MCMC MTSFB TC G027:2023

TECHNICAL CODE

IMT-2020 (FIFTH GENERATION) - SYSTEM ARCHITECTURE AND SPECIFICATIONS (FIRST REVISION)

Developed by

Malaysian Technical Standards Forum Bhd

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MCMC

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Contents

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Foreword

This technical code for IMT-2020 (Fifth Generation) - System Architecture and Specifications ('this Technical Code') was developed pursuant to Section 95 and Section 184 of the Act 588 by the Malaysian Technical Standards Forum Bhd ('MTSFB') via its International Mobile Telecommunications and Future Networks Working Group.

This Technical Code shall replace the MCMC MTSFB TC G027:2021, IMT-2020 (Fifth Generation) - System Architecture and Specifications.

Major modification of this revision are as follows:

a) Adding 2 IMT-2020 Radio Interface Technologies (RITs) which are:

    i) 5Gi.

    ii) DECT 5G-SRIT.

b) Updating the existing 3GPP 5G-SRIT and 3GPP 5G-RIT up until 3GPP Rel-17 covering:

    i) Radio Access Network (RAN) functions.

    ii) Core network functions.

    iii) New Radio (NR) operating bands and frequency range.

    iv) 5G QoS flow and QoS identifier.

This Technical Code shall continue to be valid and effective from the date of its registration until it is replaced or revoked.

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IMT-2020 (FIFTH GENERATION) – SYSTEM ARCHITECTURE AND SPECIFICATIONS

0. Introduction

This Technical Code refers to the IMT-2020 system architecture and specifications, also known as 5G, which is based on radio interfaces defined in Recommendation ITU-R M.2150-1. It fulfils the requirements and evaluation criteria for the development of IMT-2020 which is defined in Reports ITU-R M.2410 and ITU-R M.2412. The terrestrial radio interfaces for IMT-2020 specified in this Technical Code are based on requirements from 3GPP Set of Radio Interface Technologies (SRIT) and 3GPP 5G Radio Interface Technologies (RIT). In addition, this Technical Code also provides details, features, parameters and specifications of the core network architecture of IMT-2020, based on the requirements of Recommendations ITU-T Y.3101, ITU-T Y.3102 and ITU-T Y.3104.

5G is designed to support a diverse range of services with different data traffic profiles (e.g. high throughput, low latency and massive connection numbers) and models (e.g. Internet Protocol (IP) data traffic, non-IP data traffic, short data bursts and high throughput data transmission). Various Protocol Data Unit (PDU) session types are supported including Internet Protocol version 4 (IPv4), Internet Protocol version 6 (IPv6), Internet Protocol version 4 and version 6 (IPv4v6), Ethernet and unstructured. The main characteristic of 5G is the introduction of a new radio network interface, which offers the flexibility needed to support these very different types of services.

A 5G Access Network (AN) connected to a 5G Core Network (CN) is referred to as Standalone (SA) architecture. A second option, known as Non-Standalone (NSA) architecture, makes the 5G NR available without the need to deploy a 5G CN. Note that it is only in a SA configuration where there is a 5G CN and 5G AN that the full set of Phase 1 services are supported.

The main difference between NSA and SA is that NSA uses the 4G CN, also known as Evolved Packet Core (EPC), to connect to the 4G and 5G base stations. In the SA scheme, the 5G base station is directly connected to the 5G CN and the control signalling does not depend on the 4G network.

In the NSA architecture that supports 3GPP Set of Radio Interface Technologies (SRIT) and Radio Interface Technologies (RIT), also known as Evolved Universal Terrestrial Radio Access New Radio Dual Connectivity (EN-DC) or architecture Option 3, there are 3 variants supported as shown below in Figure 1. In this diagram, the Next Generation E-Node B (ng-eNB) is the enhanced 4G base station and the G-Node B (gNB) is the 5G base station.

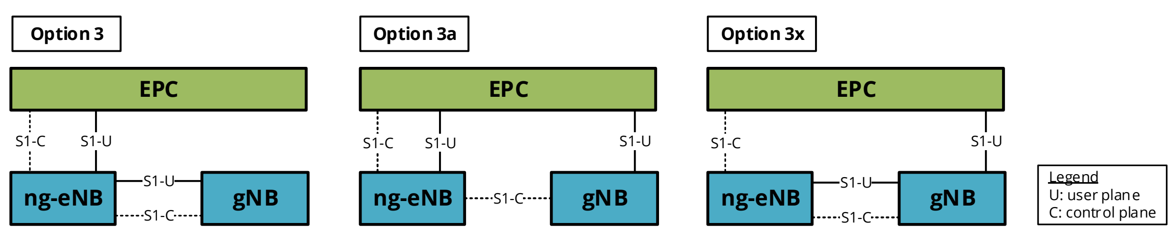

Figure 1. 5G NSA options using the 4G EPC

A 5G SA network implementation that supports 3GPP SRIT and RIT is illustrated in Figure 2 below.

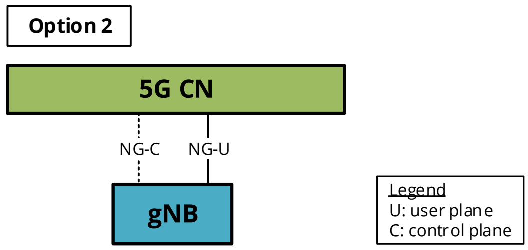

Figure 2. 5G SA configuration

3GPP also incorporates 4G/5G variants using the 5G CN to support 4G and 5G Radio Access Networks (RAN), as shown in Figure 3 below. This offers much flexibility to operators in how they deploy their 5G networks.

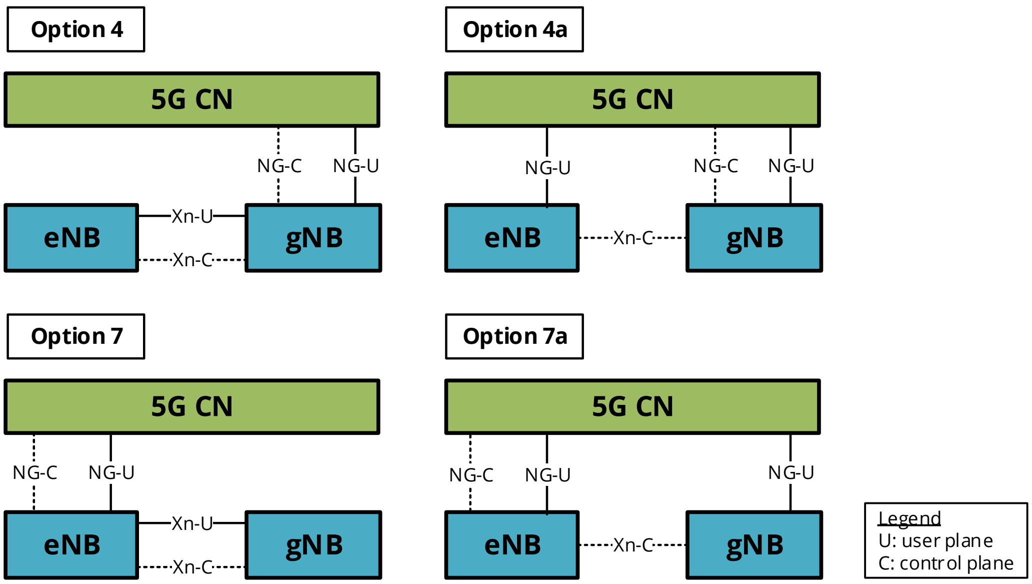

Figure 3. NSA deployment variations using the 5G CN

The terminologies used in 3GPP's 5G architecture options, as discussed earlier in this clause, are aligned with the Recommendation ITU-R M.2150-1 and this is depicted in Table 1. An important element of the 5G system architecture variations shown in Table 1 is the option involving Multi-Radio Dual Connectivity (MR-DC), whereby a User Equipment (UE) is configured to utilise 2 radio resources provided by eNB or gNB as master node and eNB or gNB as secondary node. The various MR-DC deployment options are aligned with the 5G Architecture options 1, 2, 3, 4, 5 and 7 and these options are explained in Recommendation ITU-R M.2150-1, 3GPP TS 38.300, 3GPP TS 37.340 as well as 3GPP TR 38.801.

