5G NC SPECIFICATIONS

Cumucore Private Mobile Network

About this document

This document provides a specification of the Cumucore 5G Core platform. It introduces the features and requirements of the platform, as well as provides an explanation how to integrate Cumucore with gNB

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Summary

Cumucore offers a 3GPP compliant Packet Core that includes 5G NC. The Packet Core is designed using microservices for each of the functions defined in the 5G architecture. The system can be deployed in bare metal, virtual servers or Kubernetes container environments providing a unique framework to build private mobile networks. The design is focused on flexibility, cost reduction and efficiency leveraging the advantages of Network Function Virtualization (NFV).

Components and interfaces

The 5GC is 3GPP Rel16 compliant and includes the modules depicted in Figure 1.

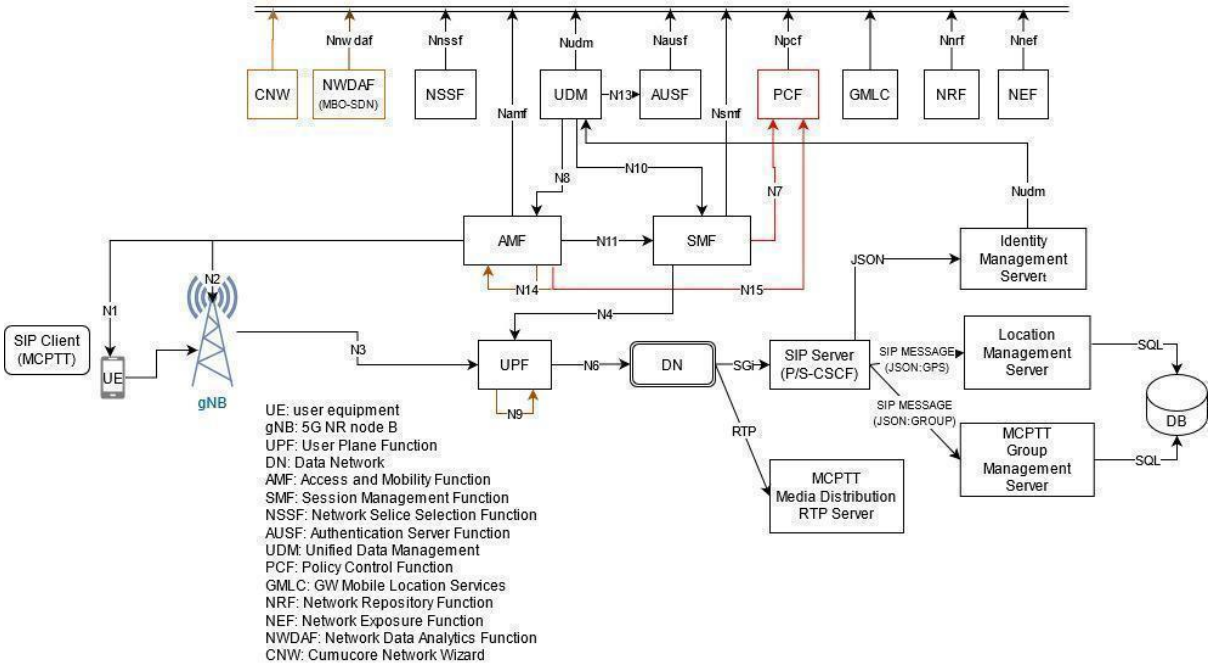

Figure 1 5GC Architecture and interfaces

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.

Cumucore's SDN Mobile Backhaul Orchestrator

Cumucore's standard compliant NETCONF based 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 transport network to assign different priorities to different slices or UEs based on the DSCP or VLAN tag values assigned in the eNB/gNB to encapsulate GTP-U. The MBO manages the SDN switches in the backhaul as shown in Figure 3. It registers into the NRF as standard Transport Network Slice Subnet Network Function (TN-NSSF) so it can be discovered by NSSF or network orchestrator to prioritize traffic encapsulated by eNB/gNB into specific VLAN or MPLS tags for routing the traffic as part of selected slices.

