HOW SHOULD TECHNOLOGY IN MOBILE INFRASTRUCTURE BE RECONFIGURED OR REDESIGNED TO ACCOMMODATE THE DEMANDS OF 5G?

5G mobile and wireless networks have progressively developed in the last few years. The 5G network has the capability to enable the widest range of services and has compelling use cases in areas such as enhanced Mobile Broadband (eMBB), Ultra-Reliable and Low Latency Communication (URLLC), and massive Machine-Type Communication (mMTC). 5G also aims to offer a flexible platform for new use cases across multiple industries such as automotive, manufacturing, energy, health and entertainment.

5G architecture

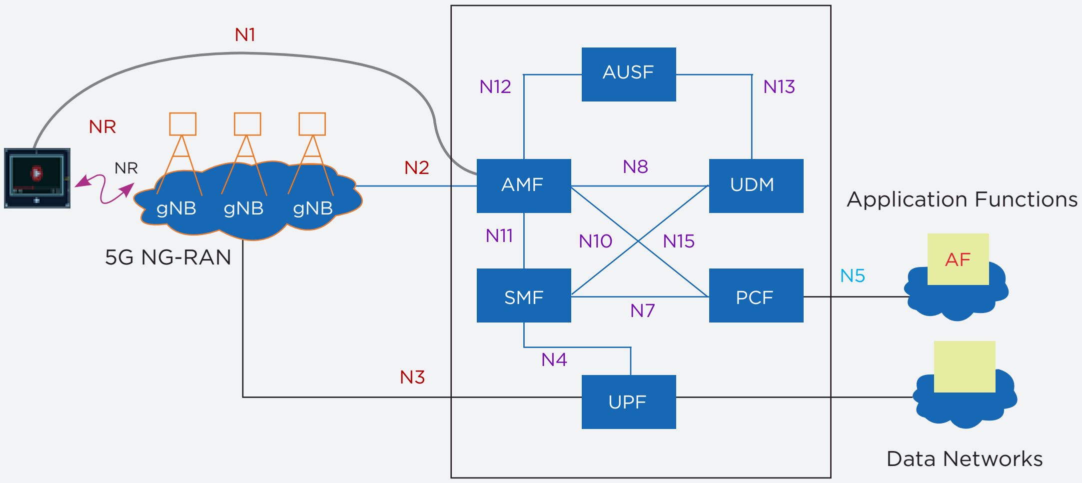
The 5G network will help industries to rapidly progress to new milestones with respect to mobility and ubiquitous connectivity. In supporting the communication needs of machine-to-machine applications, it will endeavour to make our life convenient and safe. The coexistence of human-centric as well as machine-type applications will force diverse functional and performance requirements to the forefront – all of which the 5G network will have to support.

In this context, two key technological enables are:

1. Virtualised network functions
2. Software-defined or programmable network functions (NFs) and resources.

To effectively deploy custom network services with different virtualised NFs, a scalable and service-centric analytics algorithm, complemented with a reliable security mechanism, will be needed.

5G Network Architecture



Network slicing

Network slicing is a specific form of virtualisation that allows multiple logical networks to run on top of a shared physical network infrastructure. 5G network slicing provides a future-proof framework conducive to the technological and business needs of various industries like automotive, manufacturing, energy, health and entertainment. Slicing needs to be done with an end-to-end perspective, across network domains (including core, transport and access) and the administrative domain (including management and orchestration).

These networks are designed to cater to a wider range of services under three groups, namely eMBB, mMTC and URLLC. These groups, which differ largely in their network service characteristics, provide new business opportunities for Communications Service Providers (CSPs). The performance requirements of these services in terms of data rate, latency, mobility, security, availability, reliability, QoS, capacity, coverage and other varying parameters, demand dynamic connectivity from the network.

The 5G environment brings new challenges in terms of timing (minimum) and agility, in addition to complex performance and business-related challenges. Timing refers to the speed of deploying innovative features on the network and bringing them to the user. In this context, tools such as SON, virtualisation and orchestration, which enable the rapid introduction of features, become a prerequisite.

5G network deployment options

With 5G, it is possible to integrate the technology elements of different generations into different configurations such as:

