF packet sent to the S-gNB uses a SRv6 header as the routing field to carry routing information. The routing information contains one or more path nodes' information through which the packet traverses from anchor UPF to S-gNB.. Each SRv6 header includes one or more IPv6 addresses, and each IPv6 address is in one-to-one correspondence with a path node. The 128-bit IPv6 address is divided into a route identifier field and a packet source flag field, where the route identifier field is used to carry path node's information, the packet source flag field is used to carry the packet source flag.

After the handover notification is sent, S-gNB creates a temporary forwarding entry for the data transmission path from the S-gNB to the T-gNB. The forwarding entry records the routing information of the forwarding nodes for packets to be forwarded from the S-gNB to the T-gNB. At the same time, the S-gNB receives packet from the anchor UPF on the path before handover, and the "Forward" flag carried in the packet indicates that the packet is directly from the anchor UPF, and the S-gNB obtains routing information from the temporary forwarding entry and the SRv6 header of the received data packet is modified according the routing information, the obtained routing information is carried in the SRv6 header, and the "Forward" flag carried in the previous SRv6 header is changed to "Transit" flag, which is used to indicate that the transmitted data packet is an in-transit packet, and then forward the modified packet to the T-gNB.

The packet sent by the S-gNB to the T-gNB is encapsulated using a

SRv6 header as the routing field to carry the routing information, similar to the SRv6 header encapsulated on packets sent from the anchor UPF to the S-gNB, where the SRv6 header contains one or more IPv6 addresses, each IPv6 address is in one-to-one correspondence with a path node, and the 128-bit IPv6 address is divided into a route identifier field and a packet source flag field, where the route identifier field is used to carry path node's information, the packet source flag field is used to carry

the packet source flag.

An alternative method to carry the packet source flag is to carry it in the extension field of the SRv6 header, and not in the IPv6 address in the SRv6 header.

When the S-gNB receives a packet with the "End" flag from the anchor UPF, it forwards the modified packet to the T-gNB by using a method similar to deal with the "Forward" flag packets. The difference is that the packet is forwarded to the T-gNB with "End" flag set instead of "Transit" flag. The "End" flag indicates anchor UPF will stop transmitting data packets on the path used before the handover.

Before receiving packets from S-gNB with "End" flag set, the T-gNB will buffer the packets from anchor UPF transmitted on new path after handover, and will transmit the in-transit packets from the S-gNB to UE. When the T-gNB receives the packet with "End" flag set from the S-gNB, it starts transmitting the packets receiving from the new path established after handover.

5. Extensions of SRv6

This section describes extensions of SRv6 that are needed when SRv6 is used for 5G LAN, and there are two kinds of options for the extensions.

Option 1: IPv6 Address Redefinition

Redefine the 128-bit IPv6 address into two parts: a route identifier field and a packet source flag field, where the route identifier field is used to carry path node's information, the packet source flag field is used to carry the packet source flag.

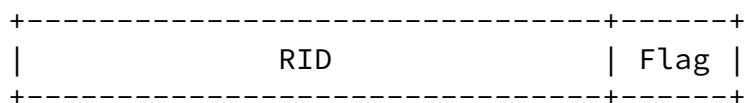


Figure 3: IPv6 Address Redefinition

Contains path node's information, the information will be used for routing packet to the specific node.

Flag:

00, "Forward", the default flag that indicates the packet is from UPF.

01, "Transit", indicates the packet is an in-transit packet.

10, "End", indicating anchor UPF will stop transmitting data packets on the path used before the handover.

11, reserved.

Option 2: SRv6 Header Extension

Because SRv6 header itself contains an "Optional Type Length Value objects" field, so this field can be used to carry packet source flag field, and segment list of IPv6 address in SRv6 header acts as route identifier field.

+-----+-----+-----+			
Type	Length	Flag	
+-----+-----+-----+			

Figure 4: New Optional Type Length Value Object for SRv6 Header

Type: TBD1.

Length: 1

Flag:

00, "Forward", the default flag that the packet is from UPF.

01, "Transit", indicates the packet is an in-transit packet.

10, "End", anchor UPF will stop transmitting data packets to the path used before the handover.

11, reserved.

[3](#) Security Considerations

TBD.

[4](#) IANA Considerations

TBD.

[5](#) References

[5.1](#) Normative References

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", [BCP 14](#), [RFC 2119](#), March 1997.

[5.2](#) Informative References

[I-D.filsfils-spring-srv6-network-programming-05] Filsfils, C., Camarillo, P., Leddy, J., daniel.voyer@bell.ca, d., Matsushima, S., and Z. Li, "SRv6 Network Programming", [draft-filsfils-spring-srv6-network-programming-05](#) (work in progress), July 2018.

[TS 23.501] 3GPP, "System Architecture for the 5G System", 3GPP TS23.501 15.0.0, November 2017.

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