# 5G NC SPECIFICATIONS

*Cumucore Private Mobile Network*

## About this document

This document provides an overview of the Cumucore 5G NC. It introduces 3GPP compliance, main features and environment requirements of the NC

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June 2023

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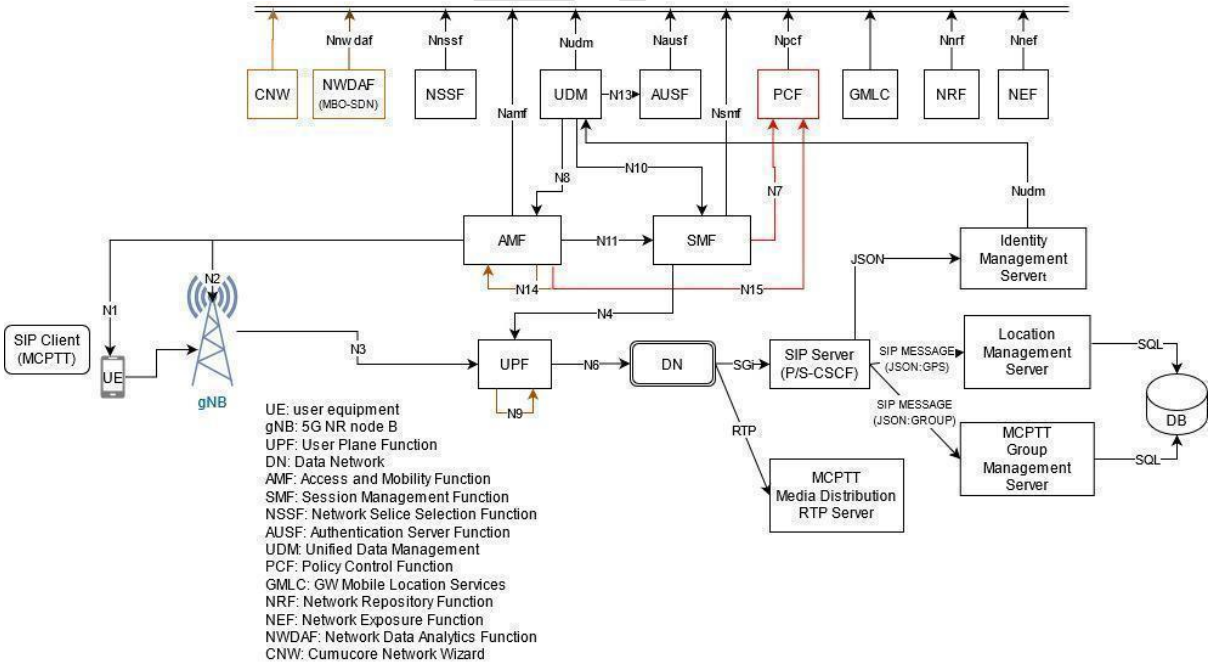
# 1 Summary

Cumucore offers a 3GPP compliant 5G NC Packet Core supporting 5G SA functionality. 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 or virtualized platforms (e.g. OpenStack, OpenShift and 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

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

*Figure 1. 5GC Architecture and interfaces*



# 3 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).

# 4 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.

# 5 Security

The 5G NC can be configured with IPSec to secure the connection between RAN and Core network elements.

The 5G NC security includes the following levels of authentication.

- Primary authentication: This is mandatory and currently implemented in 5 NC for mutual network and device authentication. 5 NC includes the 5G Authentication and Key Agreement (5G-AKA) and Extensible Authentication Protocol (EAP)-AKA. 5 NC uses EAP-AKA for device authentication in non-3GPP technology such as IEEE 802.11 WLANs. The EAP-AKA is also used for device provisioning for devices with eSIM e.g. Apple devices.
- Secondary authentication: This is optional and used for authentication with data networks outside the mobile operator domain. This feature is not currently implemented by Cumucore.
- Service Based Architecture (SBA): The 5 NC is based on a service-based architecture using TLSv2 with OAth.

# 6 3GPP R16 Implemented functions and interfaces

*Table 1. Supported Interfaces*

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

| | | | | |
|---|---|---|---|---|
| N13 | AUSF - UDM | Exist | Feature:<br>· UE Authentication | |
| N14 | | | | |
| N15 | AMF - PCF | Exist | Missing:<br>Notifications | |
| N22 | AMF - NSSF | Exist | Feature:<br>· NSSAI Availability<br>· 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 | Not exist | | |
| N30 | PCF - NEF | Not exist | | |
| 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 | Not exist | | |
| N34 | NSSF - NWDAF | Not exist | | |
| 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:<br>· To setup N3 tunnel when the UE is in Idle mode.<br>· To setup PDU session when the UE requests for it<br>· To release PDU session<br>'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 | | |
| Nnrf | NRF | Exist | | |
| Nnef | NEF | Not exist | | |

# 7 Cumucore 5.4 features June 2022

## 7.1 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

## 7.2 Network deployment

- Server Image based deployment
- VM Based deployment
- Container based deployment
- Local server deployment
- Cloud server deployment

## 7.3 Network Slicing

- User profile based - Static slice support
- User dynamic dataflow - dynamic slice support
- NSM Application Function with GUI

## 7.4 NRF

- NF registration
- NF Heartbeat
- Container image

## 7.5 UDM

- User profile data
- Container Image
- UDM-HSS integration

## 7.6 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

## 7.7 Scaling & high availability

- MySQL Clustering 2+3
- UPF Scaling
- AMF & SMF scaling + HA

## 7.8 MEC

- Discovery UPF closer to UE for running MEC
- Deploy MEC in UPF

## 7.9 NEF

- Resource block utilization reporting
- UE MCI usage reporting
- Packet error rate reporting
- UE Cell location reporting

## 7.10 SDN Management

- MBO 3GPP Network Function profile
- VLAN CRUD
- DSCP Marking configurations
- OVS API support for SDN switch management
- XXX protocol for router management
- NETCONF THZ Modem management

## 7.11 5G LAN Features

- Local breakout ( gNB site local UPF)
- 5G LAN management (eg. IP addressing )

## 7.12 Time sensitive networking

- TSN
- TSN-AF
- UPF NW-TT

## 7.13 Minimum hardware requirements for running Cumucore 5G NC:

*Table 2. Minimum Hardware requirements*

| Resource | 5G (NC) |
|---|---|
| RAM DDR | 8 GB |
| Hard drive | 10 GB min, 100 GB recommended |
| Processor | 4 core 64 bits |
| NIC | 2 x 10Gbs<br>Tested with XYZ |
| OS | Ubuntu 22.XZ |

The hardware system that runs the 5 NC requires at least two interfaces.

- The first interface (e.g. enp2s0) is used to connect the 5 NC to the Radio Access Network (RAN).
- The second interface (e.g., enp3s0) connects the 5 NC with Packet Data Network (PDN) that can be a 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 5 NC. NAT (for outgoing traffic on enp3s0 interface) and IP forwarding is enabled.

- The 5 NC have another interface (e.g., enp1s0) for management purposes (e.g. ssh connectivity).

Cumucore 5G NC can be run on AWS or Azure Virtual Machines. OpenShift and OpenStack container environments are supported.

**Example 1.** Network implementation on VM

**Example 2.** Network implementation on OpenShift