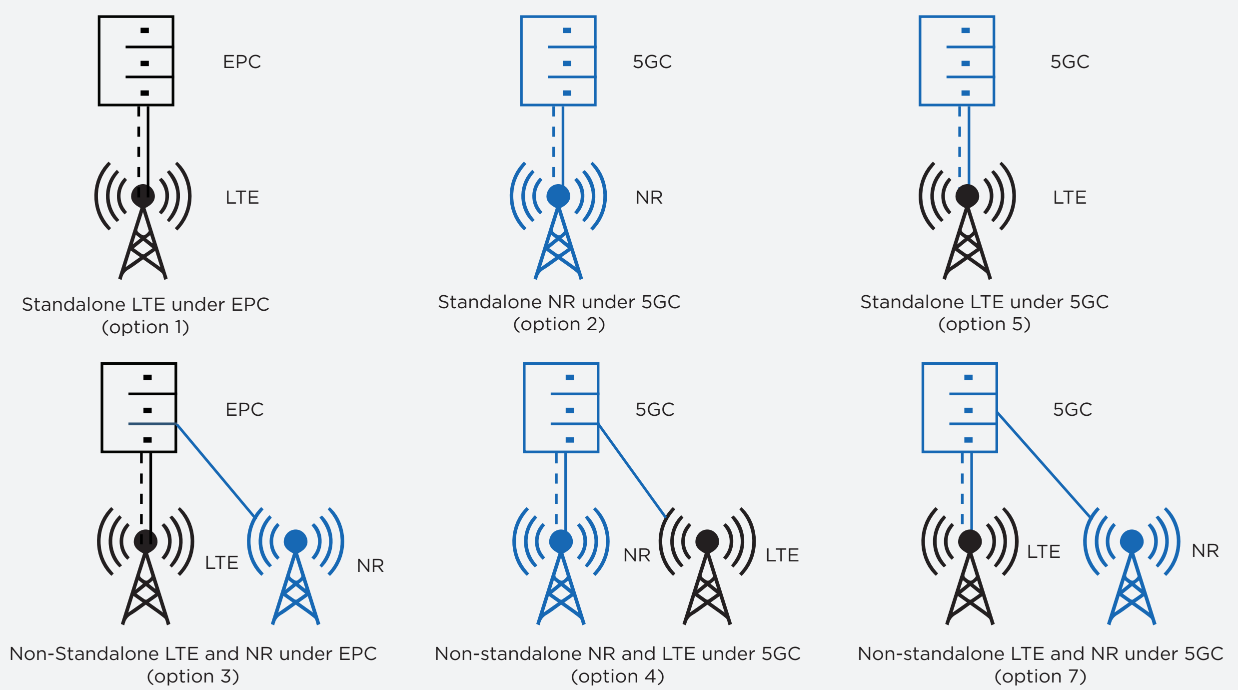
- Standalone (SA) networks, using only one Radio Access Technology (RAT)
- Non-standalone (NSA) networks, combining multiple RATs.

In SA, 5G New Radio (5G-NR) cells and the core network are operated alone. Deployment may be done as an independent network, using normal inter-generation handover between 4G and 5G for service continuity. In SA deployments, multi-RAT Dual Connectivity (DC) is not applicable, and only single RAT is used to connect user equipment to the relevant core network. Only same generation radio access elements are interconnected.

In NSA, which is a combination of NR cells and Long Term Evolution (LTE) radio cells using DC, the core network can be Evolved Packet Core (EPC) or 5G Core (5GC) as per the operator's choice. This solution requires tight interworking with LTE Radio Access Network (RAN). Multi-RAT dual connectivity will be employed in NSA deployment, where the user equipment will use radio resources by two distinct schedulers in two different nodes connected via non-ideal or ideal backhaul. The scheduler is located in the master and secondary nodes.

Currently there are three options of NSA that are defined in Third Generation Partnership Project (3GPP):

- Option 3 using EPC and LTE eNB (evolved B) acting as master and NR en-gNB (gNB = fifth generation node B) acting as secondary
- Option 4 using 5GC and an NR gNB acting as master and LTE ng-eNB acting as secondary
- Option 7 using 5GC and an LTE ng-eNB acting as master and an NR gNB acting as secondary



EPC and 5GC

5GC network deployment options are defined in 3GPP using either the existing EPC or 5GC. The design principle of both architectures are quite different from each other. EPC is, in many aspects, an evolution of the previous generation packet core network. On the other hand, 5GC is cloud native, inheriting several technology solutions used in cloud computing and virtualisation at its core.

Superior network slicing and QoS features are possible through 5GC. Other benefits, which 5GC would bring in, include separation of control- and user-plane functionalities, which adds flexibility in connecting users and supporting different access technologies.

Voice/video in 5G

IMS voice and video call will be supported in all the 5G deployment options . However, there are differences considering which core network and RAT is being used for media and Session Initiation Protocol (SIP) signalling in each of the options.

For option 3 (E-UTRAN (Evolved Universal Terrestrial RAN) NR DC), 4 (NR-E-UTRA DC) and 7 (Next-Gen or NG-RAN E-UTRA NR DC) where both NR and LTE can be used as RAT, the decision on which RAT is used for SIP signalling and media is made in the RAN.

