GTI
Sub-6GHz 5G Core Network

GTI Sub-6GHz 5G Core Network White Paper

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1 Introduction

In recent years, 4G has profoundly changed our daily life, and stimulate people's desire for higher performance and better user experience for more innovative services and applications. Towards 2020, the mobile communication will rapidly penetrate to more and more elements of the human's daily life and the society's operation, which will create the opportunities for the mobile industry and other vertical industries. With the new capabilities, e.g. extremely high data rate, extremely low latency and extremely high reliability, massive connection and traffic density, the 5th generation mobile communication technology (5G) will shine a light on the great change on both our daily life and the whole society's operation.

Targeting for commercial launch of 5G in 2020, the global telecommunication operators, network, chipset and device vendors, test instrument manufacturers and solution providers are deeply involved to promote end-to-end maturity of standard and industry. 5G technology development and trial activities comprise some main phases, such as Key technology feasibility validation, Prototype development and trials, Pre-commercial product development, Lab tests and Field trials for pre-commercial and commercial product, Commercial Launch and so on.

In the face of 5G services and market trends, there are many key capabilities and performance indicators for 5G network, base station and device. And there are also challenges for 5G Core Network Design and Implementation, so 5G Core Network Whitepaper is necessary to define the technical requirements for 5G Device and direct the research and analysis on key points. GTI encourages the industry partners to participate the 5G activities and work together to make contributions to the 5G Corer Network White Paper.

2 Abbreviations

Abbreviation	Explanation
AMF	Access and Mobility Management Function
AUSF	Authentication Server Function
BGCF	Border Gateway Control Function
DC	Dual Connectivity
DN	Data Network
(R)AN	(Radio) Access Network
CN	Core Network
IBCF	Interconnection Border Control Function
HSS	Home Subscriber Server
IMS	IP Multimedia System
MGCF	Media Gateway Control Function
NG-RAN	Next Generation-AN
NSSF	Network Slice Selection Function
N3IWF	Non-3GPP InterWorking Function
PCF	Policy Control Function
QoS	Quality of Service
SMF	Session Management Function
SSC	Session and Service Continuity
UDM	User Data Management
UPF	User Plane Function
TAS	Telephony Application Server

3 References

[1] TS23.501 System Architecture for the 5G System, Stage 2 (Release 15)

[2] TS23.502 Procedures for the 5G System; Stage 2 (Release 15)

[3] TS23.503 Policy and Charging Control Framework for the 5G System; Stage 2 (Release 15)

[4] TS23.228 IP Multimedia Subsystem (IMS); Stage 2 (Release 15)

4 Key System Requirements and Network Architecture

This subsection will provide key system requirements of 5G Core Network:

- Different levels of UE mobility / service continuity.
- Separation of Control plane and User plane functions and flexible deployment of Control plane and user plane
- Service based architecture for control plane
- Deployment for edge computing.
- Common AN - CN interface for different Access Types e.g. 3GPP access and non-3GPP access
- QoS Flow based E2E QoS
- Voice over 5GS

5GS Network architecture consists of UE, AN, and the Core Network with separate Control Plane and user plane. The Control Plane in 5G core network is built based on Service Based Architecture (shown in Figure 1) which adopts principles like modularity, reusability and self-containment of network functions and is chosen to enable deployments to take advantage of the latest virtualization and software technologies.