Table 1. SA & NSA deployment variations and the respective terminologies

Standard	5G architecture	Terminology used in the standard		
		EPC	5GCN	
3GPP TR 38.801	SA	Option 1	Option 2	Option 5
Recommendation ITU-R M.2150-1		SA	NR-DC	SA
3GPP TS 38.300 3GPP TS 37.340		SA	NR-DC	SA
3GPP TR 38.801	NSA	Option 3, 3a, 3x	Option 4, 4a, 4x	Option 7, 7a, 7x
Recommendation ITU-R M.2150-1	MR-DC	EN-DC	NE-DC	NGEN-DC
3GPP TS 38.300 3GPP TS 37.340	MR-DC	EN-DC	NE-DC	NGEN-DC

SA : Standalone
NSA : Non-Standalone
MR-DC : Multi Radio Dual Connectivity
EN-DC : Evolved Universal Terrestrial Radio Access New Radio (E-UTRA-NR) Dual Connectivity
NE-DC : NR E-UTRA Dual Connectivity
NR-DC : New Radio Dual Connectivity
NGEN-DC : Next Generation Radio Access Network (NG-RAN) E-UTRA-NR Dual Connectivity

NOTE: Option 1 represents today’s 4G deployments

On the CN side, the 5G system also makes available a wide array of new characteristics, including the use of network slicing, multi-access edge computing and network capability exposure.

1. Scope

This Technical Code specifies system architecture and specifications for the following items below.

a) Terrestrial radio interface for IMT-2020 which consist of 3GPP 5G-SRIT and 3GPP 5G-RIT, 5Gi and DECT 5G-SRIT based on the Recommendation ITU-R M.2150-1.

b) Core network architecture for IMT-2020 which consist of 3GPP 5G CN based on ITU-T recommendations.

2. Normative references

The following normative references are indispensable for the application of this Technical Code. For dated references, only the edition cited applies. For undated references, the latest edition of the normative references (including any amendments) applies.

See Annex A.

3. Abbreviations

For the purposes of this Technical Code, the following abbreviations apply.

See Annex B.

4. Terms and definitions

For the purposes of this Technical Code, the following terms and definitions are applied.

4.1 Access Network (AN)

An Access Network (AN) is a user network that connects subscribers to a particular service provider and through the carrier network to other networks such as the Internet.

4.2 Core Network (CN)

A Core Network (CN) consists of the centralised elements of a telecommunications network which offer a range of services to customers who are interconnected via the AN. This term is also known as network core or backbone network.

4.3 Enhanced Mobile Broadband (eMBB)

This usage scenario pertains to high data rates, high user density, high user mobility, highly variable data rates, deployment and coverage. Enhanced Mobile Broadband (eMBB) will come with new application areas and requirements in addition to existing mobile broadband applications for improved performance and an increasingly seamless user experience.

4.4 Frequency Division Duplex (FDD)

Frequency Division Duplex (FDD) uses 2 frequency bands in which, one is used for transmission and another for reception.

4.5 Massive Machine Type Communications (mMTC)

This usage scenario is characterised by a very large number of connected devices typically transmitting a relatively low volume of non-delay sensitive data. Devices are required to be low cost and to have a very long battery life.

4.6 Massive Multiple-Input and Multiple-Output (MIMO)

Massive Multiple-Input and Multiple-Output (MIMO) is seen as a key technology to support the delivery of mobile 5G. Massive MIMO is an extension of MIMO which essentially groups together antennas at the transmitter and receiver to provide better throughput and enhanced spectral efficiency.

4.7 Non-standalone (NSA)

The Non-standalone (NSA) mode of 5G NR refers to an option for 5G NR deployment that depends on the control plane of an existing LTE network for control functions, while 5G NR is focused on the user plane.

4.8 Standalone (SA)

The Standalone (SA) mode of 5G NR refers to the use of 5G cells for both signalling and information transfer.

4.9 Time Division Duplex (TDD)

Time Division Duplex (TDD) uses a single frequency band for both transmit and receive. It shares a single band by assigning different time slots to transmit and receive operations.

4.10 Ultra-Reliable Low Latency Communications (URLLC)

This usage scenario has stringent requirements for capabilities such as throughput, latency and reliability. Some examples include wireless control of industrial manufacturing or production processes, remote medical surgery, distribution automation in a smart grid, transportation safety, etc.

5. General requirements

The 5G system requirements shall be able to support the following usage scenarios from a service point of view and flexible network operation from a network operation point of view.

a) eMBB

The eMBB refers to a usage scenario related to higher data rates, higher density, higher user mobility, fixed mobile convergence and small-cell deployments.

b) mMTC

mMTC focuses on a usage scenario with a massive number of devices (e.g. sensors and wearables) relevant to vertical services, such as smart home and city, smart utilities, e-Health and smart wearables.

c) URLLC

The URLLC usage scenario focuses on improving latency, reliability and availability to enable, for example, industrial control applications, mission critical communications and tactile Internet with an improved radio interface, optimized architecture and dedicated core and radio resources.

d) Flexible network operation

Flexible network operation addresses the functional system requirements, including aspects such as flexible functions and capabilities, new value creation, migration and interworking, optimisation and enhancements and security.

The above requirements are in line with the overall objectives of the future development of IMT-2020 and beyond defined in Recommendation ITU-R M.2083-0 and also with the requirements defined in Recommendation ITU-T Y.3101.

5.1 5G usage scenarios technical performance

The 5G radio interface technical performance for various usage scenario shall meet the requirements of Report ITU-R M.2410-0 as defined in Annex C. The summary of the requirements is as below:

a) eMBB

The minimum requirement for user experienced data rate is 100 Mbps Downlink (DL) and 50 Mbps Uplink (UL) for a dense urban environment. The user experienced data rate or cell edge data rate is the 5 % point of the Cumulative Distribution Function (CDF) of the user throughput. The assumed DL/UL aggregated system bandwidth (for FDD) or overall aggregated system bandwidth (for TDD) is based on the aggregation of multiple component carriers. The minimum requirement for user plane latency assuming unloaded conditions (i.e. a single user) for small IP packets (e.g. 0 byte payload + IP header), for both DL and UL is 4 ms. The evaluation of user plane latency is based on the procedure defined in Report ITU-R M.2412-0.

b) mMTC

The minimum requirement for capacity targets or connection density is 1,000,000 devices/km^2 for an urban macro environment. Connection density is the system capacity metric defined as the total number of devices fulfilling a specific Quality of Service (QoS) per unit area (per km^2). The required QoS is that a 32-byte packet is successfully received within 10 s. The evaluation of user plane latency is based on the procedure defined in Report ITU-R M.2412-0.

c) URLLC

End-to-end latency targets, an important performance indicator for 5G, are as low as 1 ms to 10 ms for automotive and automation interaction. The minimum requirement for user plane latency assuming unloaded conditions (i.e. a single user) for small IP packets (e.g. 0 byte payload + IP header), for both DL and UL is 1 ms. The evaluation of user plane latency is based on the procedure defined in Report ITU-R M.2412-0.

Figure 4 categorises various use cases into 3 main usage scenarios for IMT-2020 as described in ITU-R M.2083-0 namely enhanced Mobile Broadband (eMBB), massive Machine Type Communications (mMTC), and Ultra-Reliable and Low Latency Communications (URLLC).

