4G EPC SPECIFICATIONS

Cumucore Private Mobile Network

About this document

This document provides a specification of the Cumucore 4G Core platform. It introduces the features and requirements of the platform, as well as provides an explanation how to integrate Cumucore with eNB

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Contents

1 Summary

Cumucore offers a 3GPP compliant Packet Core that includes 4G EPC. The Packet Core is designed using microservices for each of the functions defined in the 4G architecture. The system can be deployed in bare metal or virtualized platforms (e.g. OpenStack, Kubernetes) and provides a unique framework to build industrial and private networks. The design is focused on flexibility, cost reduction and efficiency leveraging the advantages of Network Function Virtualization (NFV).

2 Components and interfaces

4G EPC

The 4G EPC consists of 3GPP Rel15 compliant Mobility Management Entity (MME), Serving Gateway (S-GW) and PDN Gateway (P-GW) network nodes and customized Home Subscriber Server (HSS).

IMS

All IMS SIP Server external interfaces are 3GPP compliant. Cumucore IMS SIP Server design is based on containers. This architecture provides an opportunity to use 3rd party developed functions when needed and new NFVs can be developed independently from Cumucore.

NB-IoT

The EPC also includes NB-IOT compliant with 3GPP Rel13 and supports Cellular optimized IoT (CIoT) with SCEF module to deliver sensor data to application processing.

All the supported EPC modules and interfaces are included in Figure 1

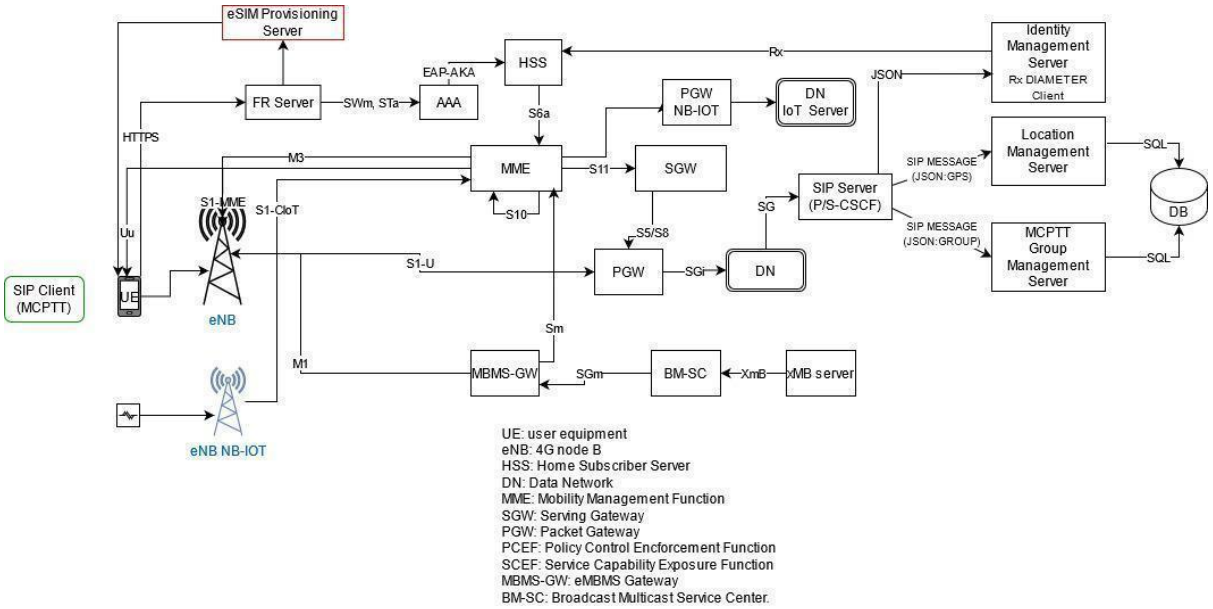

Figure 1. EPC architecture and interfaces.