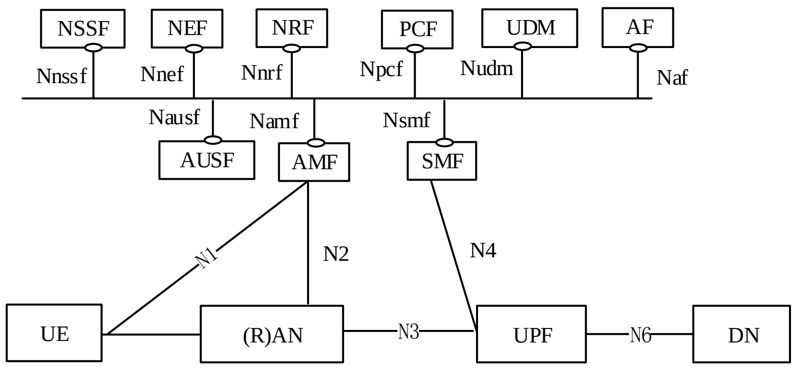

Figure 1 5G System architecture

In the service-based architecture, the NF Repository Function (NRF) provides service discovery between individual network functions. It maintains profiles of network function instances and their supported services (for example, function ID, function type, network slice identifiers, capacity information, supported services, and endpoint information such as IP addresses).

5 Key Functions

5.1 Separation of Control Plane and User Plane

5G system starts with separation of control plane and user plane, by doing this, the control plane could be more centralized and the user plane could be more distributed.

Separation of control plane and user plane can improve the flexibility in network deployment and network efficiency. The control plane, if centralized, could be made more intelligent by means of applying the unified policy, traffic management and connection management. The user plane can be deployed scale-in and scale-out flexibly based on e.g. the policy, throughout, access users, etc. The separation of Control Plane and User Plane allows independent function evolution and performance optimization.

5.2 Flexible and Efficient User Plane Selection

When the gateway functionality is split into Control Plane and User Plane, the user plane can be deployed in a flexible manner to achieve various performances. The user plane is selected by the control plane by considering different deployment scenarios such as centrally located UPF and distributed UPF located close to or at the Access Network site. The selection of the UPF shall also enable deployment of UPF with different capabilities, e.g. UPFs supporting no or a subset of optional functionalities. To ensure session and service continuity, the 5G System supports different modes as follows.

- With SSC mode 1, the network preserves the connectivity service provided to the UE. For the case of PDU Session of IPv4 or IPv6 type, the IP address is preserved.
- With SSC mode 2, the network may release the connectivity service delivered to the UE and release the corresponding PDU Session. For the case of IPv4 or IPv6 type, the network may release IP address(es) that had been allocated to the UE.
- With SSC mode 3, changes to the user plane can be visible to the UE, while the network ensures that the UE suffers no loss of connectivity. A connection through new PDU Session Anchor point is established before the previous connection is terminated in order to allow for better service continuity. For the case of IPv4 or IPv6 type, the IP address is not preserved in this mode when the PDU Session Anchor changes.

5.3 Edge Computing

Edge Computing, i.e. computing at the edge Clouds or distributed Clouds, is an approach of optimizing the Cloud Computing by moving data processing to the edge of networks. As the computing resource is closer to end consumers, it would significantly reduce required communication bandwidth and transmission latency between end users and the data center, especially for support of time sensitive services, while keeping opportunities for service providers to define their own services in the shared computing environment. Edge Computing can provide a unique computing environment to support 5G applications, and would become the convergence point of IT and CT industries.

Support of Edge Computing in 5GC enables operator's and 3rd party services to be hosted close to the UE's access point of attachment, so as to achieve an efficient service delivery through the reduction of end-to-end latency and load on the transport network.

The 5GC selects a UPF close to the UE and executes the traffic steering from the UPF to the local Data Network via a N6 interface. This may be based on the UE's subscription data, UE location, the information from Application Function (AF), policy or other related traffic rules.

The 5G Core Network may expose network information and capabilities to an MEC application. The functionality supporting for edge computing includes:

- User plane (re)selection: the 5G Core Network (re)selects UPF to route the user traffic to the local Data Network;
- Local Routing and Traffic Steering: the 5G Core Network selects the traffic to be routed to the applications in the local Data Network; this includes the use of a single PDU Session with multiple PDU Session Anchor(s) (UL CL / IP v6 multi-homing).
- Session and service continuity to enable UE and application mobility
- An Application Function may influence UPF (re)selection and traffic routing via PCF or NEF;
- Network capability exposure: 5G Core Network and Application Function to provide information to each other via NEF or directly.
- QoS and Charging: PCF provides rules for QoS Control and Charging for the traffic routed to the local Data Network;
- Support of Local Area Data Network: 5G Core Network provides support to connect to the LADN in a certain area where the applications are deployed.