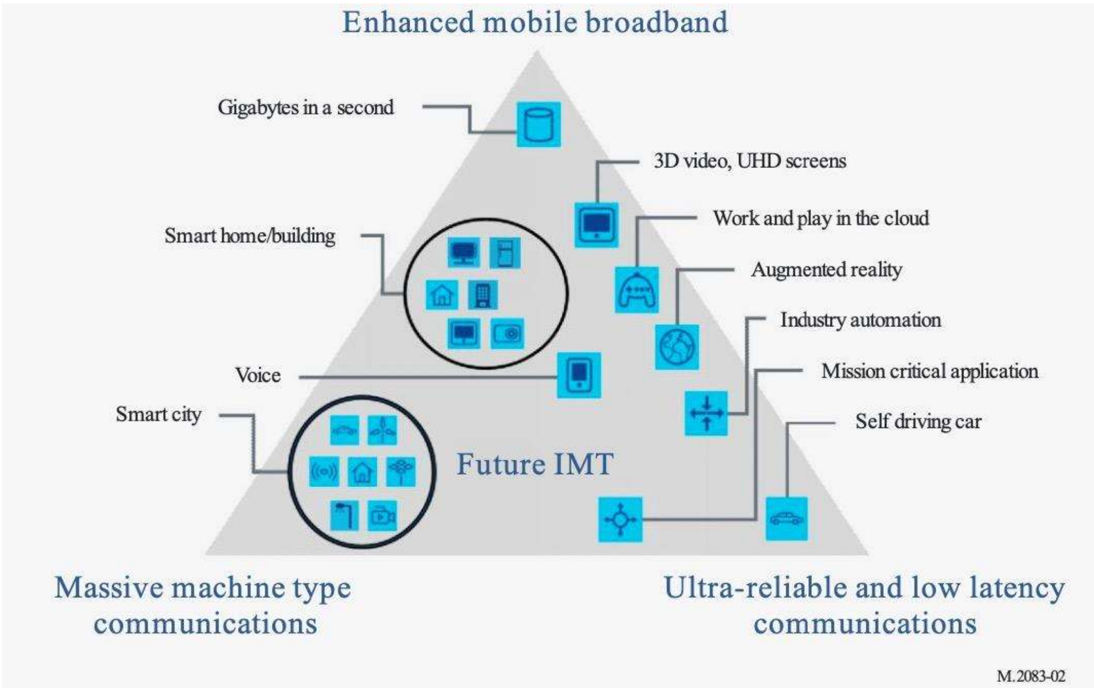

Figure 4. IMT-2020 usage scenarios

The enhancement of key capabilities of 5G IMT-2020 compared with 4G IMT-Advanced is shown in Figure 5 as described in ITU-R M.2083-0. These usage scenarios and performance capabilities provide technical guidance for the ensuing development of IMT-2020 technologies as described in ITU-R M.2150-1.

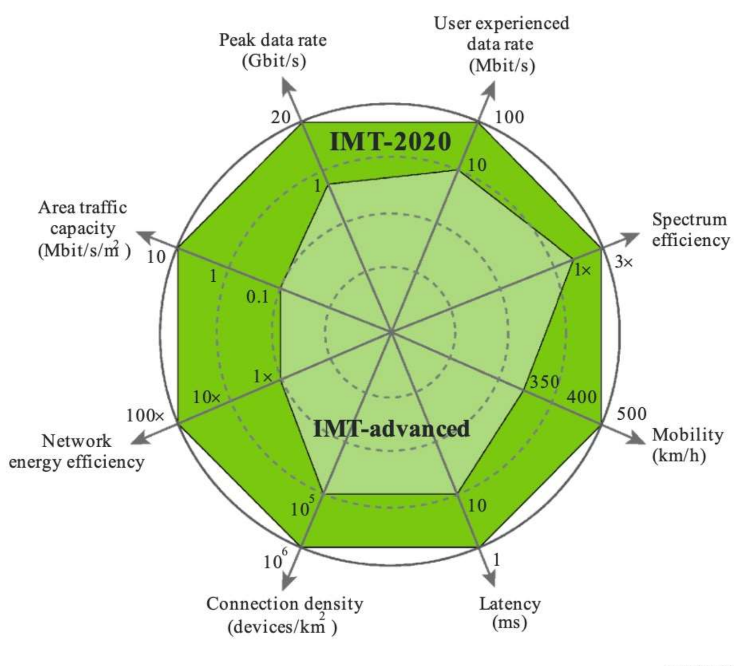

Figure 5. IMT-Advanced to IMT-2020 key capability enhancements

5.2 5G system architecture

The 5G system architecture shall be deployed as either:

a) NSA architecture where the 5G RAN and its NR interface is used in conjunction with the existing LTE and EPC (respectively 4G radio and 4G core), thus making the NR technology available without network replacement. The NSA architecture is reflected in Figure 1. EN-DC offering dual connectivity via both the upgraded 4G AN and the 5G AN using 5G CN, as defined in 3GPP TS 37.340, is also known as NSA as illustrated in Figure 3; or

b) SA architecture where the NR is connected to the 5G CN. The SA architecture is shown in Figure 2.

The NSA architecture shall support at least the eMBB service whereas the SA architecture shall be able to meet full compliance to 5G, supporting eMBB, mMTC and URLLC. The NSA architecture deployment is aligned with the requirements of IMT-2020 network deployment and migration as defined in Recommendation ITU-T Y.3101. The IMT-2020 network should support incremental deployment methods and to support the migration processes of services and related users from legacy networks.

6. 5G SA system

The 5G SA system consists of a 5G AN connected to a 5G CN via the Next Generation (NG) interface following the architecture reference model of the IMT-2020 network in Recommendation ITU-T Y.3104.

The 5G CN shall use a Service-Base Architecture (SBA) framework where the architecture elements are defined in terms of Network Function (NF) offering modularity and reusability in accordance with Recommendation ITU-T Y.3102.

The following splits between the 5G AN and 5G CN shall be implemented in accordance with 3GPP TS 38.300.

a) 5G AN

   i) Inter cell radio resource management.

   ii) Resource block control.

   iii) Connection mobility control.

   iv) Radio admission control.

   v) Measurement configuration and provision.

   vi) Dynamic resource allocation.

b) 5G CN

   i) Network Attached Storage (NAS) security.

   ii) Idle state mobility handling.

   iii) Mobility anchoring.

   iv) PDU handling.

v) UE IP address allocation.

vi) PDU session control.

6.1 5G AN

A 5G AN shall consist of a set of gNBs connected to the 5G CN. The gNB can be connected to another gNB via the X_n interface. A gNB shall be able to be further split into a gNB-Central Unit (gNB-CU) and one or more gNB-Distributed Unit(s) (gNB-DU) linked by the F1 interface as defined in 3GPP TS 38.401 and ITU-R M.2150-1. The 5G RAN architecture emphasising on 5G AN (NG-RAN) and 5G CN (5GC) are shown in Figure 6.

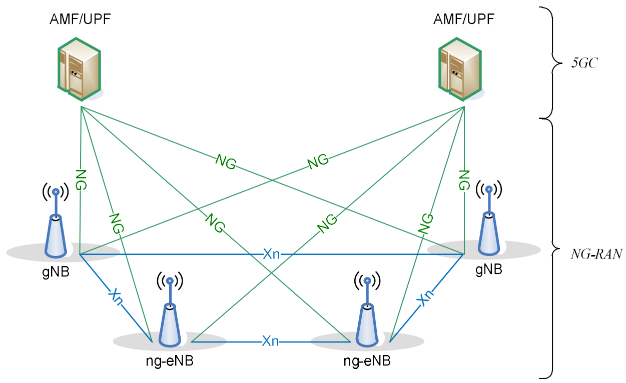

Figure 6. 5G RAN architecture

The gNB shall be able to perform the following functions as stipulated in 3GPP TS 38.300.

a) Functions for radio resource management which are radio bearer control, radio admission control, connection mobility control, dynamic allocation of resources to use in both UL and DL (scheduling).

b) IP header compression, encryption and integrity protection of data.

c) Selection of an Access and Mobility Management Function (AMF) at UE attachment when no routing to an AMF can be determined from the information provided by the UE.

d) Routing of user plane data towards User Plane Functions (UPF).

e) Routing of control plane information towards AMF.

f) Connection setup and release.

g) Scheduling and transmission of paging messages.

h) Scheduling and transmission of system broadcast information originated from the AMF or operation and maintenance.

i) Measurement and measurement reporting configuration for mobility and scheduling.

j) Transport level packet marking in the UL.

k) Session management.

l) Support of network slicing.

m) Qos flow management and mapping to data radio bearers.

n) Support of UEs in Radio Resource Control (RRC) inactive state.

o) Distribution function for NAS messages.

p) RAN sharing.

q) Dual connectivity.

r) Tight interworking between NR and Evolved Universal Terrestrial Radio Access (E-UTRA).

s) Maintain security and radio configuration for user plane Cellular Internet of Things (CIoT) 5GS optimisation, as defined in 3GPP TS 23.501.