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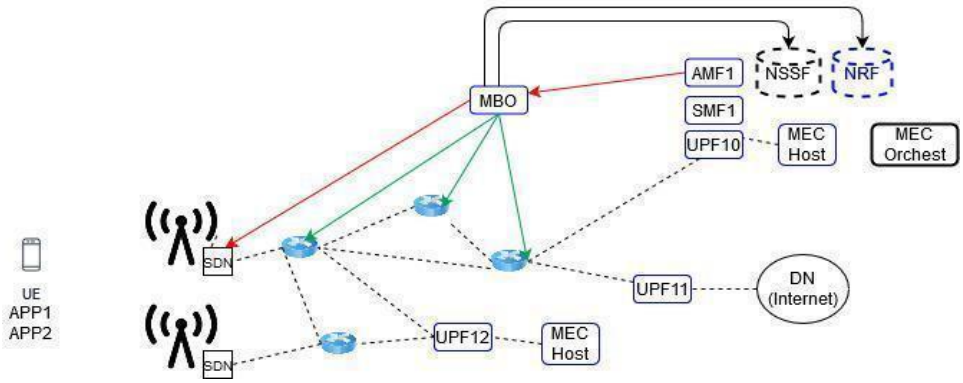

Figure 3. 5GC architecture integrated with SDN Mobile Backhaul Orchestrator.

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.

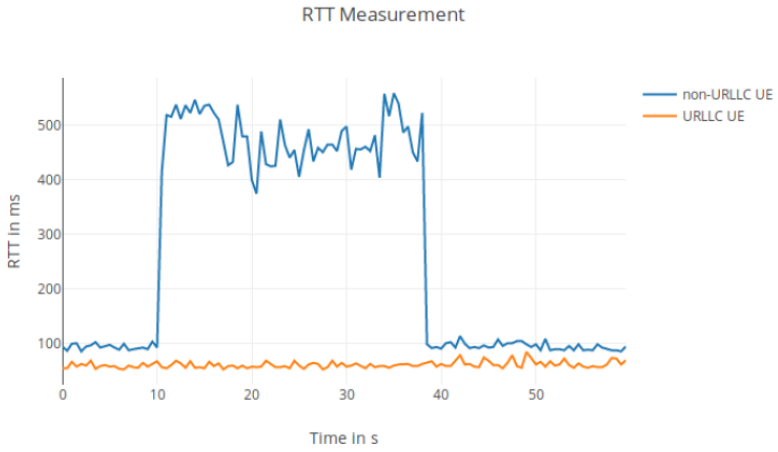

Figure 4. Round Trip Time (RTT) results of network congestion impact to URRLC traffic with MBO managed slices.

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5G NC Functionality

5G NC includes all the required functionality for interoperability with 3GPP Rel 16 and has been tested with different RAN vendors. The current release of 5 NC includes the network functions from Service Based Architecture (SBA) required for supporting network slicing i.e. Network Slice Selection Function (NSSF) and discovery of Multi-Access Edge Computing (MEC) through the Network Repository Function (NRF).

Network Slicing Manager

The Network Slicing Manager is integrated with the Cumucore Network Wizard that includes a Graphical interface for managing the network. Delivering several virtual networks from one physical network is enabled by Network Slicing Manager. Network Slicing Manager can define slice sizes, different quality of service per slice, traffic rules per slice including prioritization and pre-emption rules. Through Network Slicing Manager you can manage access right to the network slices in the multitenant use case.

Security

Cumucore 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 EPC.

OS level firewall protection of the deployment platform

SIM/eSIM security

User plane data security

Database encryption

Known attack type prevention mechanisms (DoS, SQL injections, etc)

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Implemented features and interface release 5.6

Interface	Elements involved	Status	Implementation features	Note
N1	AMF - UE	Exist		
N2	AMF - gNB	Exist		
N3	UPF - gNB	Exist		
N4	SMF - UPF	Exist	PDU session management for NSA/SA Session reporting for RTT delays to UEs	delay measurements still WIP
N5	PCF - AF	Exist	Internal AF	Planned for SA5.5
N6	UPF - DN	Exist		
N7	SMF - PCF	Exist	SMPolicy control APIs Qos monitoring feature implemented	
N8	AMF - UDM	Exist	Fetch AM subscription data	
N9	UPF- UPF	Not exist		
N10	SMF - UDM	Exist	Subscriber Data management APIs	
N11	AMF - SMF	Exist	Supports creation, deletion, release, modification of single PDU session per UE	
N12	AMF - AUSF	Exist	UE Authentication	