3 Cumucore's SDN Mobile Backhaul Orchestrator

Cumucore's proprietary SDN Mobile Backhaul Orchestrator (MBO) integrates SDN to dynamically manage network resources in the backhaul to deploy network slices. The MBO provides an SDN component connected directly to eNB/gNB to encapsulate GTP-U into Ethernet, MPLS or GRE. The MBO manages the SDN switches in the backhaul as shown in Figure 3. It registers into the NRF so it can be discovered by AMF that will indicate the TEIDs to be encapsulated into specific VLAN or MPLS tags for routing the traffic as part of selected slices.

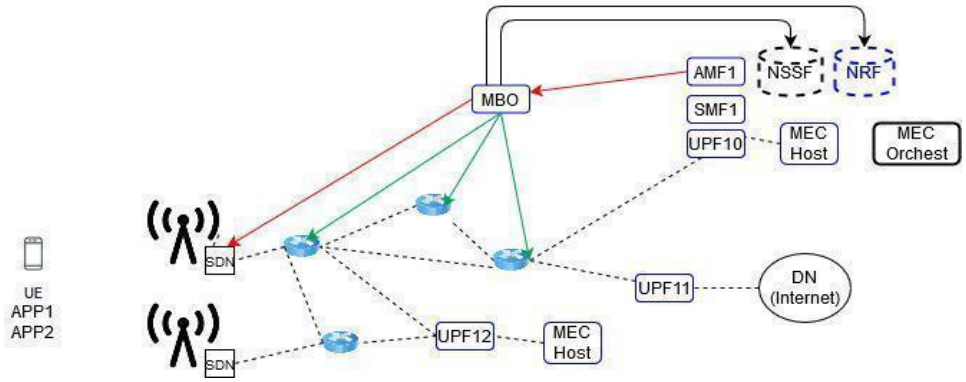

Figure 3. 5GC architecture integrated with SDN Mobile Backhaul Orchestrator.

The MBO includes machine learning function that based on user data collected through LLDP from SDN switches will calculate disjoint paths using Dijkstra. The MBO takes into use the disjoint path when congestion or link break is detected to deliver reliable and low latency communication for selected users i.e. IMSI/TEIDs. The graph in Figure 4 shows that 5GC architecture integrated with SDN MBO including NRF and NSSF for network slicing delivers Ultra Reliable Low Latency Communications despite broken links or network congestion.

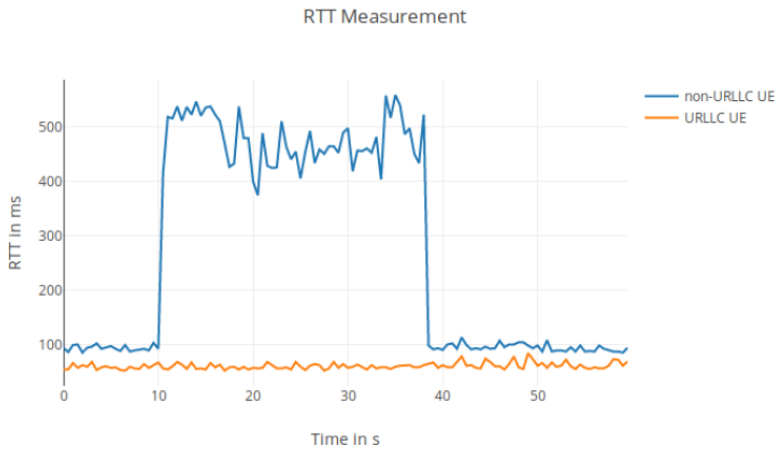

Figure 4. Round Trip Time (RTT) results of network congestion impact to URRLC traffic with MBO managed slices.