5.4 Network Slicing

A network Slice is a logical network that provides specific network capabilities and network characteristics. A network slice is defined within a PLMN and shall include:

- The core network control plane and user plane network functions; and,
- The NG radio access network or the N3IWK functions for the non 3GPP access network.

A set of network function instances and required resources consist a network slice instance, which forms a deployed network slice.

Network slice may differ for supported features and network functions optimizations and have different S-NSSAIs with different Slice/Service Types. The operator can deploy multiple Network Slice instances delivering exactly the same features but for different groups of UEs, in which case such Network Slices may have different S-NSSAIs with the same Slice/Service Type but different Slice Differentiators.

The operators could decide whether different network slices are shared or isolated. There could be three deployments as:

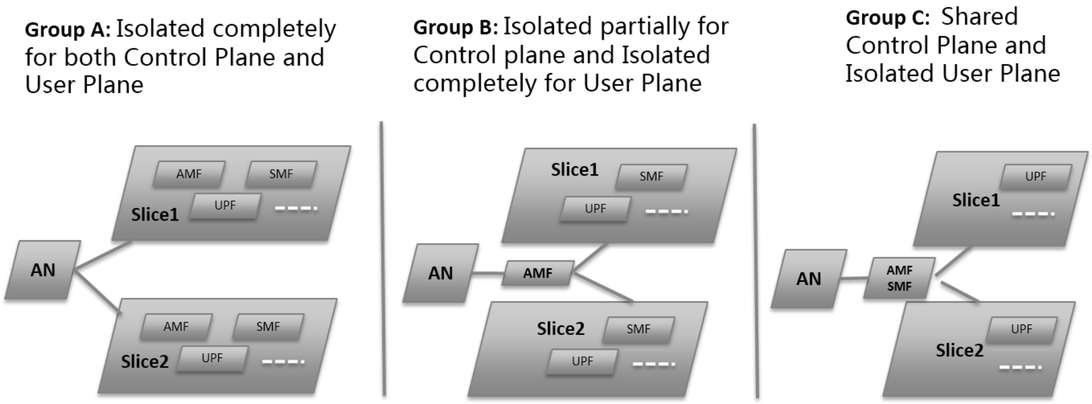

Figure 2 5G Network Slicing Deployment Example

The selection of the set of Network Slice instances for a UE is triggered by the first contacted AMF in a registration procedure normally by interacting with the NSSF, and can lead to a change of AMF. During the PDU session establishment, the AMF selects the SMF and the SMF select UPF based on the S-NSSAI provided by the UE.

5.5 QoS Framework

The new QoS model of the 3GPP 5G system provides an end-to-end QoS mechanism to enable differentiated data services to support diverse application requirements while using radio resources efficiently. The main functionalities are

- QoS Flow-based control, both GBR and Non-GBR QoS Flows are possible
- U-plane marking for QoS is carried in encapsulation header on N3 i.e. without any changes to the e2e packet header
- QoS signalling via N1 using QoS rules, via N2 using QoS profiles and via N4 using QoS Enforcement Rules
- A QoS Flow shall be created in RAN and a QoS rule shall be provided to the UE at PDU Session establishment.
- QoS Flows and/or QoS rules and QoS Enforcement Rules may be modified using PDU Session Modification procedure

  Main QoS parameters are:

  5QI (5G QoS Identifier)
  ARP (Allocation Retention Priority)
  Reflective QoS
  Notification Control
  Flow bit rate
  Aggregated bit rate
  Max Packet Loss Rate

5.6 Multiple Access

The mobile packet core has supported non-3GPP access (typically WiFi) for some years and recently a number of operators have deployed successful WiFi calling services using VoLTE core networks.