6.1.1 Radio physical layer

The 5G AN shall support the use of Orthogonal Frequency Division Multiplexing (OFDM) with Cyclic Prefix (CP) as the NR waveform for both DL and UL in addition to the use of Discrete Fourier Transform precoding (DFT-s-OFDM) as the UL waveform for UL coverage improvement.

The 5G AN shall support NR channel bandwidths as indicated in Table 2 as specified in 3GPP TS 38.104 for various deployment scenarios.

Table 2. NR channel bandwidth source

Frequency range		Frequency band (MHz)	Supported channel bandwidth (MHz)
FR1		410 - 7 125	5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100
FR2	FR2-1	24 250 - 52 600	50, 100, 200, 400
	FR2-2	52 600 - 71 000	100, 400, 800, 1 600, 2 000

6.1.2 MIMO

The 5G AN shall support multi-layer data transmission for a single UE on single-user MIMO with a maximum of 8 transmission layers for DL and 4 for UL. Also, the 5G AN shall be able to support multi-layer data transmission with multiple UEs on multi-user MIMO with a maximum of 12 transmission layers for DL and UL transmission as referred in 3GPP TR 21.916, 3GPP TR 21.917 and ITU-R M.2320-0.

6.1.3 New Radio - Long Term Evolution (NR-LTE) co-existence

The 5G AN shall support NR DL or UL transmission within the bandwidth of an LTE carrier without impact on legacy LTE devices.

6.1.4 Supplementary Uplink (SUL)

The 5G AN shall be able to support the configuration of a UE with 2 ULs consisting of a normal UL and Supplementary Uplink (SUL) for 1 DL in the same cell.

6.1.5 UL Transmit Power Control (TPC)

The 5G AN shall support dynamic power adjustment for relevant physical channels.

The above requirements are defined in 3GPP TR 21.915 and ITU-R M.2150-1.

6.2 5G CN

The 5G CN shall consist of the following main Network Functions (NF) in accordance with Recommendation ITU-T Y.3102.

a) The Access and Mobility Management Function (AMF) shall provide functions similar to those performed by the Mobility Management Entity (MME) in a 4G network, including NAS signalling, mobility management, registration management, connection management, reachability management, Session Management (SM) message forwarding and access authentication or authorisation.

b) The Session Management Function (SMF) shall provide the session management functions that are handled by MME, Serving Gateway Control (SGW-C) and Packet Data Network Gateway Control (PGW-C) in a 4G network, including UE IP address allocation and management, NAS signalling for session management, configuring traffic steering at the UPF, lawful interception CP, DL data notification, sending QoS and policy information to RAN and supporting charging interfaces.

c) The UPF shall provide the data plane functionality that is performed by the SGW and PGW in a 4G network, including packet routing and forwarding, lawful interception of the user plane, mobility anchor points for intra-/inter-Radio Access Technology (RAT) mobility and traffic usage reporting.

d) The Network Repository Function (NRF) shall provide functions such as service registration and discovery function which allows network functions to discover each other, as well as maintaining the NF profile of available NF instances and their support services.

e) The Network Exposure Function (NEF) shall provide functions such as exposing capabilities and events, securing provision of information from external applications to a 3GPP network, translating internal or external information and managing packet flow descriptions.

f) The Unified Data Management (UDM) shall provide functions similar to the Home Subscriber Server (HSS) in a 4G network, such as generation of Authentication and Key Agreement (AKA) credentials, handling of user identification, access authorisation based on subscription data and management of subscriptions.

g) The Unstructured Data Storage Function (UDSF) is an optional function that supports storage and is used for retrieval of information as unstructured data by any NF.

h) The Unified Data Repository (UDR) shall provide function such as a common data storage function for all IMT radio technologies subscription and policy data. It shall provide a distributed, central data repository and a unified data model for all kinds of applications in a telecommunications network. All data stored in the UDR can be accessed through single data access points from the whole network and it is accessible both for traffic and provisioning components. The 3GPP defined Nudr interface is used by the UDM, Policy Control Function (PCF) and NEF to access a particular set of data stored in UDR as defined in 3GPP TS 29.504.

i) The Network Slice Admission Control Function (NSACF) shall support the monitoring and control of the number of registered UEs per network slice, the number of established PDU Sessions per network slice and event-based network slice status notification and reports to a consumer NF.

j) The Network Slice Selection Function (NSSF) as defined in Recommendation ITU-T Y.3112 shall provide functions such as selecting the set of network slice instances serving the UE, determining the allowed Network Slice Selection Assistance Information (NSSAI) as well as determining the AMF set to be used to serve the UE.

k) PCF shall provide functions such as governing network behaviour via the unified policy framework, providing policy rules to control plane functions and accessing subscription information relevant for policy decisions stored in a UDR.

l) The UE radio Capability Management Function (UCMF) shall provide storage of dictionary entries corresponding to either Public Land Mobile Network (PLMN)-assigned or Manufacturer-assigned UE Radio Capability IDs. An AMF may subscribe with the UCMF to obtain from the UCMF new values of UE Radio Capability ID that the UCMF assigns for the purpose of caching them locally.

m) The 5G-Equipment Identity Register (5G-EIR) is an optional network function to check the status of a Permanent Equipment Identifier (PEI).

n) The Network Data Analytics Function (NWDAF) represents an operator managed network analytics logical function. The NWDAF shall support data collection from NFs and AFs, data collection from Operations, Administration and Maintenance (OAM) systems, NWDAF service registration and metadata exposure to NFs or AFs, analytics information provisioning to NFs and AFs. The details of the NWDAF functionality are defined in 3GPP TS 23.288.

o) The Data Collection Coordination Function (DCCF) shall support the control and management of data sources sharing and messaging framework on coordination of data formatting and processing for network data analytics purpose.

p) The Analytics Data Repository Function (ADRF) shall support the storage and retrieval of analytics generated by NWDAFs and collected data.

q) The Messaging Framework Adaptor Function (MFAF) interfaces with a DCCF and shall control a messaging framework for data processing, data formatting and data sending to consumers or notification endpoints.

r) The Edge Application Server Discovery Function (EASDF) shall support the session breakout connectivity model by acting as a Domain Name System (DNS) resolver to resolve application servers close to the UE location.

s) The Service Communication Proxy (SCP) shall support indirect communication, delegated discovery, message forwarding and routing to destination in NF/NF service, message forwarding and routing to a next hop SCP, communication security (e.g. authorisation of the NF Service Consumer to access the NF Service Producer Application Programming Interface (API), load balancing, monitoring, overload control, etc.

t) The Time Sensitive Networking (TSN) Time Synchronisation Function (TSNTSF) shall support the association of the time synchronisation service requests from the NF consumer to the AF sessions with the PCF (the session between the PCF and TSNTSF provides time synchronisation service based on IEEE 802.1AS-2020 or IEEE 1588-2019 for ethernet or IP type PDU Sessions).

u) The Non-Seamless Wireless Local Area Network (WLAN) Offload Function (NSWOF) interfaces with a WLAN access network using the SWa interface as defined in 3GPP TS 23.402 and interfaces with the Authentication Server Function (AUSF) using the Nausf Service Based Interface (SBI), performing protocol translation and AUSF discovery.

v) The Non-3GPP InterWorking Function (N3IWF) shall implement functionalities for untrusted non-3GPP access, including signalling termination, IP Security (IPSec), enforcing QoS, AMF selection, etc.

