Service Function Chaining
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Service Function Chaining Dataplane Elements in Mobile Networks
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Abstract

The evolution of the network towards 5G implies a challenge for the infrastructure. The targeted services and the full deployment of virtualization in all segments of the network will need service function chains that previously resided in the(local and remote) infrastructure of the Network operators to extend to the radio access network (RAN).

The objective of this draft is to provide a non-exhaustive but representative list of service functions in 4G and 5G networks. We base on the problem statement [RFC 7498] and architecture framework [SFC-Arch] of the working group, as well on the existing mobile networks use cases [SFC-mobile-uc] and the requirement gathering process of different initiatives around the world [5GPPP, IMT2020, 5G-FK, IMT2020-CN] to anticipate network elements that will be needed in 5G networks.

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1 Introduction

<Introduction Text>

1.1 Terminology and abbreviations

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].

Much of the terminology used in this document has been defined by either the 3rd Generation Partnership Project (3GPP) or by activities related to 5G networks like ITU-T's IMT2020. Some terms are defined here for convenience, in addition to those found in [RFC6459].

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)
HSS Home Subscriber Server (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
PCEF Policy and Charging Enforcement Function
TDF Traffic Detection Function
TSSF Traffic Steering Support Function
IDS Intrusion Detection System
FW Firewall
ACL Access Control List
PEP Performance Enhancement Proxy
IMS IP Multimedia Subsystem
LI Legal Intercept

1.2 General scope of mobile service chains

Current mobile access networks terminate at a mobile service creation point (called Packet Gateway) typically located at the edge of an operator IP backbone. Within the mobile network, the user payload is

encapsulated in 3GPP specific tunnels terminating eventually at the P-GW. In many cases application-specific IP traffic is not directly exchanged between the original mobile network, more specific the P-GW, and an application platform, but will be forced to pass a set of service functions. Network operators use these service functions to differentiate their services.

In order to cope with the stringent requirements of 5G networks (cf. Section 1.3), we expect a new architecture to appear. This architecture will surely make extensive use of virtualisation up to the RAN. We also expect that IP packets will need to be processed much earlier that in the current 3GPP architecture. In this context, it is foreseeable that Service Function Chaining will play a substantial role when managing the chains network traffic will traverse. We also expect new kinds of service functions specific to the radio access part to appear and that these new service functions will need to be managed by the SFC management infrastructure of the operator.

1.3 Requirements for 5G networks

As set forth by the 5G-PPP [5GPPP], the evolution of the infrastructure towards 5G should enable the following features in the mobile environment:

- Providing 1000 times higher wireless area capacity
- Saving up to 90% of energy per service provided
- Reducing the average service creation time cycle from 90 hours to 90 minutes
- Facilitating very dense deployments of wireless communication links to connect over 7 trillion wireless devices serving over 7 billion people

1.4 Evolution of the end-to-end carrier network

[SFC-Mobile-UC] presents the structure of end-to-end carrier networks and focused on the Service Function Chaining use cases for mobile carrier networks, such as current 3GPP- based networks. We recognise that other types of carrier networks that are currently deployed share similarities in the structure of the access networks and the service functions with mobile networks. The evolution towards 5G networks will make the distinction between these different types of networks blur and eventually disappear.

5G networks are expected to massively deploy virtualisation technologies from the radio elements to the core of the network. The four building blocks of the RAN, i.e. i) spectrum allocation or physical layer (PHY), i) Medium Access Control (MAC), iii) Radio Link Control (RLC) and iv) Packet Data Convergence, are candidates for

virtualisation.

2. Mobile network overview

[SFC-Mobile-UC] provides an overview of mobile networks up to LTE (Long Term Evolution) networks. As the specifications mature, we will provide the updates to the LTE architecture.

2.1. Building blocks of 4G and 5G networks

The major functional components of an 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), the Policy and Charging Rule Function (PCRF) and the optional components: the Traffic Detection Function (TDF) and the Traffic Steering Support Function (TSSF), 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]. The TDF resides on this interface. Finally, the SGi-LAN is the home of service function chains (SFC), which are not standardized by 3GPP.

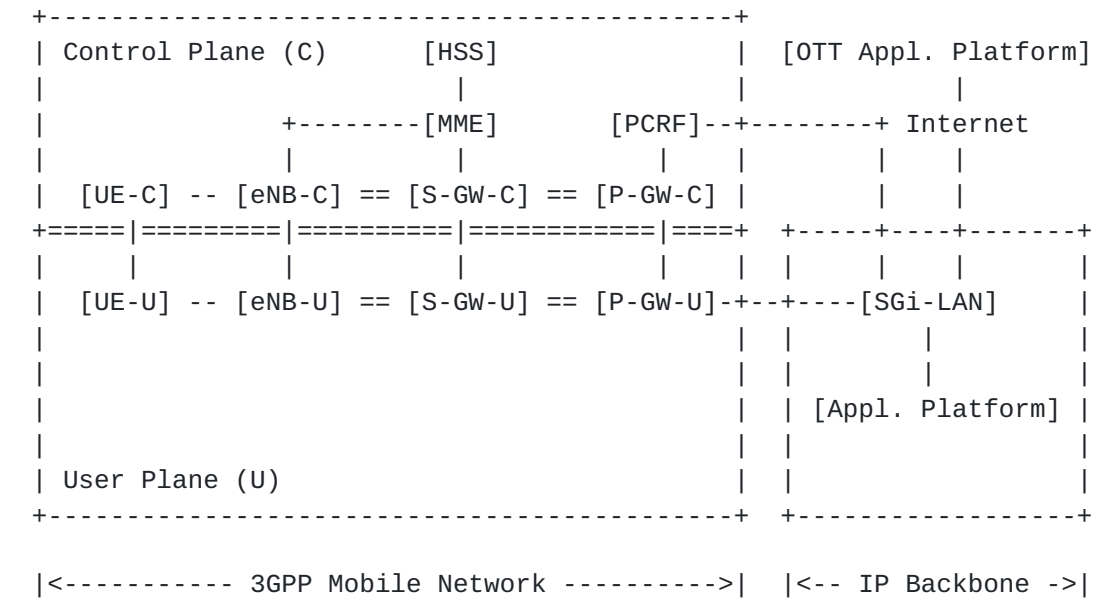

Figure 2: End to end context including all major components of an LTE network. Source [SFC-Mobile-UC]

The radio-based IP traffic between the UE and the eNB is encrypted

according to 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].