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N13	AUSF - UDM	Exist	UE Authentication	
N14				
N15	AMF - PCF	Exist	Missing: Notifications	
N22	AMF - NSSF	Exist	NSSAI Availability NS Selection	
N23	PCF - NWDAF	Exist		
N24	hPCF - vPCF	Not exist	Interface between home and visited PCF in roaming architecture	
N27	hNRF - vNRF	Exist	Interface between home and visited NRF in roaming architecture	
N28	PCF - CHF	Not exist		Charging function is not in the strategy
N29	NEF - SMF	Exist		
N30	PCF - NEF	Exist	External AF to request 2nd flow	
N31	hNSSF - vNSSF	Not exist		
N32	hSEPP - vSEPP	Exist	Reference point between SEPP in the visited network and the SEPP in the home network. Roaming architecture	
N33	NEF - AF	Exist		
N34	NSSF - NWDAF	Not exist		

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N36	UDR - PCF	Exist		
N51	AMF - NEF	Not exist		
N52	NEF- UDM	Not exist		
…				
N58	AMF - NSSAAF	Not exist		
N59	UDM - NSSAAF	Not exist		
Namf	AMF	Exist	‘N1N2MessageTransfer' service of 'Namf_Communication Service’ is implemented to enable the SMF: To setup N3 tunnel when the UE is in Idle mode. To setup PDU session when the UE requests for it To release PDU session 'N1N2Transfer Failure Notification' service of 'Namf_Communication Service’ is implemented. It is used by the AMF to notify the SMF when it failed to transfer the messages from the SMF to the UE and/or gNB.	
Nsmf	SMF	Exist	Create SM context, Update SM context and Release SM context service operation of 'Nsmf_PDUSession Service’ are implemented. All this services could only be used for managing a single PDU session per UE.	
Nudm	UDM	Exist		
Nausf	AUSF	Exist		

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Nnrf	NRF	Exist		
Nnef	NEF	Exist		

Supported features August 2024, release 5.6

Platform

UE Registration

Subscriber management

Mobility management (handover support)

Roaming (SEPP access to home UDM)

Single frequency SA network

Dynamic subscriber dataflow profiles

Multiple dataflows for single UE with each dataflow own Qos parameters

Standard 5QI handling

Operator specific 5QI handling

Traffic type level inspection and classification

PTP Time synchronization data transfer in signalling

Ethernet PDU for 5GLAN, TSN

Network deployment

Server Image based deployment

VM Based deployment

Container based deployment

Local server deployment

Cloud server deployment

Network Slicing

User profile based - Static slice support

User dynamic dataflow - dynamic slice support

NSM Application Function with GUI

NRF

NF registration

NF Heartbeat

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Container image

UDM

User profile data

Container Image

UDM-HSS integration

User Interface

Network configuration application

Static IP-address

Multioperator

User & data profile configuration application

Slicing manager (NSM-AF)

Network monitoring application

5GLAN, TSN User Interface

Scaling & high availability

Mongo DB Clustering 2+3

UPF Scaling

AMF & SMF scaling + HA

MEC

Discovery UPF closer to UE for running MEC

Deploy MEC connected to UPF (N6)

NEF

Resource block utilization reporting

UE MCI usage reporting

Packet error rate reporting

UE Cell location reporting

SDN Management

MBO 3GPP Network Function profile

VLAN CRUD

DSCP Marking configurations

NETCONF support for SDN switch management

NETCONF mmWave and THZ FWA transport modem management

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5G LAN Features

Local breakout (gNB site local UPF)

5G LAN management (eg. IP addressing)

Time sensitive networking

TSN

TSN-AF

UPF NW-TT

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Cumucore computing requirement

Minimum hardware requirements for running Cumucore NC:

Resource	5G (NC)
RAM DDR	8 GB
Hard drive	10 GB min, 100 GB recommended
Processor	8 core 64 bits AVX in CPU for Mongo DB 7.0
NIC	1 x 1Gbps and 2 x 10Gbps Tested with Intel NIC
OS	Ubuntu 22.04 Linux with mainline LTS 6.6+ kernel features

Table 1 Cumucore HW requirements

- The hardware system that runs the NC requires at least three interfaces.
- The first interface is used to connect the NC to the Radio Access Network (RAN).
- The second interface connects the NC with Packet Data Network (PDN) that can be private or public Internet based network.
    - This 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 this interface) and IP forwarding is enabled.
- The third interface is used for management purposes (e.g. ssh connectivity).
- Cumucore can run on virtual machines.

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