w) The Trusted Non-3GPP Gateway Function (TNGF) shall implement functionalities of Trusted Non-3GPP Access Network (TNAN), including signalling termination, authentication when the UE attempts to register to 5GC, AMF selection, etc.

x) The Wireline Access Gateway Function (W-AGF) shall implement the functionalities of relaying user plane traffic between the Residential Gateway (RG) and the UPF as well as handling the control plane data interfacing with the AMF as defined in 3GPP TS 23.316.

y) The Trusted WLAN Interworking Function (TWIF) shall support connectivity via a WLAN access technology, e.g. IEEE 802.11, providing interworking functionalities that enables Non-5G-Capable over WLAN (N5CW) devices to access a 5GC.

z) The Multicast Broadcast Session Management Function (MB-SMF) shall manage Multicast-Broadcast Services (MBS) session and configures a user plane function MB-UPF, based on the policy rules for multicast and broadcast services. The functionality is specified in 3GPP TS 23.247.

aa) The Multicast Broadcast User Plane Function (MB-UPF) shall be an ingress point to 5GC and works as a session anchor to 5GC as depicted in 3GPP TS 23.247.

bb) The Multicast Broadcast Service Function (MBSF) shall provide service level functionality to interact with AF and MB-SMF for MBS session operations. Further, it determines transport parameters and session transport, and control Multicast Broadcast Service Transport Function (MBSTF) if used, which can be implemented in NEF. The functionality is specified in 3GPP TS 23.247.

cc) MBSTF shall provide generic packet transport functionalities available to any IP multicast enabled application such as framing, multiple flows, packet Forward Error Control (FEC) encoding, and therefore, works as a media anchor for MBS data traffic. The functionality is specified in 3GPP TS 23.247.

More details on the functionality of the above NFs can be found in 3GPP TS 23.501.

The 5G CN shall consist of the following security related NFs as defined in MCMC MTSFB TC G028 in accordance with the deployment scenarios as follows:

a) The Security Anchor Function (SEAF) shall provide the authentication functionality via the AMF in a serving network and supports primary authentication using the Subscription Concealed Identifier (SUCI).

b) AUSF shall provide authentication functions similar to the HSS in the 4G network, supporting authentication for both 3GPP access and untrusted non-3GPP access. It shall provide the Subscription Permanent Identifier (SUPI) to the Visited Public Land Mobile Network (VPLMN) only after authentication confirmation is received from the Home Public Land Mobile Network (HPLMN). This will be sent if an authentication request with a valid SUCI was sent by the VPLMN.

c) The Authentication Credential Repository and Processing Function (ARPF) shall provide the functionality of storing credentials associated with authentication and security procedures.

d) The Security Edge Protection Proxy (SEPP) shall support the interconnection of the home and visited networks. It acts as a non-transparent proxy node and perform topology hiding by limiting the internal topology information visible to external parties.

e) The Subscription Identifier De-Concealing Function (SIDF) shall be responsible for de-concealment of the SUCI and shall be a service offered by the UDM to resolve the SUPI from the SUCI based on the protection scheme used to generate the SUCI.

f) The Network Slice Specific Authentication and Authorisation Function (NSSAAF) shall support network slice-specific authentication and authorisation with an Authentication and Authorisation (AAA) server.

More details on the functionality of the above NFs can be found in 3GPP TS 23.501 and 3GPP TS 33.501.

Overall, the 5G CN shall fulfil the general principles of an IMT-2020 network defined in Section 7 of Recommendation ITU-T Y.3101.

6.2.1 Local hosting of services and edge computing

The 5G CN shall select a UPF in close proximity to the UE for traffic steering purposes to support URLLC services by hosting the services using multi-access edge computing capabilities, thus reducing the latency in accessing services. As mentioned in the distributed network architecture of Recommendation ITU-T Y.3101, this brings a significant reduction of backhaul and core network traffic by enabling the placement of content servers closer to the end user devices and also is beneficial in terms of service latency.

6.2.2 Network slicing

The 5G CN shall support end-to-end network slicing as per the requirements of Recommendations ITU-T Y.3110, ITU-T Y.3111, ITU-T Y.3112 and ITU-T Y.3153 for each deployed PLMN to the extent necessary to interoperate with other PLMNs, e.g. the IoT slice from Operator A can interconnect directly with the IoT slice of Operator B.

The 5G CN shall able to support QoS for 3 types of predefined slice as follows:

a) Type 1 is dedicated to the support of eMBB.

b) Type 2 is for URLLC.

c) Type 3 is for mMTC support.

Network flexibility and programmability is an important requirement from a network operation point of view for an IMT-2020 network, as specified in Recommendation ITU-T Y.3101.

6.2.3 Support of 3GPP and non-3GPP access

The 5G CN shall support 3GPP access technologies, such as 5G NR and 4G E-UTRA as well as non-3GPP access technologies, even non-trusted ones, to fulfil the requirements of an IMT-2020 network. This is to support fixed mobile convergence as well as interworking with non-IMT-2020 networks as specified in Recommendation ITU-T Y.3101. The requirements of fixed mobile convergence are further described in Recommendation ITU-T Y.3130 with functional architecture as illustrated in Recommendation ITU-T Y.3131.

6.2.4 Network capability exposure

The 5G CN shall support the Service Exposure and Enablement Support (SEES) and enhanced Flexible Mobile Service Steering (FMSS) features to expose network capabilities to third parties as per the requirements of Recommendations ITU-T Y.3105 and ITU-T Y.3108. Section 9.4 of Recommendation ITU-T Y.3101 states that an IMT-2020 network should be able to expose network capabilities to third party applications located inside or outside the IMT-2020 network operator's domain.

6.2.5 IP-Multimedia Subsystem (IMS) and Short Message Service (SMS)

The 5G CN shall support the IP-Multimedia Subsystem (IMS) and Short Message Service (SMS). This is to align with the requirement of Recommendation ITU-T Y.3101 in support of migration processes for services and related users from legacy networks.

6.2.6 Multi-Operator Core Network (MOCN)

The 5G CN shall support RAN sharing via multiple core networks. This can be implemented as a Multi-Operator Core Network (MOCN), where radio access networks and spectrum are shared, or as a Multi-Operator Radio Access Network (MORAN), where RANs are shared and dedicated spectrum is used by each sharing operator. The technical classification of MOCN and MORN is shown in Figure 7. The overview of the infrastructure sharing is specified in the GSMA report as well as 3GPP TR 38.801.

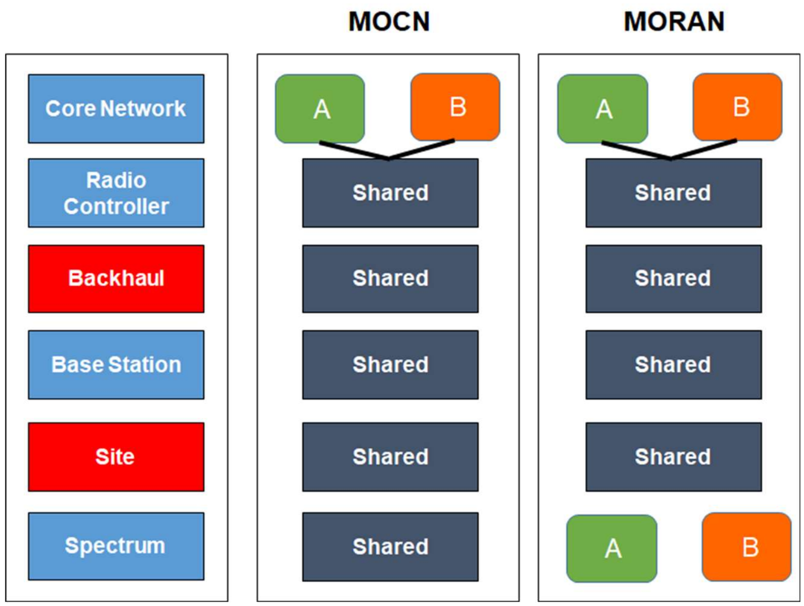

Figure 7. Technical classification of MOCN and MORAN infrastructure sharing

6.2.7 Roaming

The standard network architecture for both SA and NSA supports customer roaming as specified in 3GPP TS 23.501. It is recommended that the 5G CN follows the GSM Association (GSMA) recommendations outlined in NG.113 - 5G Roaming Guidelines which provides a standardised set of guidelines on how 5G networks can interconnect and/or interwork when a user roams to a network different from their Home Public Land Mobile Network (HPLMN).