The demand in 5G Core Network is to develop an access-independent core network with a common user-plane access and, perhaps most importantly, a control-plane that can support common AAA and policy control (see Figure 3 for the non-roaming architecture with both 3GPP access and non-3GPP access). This is important for converged operators seeking to offer “follow-the-user” services across fixed and mobile access – for example, policy control and enforcement may need to be applied to a user moving between home WiFi and wide-area cellular.

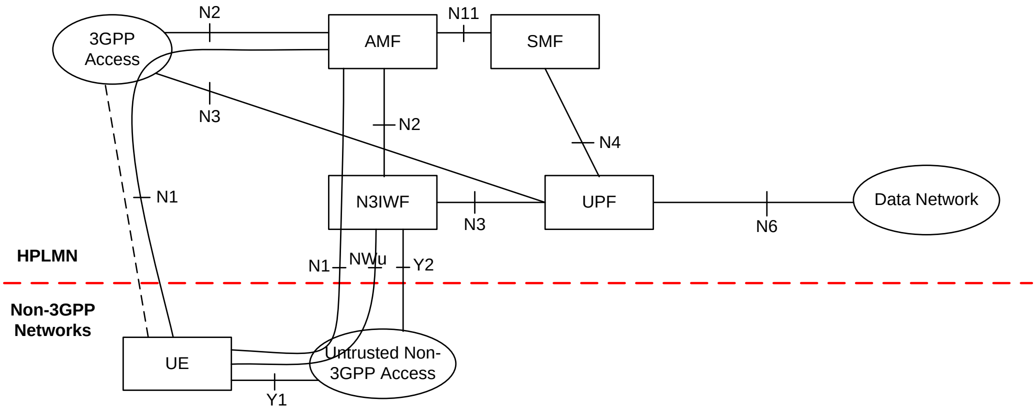

Figure 3 Non-roaming architecture for 5G Core Network with non-3GPP access

The UE can either register on both 3GPP and non-3GPP accesses or register on one access. For a given serving PLMN the same AMF serving for the UE except in the temporary situation i.e. after a mobility from EPS while the UE has PDU Sessions associated with non-3GPP access, and one common Registration Management context for each access, e.g. when the UE is consecutively or simultaneously served by a 3GPP access and by a non-3GPP access (via an N3IWF) of the same PLMN. When the UE is successfully registered to an access (3GPP access or Non-3GPP access respectively) and the UE registers via the other access via a PLMN different from the registered PLMN of the first access, a new AMF may be selected. UDM manages separate/independent UE Registration procedures for each access.

The CM state for 3GPP access and Non-3GPP access are independent of each other, i.e. one can be in CM-IDLE state at the same time when the other is in CM-CONNECTED state.

5.7 Interworking and Migration

5G core network provides connection to LTE access. The EPC also provides connection to a 5G NR via supporting Multi-RAT Dual Connectivity. Different operators can selection different deployment or migration options, considering the legacy network and UE with different capabilities. Such options may coexist at the same time within one PLMN. Figure X indicates various options as:

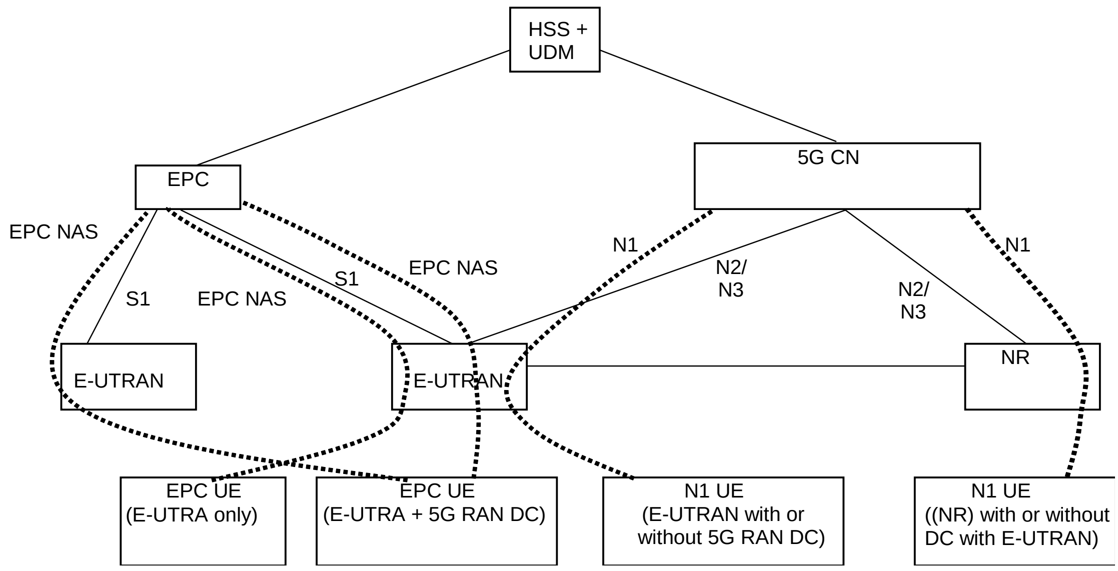

Figure 4 Interworking between 5GS and EPC/E-UTRAN

It is assumed that a UE that is capable of supporting 5GC NAS procedures may also be capable of supporting EPC NAS to operate in legacy networks e.g. in case of roaming. The UE will use EPC NAS or 5GC NAS procedures depending on the core network by which it is served.

In order to support smooth migration, it is assumed that the EPC and the 5GC have access to a common subscriber database, that is HSS in case of EPC and the UDM in case of 5GC.

5.8 IMS Voice

To allow the 5G system to interwork with the network entities serving IMS based services today, the PCF shall support the corresponding Rx procedures with P-CSCF and the UDM shall support the corresponding Sh procedures with TAS and Cx procedures with S-CSCF, as shown in Figure 5. This facilitates the migration from EPC to 5GC without requiring the existing network entities in the IMS network to upgrade to support the Service Based Interfaces in 5GC.

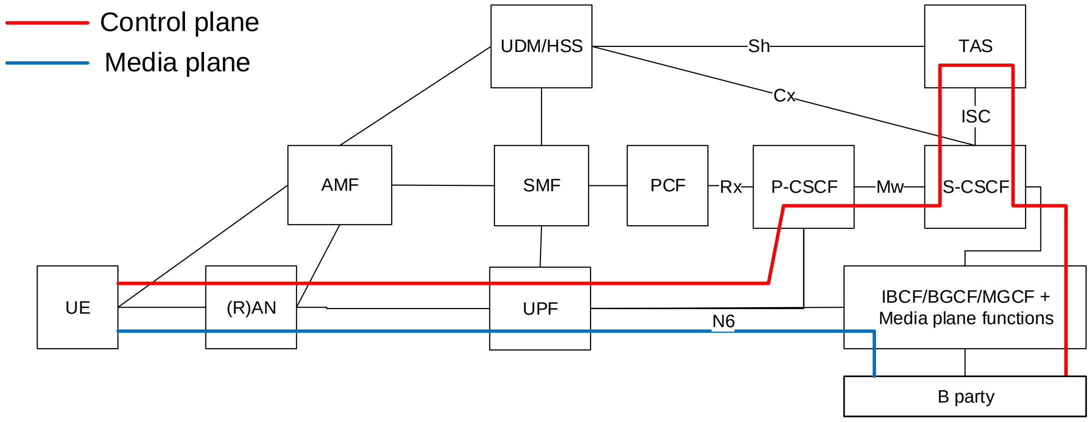

Figure 5 IMS Traffic in 5GS

The QoS framework in 5GS will fulfil the same QoS requirement for both IMS signalling and IMS media, e.g. voice or video services.