



4G EPC PACKET CORE SPECIFICATIONS

Cumucore Private Mobile Network

About this document

This document provides an overview of the Cumucore 4G EPC. It introduces 3GPP compliance, main features and environment requirements of the EPC

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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

2.1 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).

2.2 NB-IoT

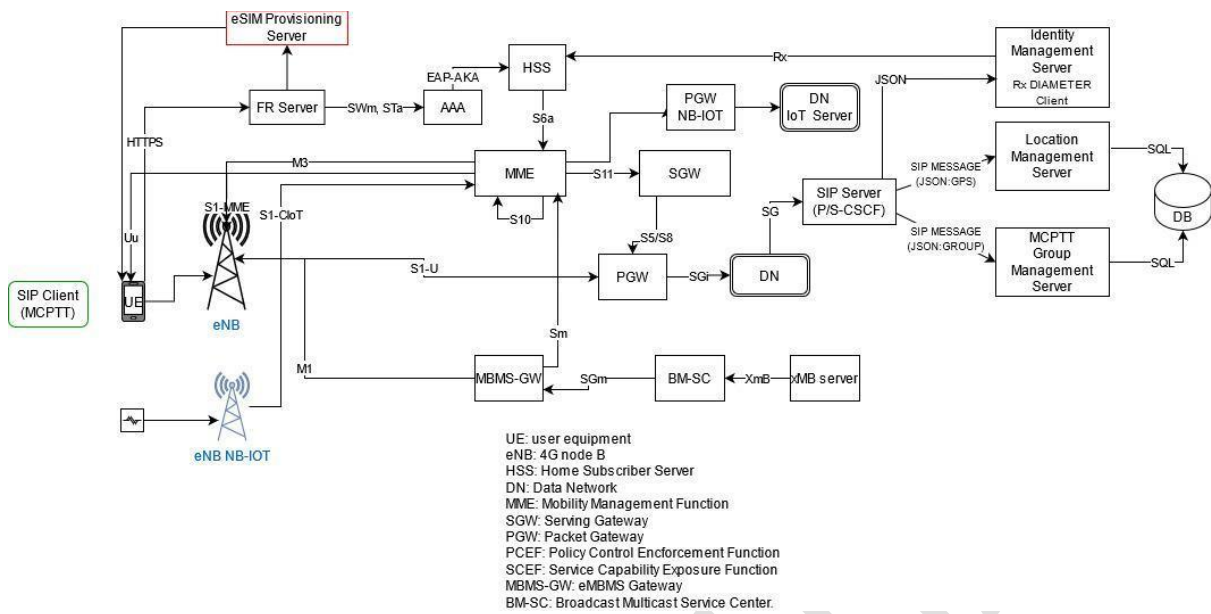
The EPC also includes NB-IOT compliant with 3GPP Rel13 and supports Cellular optimized IoT (CIoT) with SCEF module to deliver sensor data to application processing.

2.3 eMBMS

The EPC also includes eMBMS which consists of a BM-SC and a MBMS-GW. The EPC also includes the xMB interface to simplify the access to eMBMS system functionalities for the content providers and broadcasters. The standardized xMB interface defined in 3GPP Rel16 allows to establish a media broadcast service through an application programming.

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

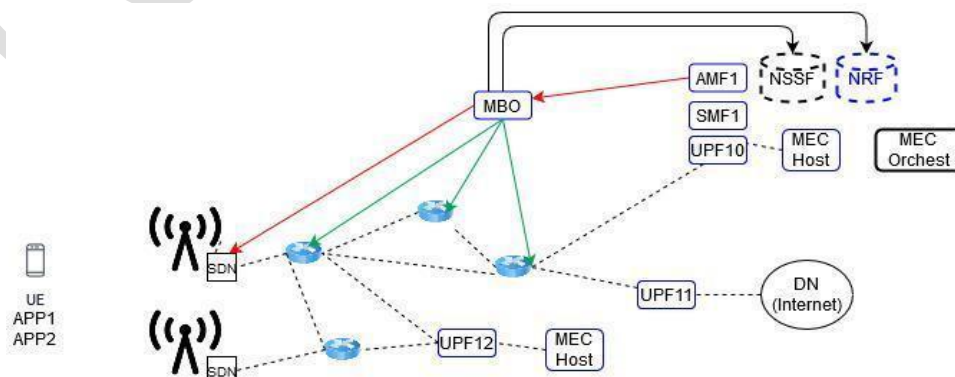
Figure 1. EPC Architecture and interfaces



3 Cumucore's SDN Mobile Backhaul Orchestrator

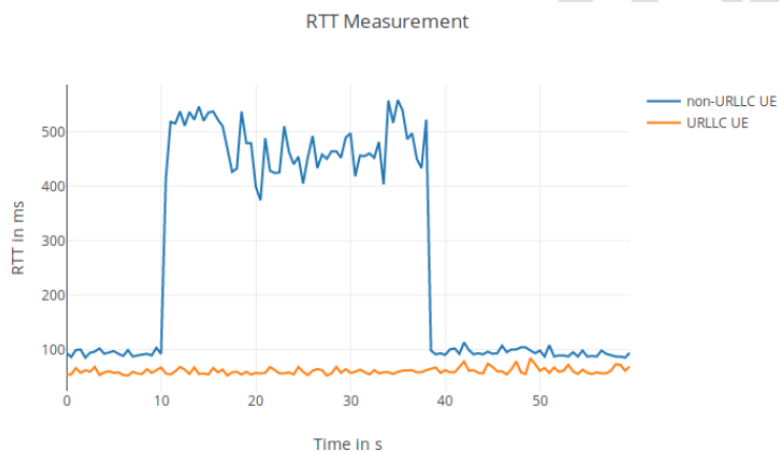
Cumucore's proprietary SDN Mobile Backhaul Orchestrator (MBO) integrates SDN to dynamically manage network resources in the backhaul to deploy network slices. The MBO provides an SDN component connected directly to eNB/gNB to encapsulate GTP-U into Ethernet, MPLS or GRE. The MBO manages the SDN switches 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 2. 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 3. Round Trip Time (RTT) results of network congestion impact to URLLC traffic with MBO managed slices



3.1 Security

The 4G EPC can be configured with IPSec to secure the connection between RAN and Core network elements.

3.2 Supported features June 2022

3.2.1 3GPP R16

- MME
- HSS
- UPF
- IMS

3.2.2 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

3.2.3 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

3.2.4 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

3.2.5 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)
- Spare
- QoS Class Identifier (QCI)
- Reflective QoS Indicator (RQI)
- Padding
- Paging Policy Presence (PPP)
- Paging Policy Indicator (PPI)

4 Available interfaces

Table 1. 4G EPC 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			

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

Table 2. Minimum hardware requirements

Resource	4G (EPC)
RAM DDR	4 GB
Hard drive	10 GB min, 100 GB recommended
Processor	4 core 64 bits
NIC	2 x 1Gbs Tested with XYZ
OS	Ubuntu 22.XZ

The hardware system that runs the 4 EPC requires at least two interfaces.

- The first interface (e.g. enp2s0) is used to connect the 4G EPC to the Radio Access Network (RAN).
- The second interface (e.g., enp3s0) connects the 4 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 4G EPC. NAT (for outgoing traffic on enp3s0 interface) and IP forwarding is enabled.
- The 4 EPC has another interface (e.g., enp1s0) for management purposes (e.g. ssh connectivity).

Cumucore EPC can be run on Virtual Machines.