6.2.8 Network data analytics

Artificial Intelligence (AI) or Machine Learning (ML) have been used to generate insights so that action can be taken to improve the network quality paving the way towards further network automation. To streamline the way core network data is produced and consumed, a data collection interface from network nodes, predefined analytics insights and a data exposure interface to consumers are standardised to overcome market fragmentation and proprietary solutions in the area of network analytics.

6.3 5G Quality of Service (QoS)

The 5G network shall fulfil the QoS functional requirements for the IMT-2020 network defined in Recommendation ITU-T Y.3106 and support the functional architecture for QoS assurance defined in Recommendation ITU-T Y.3107. The 5G network shall have a standardised set of Quality of Service (QoS) characteristics, which are based on the QoS Class Identifier (QCI). The QCI will be aggregated from the multiple sessions of Service Data Flows (SDF). The QCI shall be used as a reference to node specific parameters that control packet forwarding treatment (e.g. scheduling weights, admission thresholds, queue management thresholds, link layer protocol configuration, etc.) and that have been pre-configured by the operator controlling the node e.g. gNB.

The standardised characteristics associated with SDF are listed below. The characteristics describe the packet forwarding treatment that an SDF aggregate receives edge-to-edge between the UE and UPF in terms of the following performance characteristics.

a) Resource type (Guaranteed Bit Rate (GBR) or Non-GBR).

b) Priority level.

c) Packet delay budget.

d) Packet error rate.

e) Maximum data burst volume.

f) Data rate averaging window.

The 5G QoS characteristics should be understood as guidelines for setting node specific parameters for each QoS flow e.g. for 3GPP radio access link layer protocol configurations. Signalled 5G QoS characteristics are provided as part of the QoS profile and shall include all of the characteristics listed above.

The principle for classification and marking of user plane traffic and mapping of QoS flows to AN resource is illustrated in Figure 8 and further discussed in 3GPP TS 23.501.

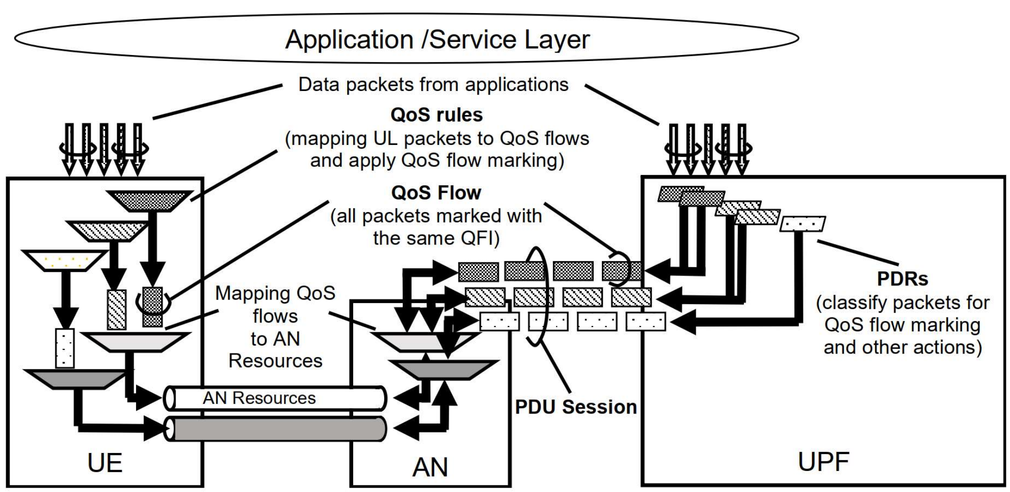

Figure 8. Classification of user plane QoS flows and mapping to AN resources

6.3.1 5QI

A 5QI is a scalar that is used as a reference to 5G QoS characteristics. The standardised 5QI values have one-to-one mapping to a standardised combination of 5G QoS characteristics as specified in Table 3. The 5G QoS characteristics for pre-configured 5QI values are pre-configured in the access network.

Standardised 5QI values are specified for services that are assumed to be frequently used and thus benefit from optimised signalling by using standardised QoS characteristics. Dynamically assigned 5QI values (which require a signalling of QoS characteristics as part of the QoS profile) can be used for services for which standardised 5QI values. Table 3 specifies the one-to-one mapping of standardised

5QI values to the minimum 5G QoS characteristics which reference made to 3GPP TS 23.501 for the mentioned example services.

Table 3. Standardised 5QI to QoS characteristics mapping

5QI Value	Resource type	Default Priority level	Packet delay budget[c]	Packet error rate	Default Maximum Data Burst Volume[b]	Default Averaging Window	Example services
1	GBR[a]	20	100 ms[k,m]	10^{-2}	N/A	2000 ms	Conversational voice
2		40	150 ms[k,m]	10^{-3}	N/A	2000 ms	Conversational video (live streaming)
3		30	50 ms[k,m]	10^{-3}	N/A	2000 ms	a) Real time gaming, Vehicle-to-everything (V2X) messages b) Electricity distribution – medium voltage c) Process automation – monitoring

Table 3. Standardised 5QI to QoS characteristics mapping *(continued)*

5QI Value	Resource type	Default Priority level	Packet delay budget[c]	Packet error rate	Default Maximum Data Burst Volume[b]	Default Averaging Window	Example services
4	GBR[a]	50	300 ms[k,m]	10^{-6}	N/A	2000 ms	Non-conversational video (buffered streaming)
65[i,l]		7	75 ms[g,h]	10^{-2}	N/A	2000 ms	Mission critical user plane push to talk voice (e.g. Mission Critical Push to Talk (MCPTT))
66[l]		20	100 ms[j,m]	10^{-2}	N/A	2000 ms	Non-mission-critical user plane push to talk voice
67[l]		15	100 ms[j,m]	10^{-3}	N/A	2000 ms	Mission critical video user plane
75[n]							
71		56	150 ms[k,m,o]	10^{-6}	N/A	2000 ms	“Live” uplink streaming
72		56	300 msk,m,o	10-4	N/A	2000 ms	“Live” uplink streaming
73		56	300 msk,m,o	10-8	N/A	2000 ms	“Live” uplink streaming
74		56	500 msk,o	10-8	N/A	2000 ms	“Live” uplink streaming
76		56	500 msk,m,o	10-4	N/A	2000 ms	“Live” uplink streaming
5	Non-GBR[a]	10	100 msj,m	10-6	N/A	N/A	IP-Multimedia Subsystem (IMS) signalling
6		60	300 msj,m	10-6	N/A	N/A	Video (buffered streaming) TCP-based (e.g. www, e-mail, chat, ftp, p2p file sharing, progressive video, etc.)
7		70	100 msj,m	10-3	N/A	N/A	Voice Video (live streaming) Interactive gaming

Table 3. Standardised 5QI to QoS characteristics mapping *(continued)*

5QI Value	Resource type	Default Priority level	Packet delay budget[c]	Packet error rate	Default Maximum Data Burst Volume[b]	Default Averaging Window	Example services
8	Non-GBRa	80	300 msm	10-6	N/A	N/A	Video (buffered streaming) TCP-based (e.g. www, e-mail, chat, ftp, p2p file
9		90	N/A	N/A	N/A	N/A	Sharing and progressive video
10		90	1100msm, q	10-6	N/A	N/A	Video (Buffered streaming) TCP-based (e.g. www, e-mail, chat, ftp, p2p file sharing, progressive video, etc.) and any service that can be used over satellite access type with these characteristics
69 (N0TE 9, NOTE 12)		5	60 msg,h	10-6	N/A	N/A	Mission critical delay sensitive signalling such as MCPTT signalling, Mission Critical Video (MCVideo) signalling
70l		55	200 msg,j	10-6	N/A	N/A	Mission critical data (e.g. services are the same as QCI 6, 8 or 9)
79		65	50 msj,m	10-2	N/A	N/A	V2X messages
80		68	10 msd	10-6	255 bytes	2000 ms	Low latency eMBB applications (TCP or UDP-based) Augmented reality