4 Security

Cumucore 5G security solutions have following areas

- Inter NF communication security. HTTP2 protocol is used as base protocol for messaging with payload message data modelled using JSON.
- SSH / console access to operating system level running network functions
- WebUI user protocol security when used for configurations of the 5G Core.
- OS level firewall protection of the deployment platform
- 5G SIM security
- Userplane data security
- Database encryption
- Known attack type prevention mechanisms (DoS, SQL injections, etc)

5 Supported features August 2024, release 4.3

3GPP R16

- MME
- HSS
- UPF
- IMS

NG signalling transport

- 3GPP release version R15.2.0 (2019-07)
- Data link layer
- Ethernet
- IP layer
- Support of IPv4
- Support of IPv6
- Support of Diffserv Code Point marking
- Transport layer
- SCTP (IETF RFC 4960 [2])
- configuration with a single SCTP association per NG-RAN node/AMF pair

configurations with multiple SCTP endpoints per NG-RAN node/AMF pair

Data transport

3GPP release version R15.2.0 (2019-07)

Data link layer

Ethernet

DPDK

NG Interface user plane protocol

"General -> transport protocol stack: GTP-U protocol over UDP over IP "

GTP-U

UDP/IP

support of fragmentation and assembly of GTP packets at IP layer

Support of IPv4

Support of IPv6

Diffserv code point marking

NG Application Protocol (NGAP)

3GPP release version R15.3.0 (2019-03)

PDU Session Management Procedures

UE Context Management Procedures

UE Mobility Management Procedures

Paging Procedures

Transport of NAS Messages Procedures

Interface Management Procedures

Warning Message Transmission Procedures

NRPPa Transport Procedures

Trace Procedures

Location Reporting Procedures

UE TNLA Binding Procedures

UE Radio Capability Management Procedures

Data Usage Reporting Procedures

PDU Session User Plane protocol

- 3GPP release version R15.1.0 (2018-09) and R15.2.0 (2018-12)

Elementary procedures

- Transfer of DL PDU Session Information
- Transfer of UL PDU Session Information
- Elements for the PDU Session user plane protocol

General

- Frame format for the PDU Session user plane protocol
- DL PDU SESSION INFORMATION (PDU Type 0)
- UL PDU SESSION INFORMATION (PDU Type 1)
- Coding of information elements in frames
- PDU Type (Default bearer, dedicated bearer)
- QoS Class Identifier (QCI)
- Reflective QoS Indicator (RQI)

Padding

- Paging Policy Presence (PPP)
- Paging Policy Indicator (PPI)

6 Available interfaces

Interface	Elements involved	Status	Implementation features	Note
S1-MME	gNB-MME	Exist		
S1-U	gNB-S/PGW	Exist		
S11	MME-SGW	Exist		
S10	MME-MME	Exist	S10 based tracking area update without SGW relocation supported.	
S6a	MME-HSS	Not exist		
S5	SGW-PGW	Exist	Instead of S5, N4 is used for communication between the SGW and the UPF(PGW)	
SGi	PGW-DN	Exist		
Gx	PGW-PCRF	Not exist		

7 Cumucore computing requirement

Minimum hardware requirements for running Cumucore 4G/5G cores:

Resource	4G (EPC)
RAM DDR	4 GB
Hard drive	10 GB min, 100 GB recommended
Processor	4 core 64 bits AVX in CPU for Mongo DB 7.0
NIC	3 x 1/10Gbs Tested with Intel NIC
OS	Ubuntu 22.04 Linux with mainline LTS 6.6+ features

Table 1 Cumucore HW requirements

- The hardware system that runs the EPC requires at least three interfaces.
- The first interface (e.g. enp2s0) is used to connect the EPC to the Radio Access Network (RAN).
- The second interface (e.g., enp3s0) connects the EPC with Packet Data Network (PDN) that can be private or public Internet based network.
    - The enp3s0 interface can have an IP address from the DHCP server or the IP address can be assigned manually as well (Depending on whether the user has a DHCP connection attached or not during installation).
    - The default route should be through this interface. Loopback addresses are also in use by the EPC. NAT (for outgoing traffic on enp3s0 interface) and IP forwarding is enabled.
- The third interface (e.g., enp1s0) for management purposes (e.g. ssh connectivity).
- Cumucore can run on Virtual Machines.