In this context, service function chains will not only act on user plane IP traffic, but also on the traffic in RAN. The way these will act on user traffic may depend not only depend on subscriber, service or network specific control plane metadata, but also on the state of the network at the particular location of the user.

2.2. Overview of mobile service chain elements in 4G networks and their evolution in 5G

[SFC-Mobile-UC] provides an overview of the service chain elements in 4G networks. Figure 3, extracted from it, shows the service chain topology in such networks.

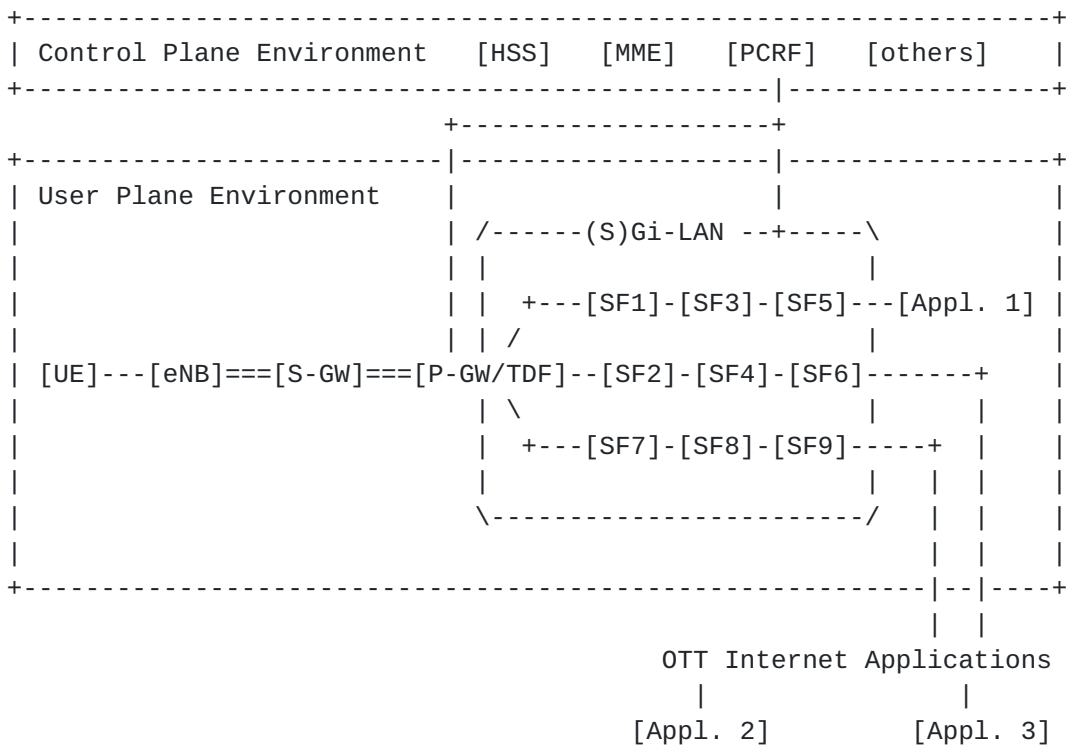

Figure 3: Typical service chain topology.

Service Functions handle session flows between mobile user equipment and application platforms. Control plane metadata supporting policy

based traffic handling may be linked to individual service functions. In 5G networks, we expect the packet gateway (P-GW) to loose its central position and be integrated with functions in the RAN. Radio Resource Control (RRC) in 5G network will be integrated into the Control Plane environment.

2.3 Classification schemes for 5G networks

TBD: We expect classification schemes for 5G networks to evolve as the standards appear.

3 Control plane considerations TBD: We except the RRC to be integrated with the SFC Control plane in 5G.

4 Operator requirements

4G mobile operators use service function chains to enable and optimize service delivery, offer network related customer services, optimize network behavior or protect networks against attacks and ensure privacy. Service function chains are essential to their business. Without these, mobile operators are not able to deliver the necessary and contracted Quality of Experience (QoE) or even certain products to their customers.

As set forth by the 5G-PPP [5GPPP], the evolution of the infrastructure towards 5G should enable the following features in the mobile environment:

- Providing 1000 times higher wireless area capacity
- Saving up to 90% of energy per service provided
- Reducing the average service creation time cycle from 90 hours to 90 minutes
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To meet these additional requirements, operators will need to make an extensive use of service chains and to extend their scope to functions in the Radio Access Network.

5 Security Considerations

Organizational security policies must apply to ensure the integrity of the SFC environment. SFC will very likely handle user traffic and user specific information in greater detail than the current service environments do today. This is reflected in the considerations of carrying more metadata through the service chains and the control systems of the service chains. This metadata will contain sensitive information about the user and the environment in which the user is situated. This will require proper considerations in the design, implementation and operations of such environments to preserve the privacy of the user and also the integrity of the provided metadata.

6 IANA Considerations

This document has no actions for IANA.

7 Acknowledgements

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