Table 3. Standardised 5QI to QoS characteristics mapping *(concluded)*

5QI Value	Resource type	Default Priority level	Packet delay budget[c]	Packet error rate	Default Maximum Data Burst Volume[b]	Default Averaging Window	Example services
82	Delay Critical GBR	19	10 ms[d]	10^{-4}	255 bytes	2000 ms	Discrete automation
83		22	20 ms[d]	10^{-4}	1254 bytes[c]	2000 ms	Discrete automation; V2X messages (UE - RSU platooning, Advanced driving: Cooperative lane Change with low LoA)
84		24	30 ms[f]	10^{-5}	1354 bytes[c]	2000 ms	Intelligent transport systems
85		21	5 mse	10-5	255 bytes	2000 ms	Electricity Distribution high voltage. V2X messages (Remote driving)p
86		18	5 mse	10-4	1354 bytes	2000 ms	V2X messages (Advanced driving, Collision avoidance, Platooning with high LoA)
87		25	5 ms[d]	10^{-3}	500 bytes	2000 ms	Interactive service - Motion tracking data
88		25	10 ms[d]	10^{-3}	1125 bytes	2000 ms	Interactive service - Motion tracking data
89		25	15 ms[d]	10^{-4}	17000 bytes	2000 ms	Visual content for cloud, edge or split rendering
90		25	20 ms[d]	10^{-4}	63000 bytes	2000 ms	Visual content for cloud, edge or split rendering

NOTES:

[a] A packet which is delayed more than PDB is not counted as lost, thus not included in the PER.

[b] It is required that default MDBV is supported by a PLMN supporting the related 5QIs.

[c] The Maximum Transfer Unit (MTU) size considerations and Annex C of TS 23.060 are also applicable. IP fragmentation may have impacts to CN PDB

[d] A static value for the CN PDB of 1 ms for the delay between a UPF terminating N6 and a 5G-AN should be subtracted from a given PDB to derive the packet delay budget that applies to the radio interface.

[e] A static value for the CN PDB of 2 ms for the delay between a UPF terminating N6 and a 5G-AN should be subtracted from a given PDB to derive the packet delay budget that applies to the radio interface.

[f] A static value for the CN PDB of 5 ms for the delay between a UPF terminating N6 and a 5G-AN should be subtracted from a given PDB to derive the packet delay budget that applies to the radio interface.

[g] For Mission Critical services, it may be assumed that the UPF terminating N6 is located "close" to the 5G_AN (roughly 10 ms) and is not normally used in a long distance, home routed roaming situation. Hence a static value for the CN PDBof 10 ms for the delay between a UPF terminating N6 and a 5G_AN should be subtracted from this PDB to derive the packet delay budget that applies to the radio interface.

[h] In both RRC Idle and RRC Connected mode, the PDB requirement for these 5QIs can be relaxed (but not to a value greater than 320 ms) for the first packet(s) in a downlink data or signalling burst in order to permit reasonable battery saving (DRX) techniques.

[i] It is expected that 5QI-65 and 5QI-69 are used together to provide Mission Critical Push to Talk service (e.g., 5QI-5 is not used for signalling). It is expected that the amount of traffic per UE will be similar or less compared to the IMS signalling.

[j] In both RRC Idle and RRC Connected mode, the PDB requirement for these 5QIs can be relaxed for the first packets in a downlink data or signalling burst in order to permit battery saving (DRX) techniques.

[k] In RRC Idle mode, the PDB requirement for these 5QIs can be relaxed for the first packets in a downlink data or signalling burst in order to permit battery saving (DRX) techniques.

[l] This 5QI value can only be assigned upon request from the network side. The UE and any application running on the UE is not allowed to request this 5QI value.

[m] A static value for the CN PDB of 20 ms for the delay between a UPF terminating N6 and a 5G-AN should be subtracted from a given PDB to derive the packet delay budget that applies to the radio interface.

[n] This 5QI is not supported in this Release of the specification as it is only used for transmission of V2X messages over MBMS bearers, but the value is reserved for future use.

[o] For "live" uplink streaming, guidelines for PDB values of the different 5QIs correspond to the latency configurations. In order to support higher latency reliable streaming services (above 500 ms PDB), if different PDB and PER combinations are needed these configurations will have to use non-standardised 5QIs.

[p] These services are expected to need much larger MDBV values to be signalled to the RAN. Support for such larger MDBV values with low latency and high reliability is likely to require a suitable RAN configuration, for which, the simulation scenarios may contain some guidance.

[q] The worst case one way propagation delay for GEO satellite is expected to be ~270ms, ,~21 ms for LEO at 1200km, and 13 ms for LEO at 600km. The UL scheduling delay that needs to be added is also typically two-way propagation delay e.g. ~540ms for GEO, ~42ms for LEO at 1200km, and ~26 ms for LEO at 600km. Based on that, the 5G-AN Packet delay budget is not applicable for 5QIs that require 5G-AN PDB lower than the sum of these values when the specific types of satellite access are used. 5QI-10 can accommodate the worst case PDB for GEO satellite type.

6.4 Frequency

This section is a guideline of frequency allocation identified by ITU and frequency bands for IMT-2020.

6.4.1 Spectrum identified by ITU for IMT-2020

ITU have categorised 3 frequency ranges for IMT-2020 as follows:

a) Below 1 GHz (for coverage).

b) 1 GHz to 6 GHz (for capacity or coverage).

c) Above 24 GHz (for capacity).

Guidance on the selection of transmitting and receiving frequency arrangements for the terrestrial IMT in the bands identified in the Radio Regulations Articles Edition of 2020 as shown in Table 4.

Table 4. Frequency bands and footnotes for band identified for IMT

Band (MHz)	Footnotes identifying the band for IMT		
	Region 1	Region 2	Region 3
450 - 470	5.286AA		
470 - 698	N/A	5.295, 5.308A	5.296A
694/698 - 960	5.317A	5.317A	5.313A, 5.317A
1 427 - 1 518	5.341A, 5.346	5.341B	5.341C, 5.346A
1 710 -2 025	5.384A, 5.388		
2 110 - 2 200	5.388		
2 300 - 2 400	5.384A		
2 500 - 2 690	5.384A		
3 300 - 3 400	5.429B	5.429D	5.429F
3 400 - 3 600	5.430A	5.431B	5.432A, 5.432B, 5.433A
3 600 - 3 700	N/A	5.434	-
4 800 - 4 990	N/A	5.441A	5.441B
24 250 - 27 500	5.532AB		
37 000 - 43 500	5.550B		
43 500 - 47 000	5.553A		
47 200 - 48 200	5.553B		
66 000 - 71 000	5.559AA		

Notwithstanding the identification by ITU, the use of the frequency bands for IMT-2020 in Malaysia are subject to the MCMC Spectrum Plan and Standard Radio System Plan (SRSP).

6.4.2 NR bands

The NR bands as specified in 3GPP TS 38.101-1 and 3GPP TS 38.101-2 are shown in Table 5.

Notwithstanding the identification by 3GPP, the use of the frequency bands for IMT-2020 in Malaysia are subject to the MCMC Spectrum Plan and Standard Radio System Plan (SRSP).