Possible options for voice and video calls are as follows:
Solution1: IMS voice or video call via 5GC media and SIP signalling

Solution2: IMS voice or video call via 5GC media and SIP signalling
(In Option 2, LTE and/or NR via EPC using Master Cell Group, Secondary Cell Group and/or split bearer (controlled by E-UTRAN))

Solution 3: Circuit-Switched (CS) voice via MSC (Mobile Switched Centre)
(In Option 3, CSFB to 2G/3G CS – Devices currently attached to EPC may use this solution to initiate or terminate a voice or video call where the call is established on CS)

Multi-Access Edge Computing (MEC)

Originally called Mobile Edge Computing, the term Multi-Access Edge Computing has been adopted to highlight the ability of end-devices to connect through multiple access technologies.

To run application at mobile edge, MEC makes use of a virtualisation platform. The best locations for the servers are determined by the deployment scenarios. Proximity to user equipment considerably reduces turnaround time, which ensures low latency and improved network responsiveness. Data production and consumption at network edge enables the realisation of high-bandwidth applications.

CSPs can leverage the existing infrastructure to serve last-mile connectivity requirements, as well as to integrate NFV and SDN deployments in the core network.

Management and orchestration

Network slicing has evolved as a fundamental feature of emerging 5G systems. Operators are enabled to provide infrastructure (including the verticals) to customers, who can then resell it to their end-customers. The infrastructure, therefore, needs to be capable of hosting multiple tenants and distinguishing between different types of flexibility and control requirements.

Multi-tenancy support is at the heart of the slicing-based service model. A traditional Network Functions Virtualisation (NFV) infrastructure, based on full Virtual Machines (VMs) implementing Virtualised Network Functions (VNFs), may not be adequate to cover all the requirements of 5G networks. Different types of virtualisation technologies will need to coexist to fully exploit its potential, including full VMs and container-based virtualisations.

A generic management and orchestration system (MANO) architecture based on an NFV MANO extension is an underlying trend in the evolution of management plane architecture. Work has to be done to avoid a single, fixed placement/scaling/lifecycle management approach and rather allow individual algorithms to be used for each chain separately. The orchestrator then deals with resource conflicts and arbitrates, if necessary.

In conclusion, 5G is going to be all about the inclusion of vertical industries in the evolution of telecommunication. However, the footprints of verticals like automotive and industrial companies are not always within a single telecommunication network coverage area. Furthermore, specialised services specific to such verticals may require technical skills or components beyond the scope of a single operator. In such a scenario, operators will have to work together to create an ecosystem that sustains positive competition, while encouraging cooperation to meet the needs of end-customers.

Getting 5G-ready with TCTS

Tata Communications Transformation Services (TCTS) enables CSPs by easing network complexities and enabling versatility and scalability by virtualising networks as groundwork for 5G. TCTS designs network topologies that advance the rollout of new services with minimum network changes in reduced time; supports heterogeneous device ecosystems; and leverages converged fibre and wireless systems. TCTS' unique proposition is to offer radio network planning incorporating both business and technical aspects, based on high-resolution crowd-sourced data, 1m 3D modelling, integrated access and backhaul.
TCTS assists CSPs in 5G readiness by migrating to an all-IP network; implementing hetnets and cloud RANs; upscaling and redesigning the transport network (including fibre); virtualising networks using SDN and NFV (including network slicing and OSS orchestration).

TATA COMMUNICATIONS
TRANSFORMATION SERVICES

TATA

References

- GSMA: Road to 5G: Introduction and Migration," GSMA, Published April 2018, Accessed March 2019
- 5G; System Architecture for the 5G System (3GPP TS 23.501 version 15.2.0 Release 15)
- 5G PPP System architecture
- 3GPP TS 23.502 Procedures for the 5G System; Stage 2
- 3GPP TS 23.214 Architecture enhancements for control and user plane separation of EPC nodes

Vishwas Gera
Principal lead- Wireless Practice
Tata Communications Transformation Services (TCTS)

Vishwas Gera has over 16+ Years of experience in telecom wireless industry. He is currently leading RAN Product Solutions at Tata Communications Transformation Services (TCTS), which includes product and services around NG-RAN, C-SON, NextGen Network Planning, and Optimization. Prior to TCTS, he has worked with major OEMs like Ericsson, Huawei, and operators including Airtel, Idea Cellular and Vodafone in India and across the globe. He has a successful track record in End-to-End Wireless Network Design, RAN Solutions, Project Management and Consulting of VoLTE, LTE Advanced, UMTS, GSM and CDMA Network. Vishwas holds Bachelor of Engineering degree, and has been awarded multiple professional certifications, including Prince2 Practitioner, iBwave IBS Design, and NGN Planning.

About Tata Communications Transformation Services (TCTS)

Tata Communications Transformation Services Limited (TCTS), a 100% subsidiary of Tata Communications Ltd, provides leading business transformation, managed network operations, network outsourcing and consultancy services to telecom companies around the world. TCTS delivers operational efficiency, cost transformation and revenue acceleration solutions for all the stages of the carrier process life cycle, including but not limited tonetwork engineering and design, implementation and operations.

Email us
tcts.marketing@tatacommunications.com

www.tatacommunications-ts.com | @tata_tctsl