Table 5. NR bands

NR operating band	UL operating band	DL operating band	Duplex mode	Malaysia band plan reference
n1	1 920 MHz - 1 980 MHz	2 110 MHz - 2 170 MHz	FDD	-
n2	1 850 MHz - 1 910 MHz	1 930 MHz - 1 990 MHz	FDD	-
n3	1 710 MHz - 1 785 MHz	1 805 MHz - 1 880 MHz	FDD	-
n5	824 MHz - 849 MHz	869 MHz - 894 MHz	FDD	-
n7	2 500 MHz - 2 570 MHz	2 620 MHz - 2 690 MHz	FDD	-
n8	880 MHz - 915 MHz	925 MHz - 960 MHz	FDD	-
n12	699 MHz - 716 MHz	729 MHz - 746 MHz	FDD	-
n13	777 MHz - 787 MHz	746 MHz - 756 MHz	FDD	-
n14	788 MHz - 798 MHz	758 MHz - 768 MHz	FDD	-
n18	815 MHz - 830 MHz	860 MHz - 875 MHz	FDD	-
n20	832 MHz - 862 MHz	791 MHz - 821 MHz	FDD	-
n24	1 626.5 MHz - 1 660.5 MHz	1 525 MHz - 1 559 MHz	FDD	-
n25	1 850 MHz -1 915 MHz	1 930 MHz - 1 995 MHz	FDD	-
n26	814 MHz - 849 MHz	859 MHz - 894 MHz	FDD	-
n28	703 MHz - 748 MHz	758 MHz - 803 MHz	FDD	MCMC SRSP MS 700
n29	N/A	717 MHz - 728 MHz	SDL	-
n30	2305 MHz – 2315 MHz	2350 MHz – 2360 MHz	FDD	-
n34	2 010 MHz - 2 025 MHz	2 010 MHz - 2 025 MHz	TDD	-
n38	2 570 MHz - 2 620 MHz	2 570 MHz - 2 620 MHz	TDD	-
n39	1 880 MHz - 1 920 MHz	1 880 MHz - 1 920 MHz	TDD	-
n40	2 300 MHz - 2 400 MHz	2 300 MHz - 2 400 MHz	TDD	-

Table 5. NR bands *(continued)*

NR operating band	UL operating band	DL operating band	Duplex mode	Malaysia band plan reference
n41	2 496 MHz - 2 690 MHz	2 496 MHz - 2 690 MHz	TDD	-
n46	5 150 MHz - 5 925 MHz	5 150 MHz - 5 925 MHz	TDD	-
n47	5 855 MHz - 5 925 MHz	5 855 MHz - 5 925 MHz	TDD	-
n48	3 550 MHz - 3 700 MHz	3 550 MHz - 3 700 MHz	TDD	-
n50	1 432 MHz - 1 517 MHz	1 432 MHz - 1 517 MHz	TDD	-
n51	1 427 MHz - 1 432 MHz	1 427 MHz - 1 432 MHz	TDD	-
n53	2 483.5 MHz - 2 495 MHz	2 483.5 MHz - 2 495 MHz	TDD	-
n65	1 920 MHz - 2 010 MHz	2 110 MHz - 2 200 MHz	FDD[4]	-
n66	1 710 MHz - 1 780 MHz	2 110 MHz - 2 200 MHz	FDD	-
n67	N/A	738 MHz - 758 MHz	SDL	-
n70	1 695 MHz - 1 710 MHz	1 995 MHz - 2 020 MHz	FDD	-
n71	663 MHz - 698 MHz	617 MHz - 652 MHz	FDD	-
n74	1 427 MHz - 1 470 MHz	1 475 MHz - 1 518 MHz	FDD	-
n75	N/A	1 432 MHz - 1 517 MHz	SDL	-
n76	N/A	1 427 MHz - 1 432 MHz	SDL	-
n77	3 300 MHz - 4 200 MHz	3 300 MHz - 4 200 MHz	TDD	MCMC SRSP MS 3500
n78	3 300 MHz - 3 800 MHz	3 300 MHz - 3 800 MHz	TDD	MCMC SRSP MS 3500
n79	4 400 MHz - 5 000 MHz	4 400 MHz - 5 000 MHz	TDD	-
n80	1 710 MHz - 1 785 MHz	N/A	SUL	-
n81	880 MHz - 915 MHz	N/A	SUL	-
n82	832 MHz - 862 MHz	N/A	SUL	-
n83	703 MHz - 748 MHz	N/A	SUL	-
n84	1 920 MHz - 1 980 MHz	N/A	SUL	-
n85	698 MHz - 716 MHz	728 MHz - 746 MHz	FDD	-
n86	1 710 MHz - 1 780MHz	N/A	SUL	-
n89	824 - 49 MHz	N/A	SUL	-

Table 5. NR bands *(concluded)*

NR operating band	UL operating band	DL operating band	Duplex mode	Malaysia band plan reference
n90	2 496 MHz - 2 690 MHz	2 496 MHz - 2 690 MHz	TDD	-
n91	832 MHz - 862 MHz	1 427 MHz - 1 432 MHz	FDD	-
n92	832 MHz - 862 MHz	1 432 MHz - 1 517 MHz	FDD	-
n93	880 MHz - 915 MHz	1 427 MHz - 1 432 MHz	FDD	-
n94	880 MHz - 915 MHz	1 432 MHz - 1 517 MHz	FDD	-
n95	2 010 MHz - 2 025 MHz	N/A	SUL	-
n96	5 925 MHz - 7 125 MHz	5 925 MHz - 7 125 MHz	TDD	-
n97	2 300 MHz - 2 400 MHz	N/A	SUL	-
n98	1 880 MHz - 1 920 MHz	N/A	SUL	-
n99	1 626.5 MHz - 1 660.5 MHz	N/A	SUL	-
n100	874.4 MHz - 880 MHz	919.4 MHz - 925 MHz	FDD	-
n101	1 900 MHz - 1 910 MHz	1 900 MHz - 1 910 MHz	TDD	-
n102	5 925 MHz - 6 425 MHz	5 925 MHz - 6 425 MHz	TDD	-
n104	6 425 MHz - 7 125 MHz	6 425 MHz - 7 125 MHz	TDD	-
n257	26 500 MHz - 29 500 MHz	26 500 MHz - 29 500 MHz	TDD	MCMC SRSP MS 28000
n258	24 250 MHz - 27 500 MHz	24 250 MHz - 27 500 MHz	TDD	MCMC SRSP MS 28000
n260	37 000 MHz - 40 000 MHz	37 000 MHz - 40 000 MHz	TDD	-
n261	27 500 MHz - 28 350 MHz	27 500 MHz - 28 350 MHz	TDD	MCMC SRSP MS 28000
n262	47 200 MHz - 48 200 MHz	47 200 MHz - 48 200 MHz	TDD	-
n263	57 000 MHz - 71 000 MHz	57 000 MHz - 71 000 MHz	TDD	-

7. Supplementary of IMT-2020 RITs

Supplementary of IMT-2020 RITs are specified by ITU-R M.2150-1.

7.1 5Gi

The 5Gi technology has been developed focusing mainly on large coverage cells in rural areas, known as Low Mobility Large Cell (LMLC). The 5Gi specifications provide a robust RIT with a framework ready for future enhancements. The merger of 5Gi NR interface into 3GPP was carried out as part of the 3GPP TS 38.211 specification to support lower capability NR devices and enhancements for NR coverage. This merger has resulted in a single common specification going forward and creating a single radio access for enhanced rural coverage. Complete details of the RIT can be found in Annex 3 of ITU-R M.2150-1.

5Gi is an extension of 3GPP 5G standards to meet the extended coverage requirements of less densely populated rural areas. The 5Gi LMLC feature extends connectivity and the range of base stations in rural areas by using a Pi/2-BPSK waveform with filtering in 5G networks. Using spectrum bands that can go lower than 700 MHz and up to 36 GHz, the LMLC technology increases the inter-site distance which should make the deployment cost-effective. It addresses lower mobility speeds (3 km/h to 30 km/h).

Enhanced cell coverage enabled by 5Gi will be beneficial to countries and regions that rely heavily on mobile technologies for connectivity in low density rural and remote areas, which may not be economically viable with traditional 3GPP coverage.

7.2 DECT 5G-SRIT

The DECT 5G-SRIT is developed by the European Telecommunications Standards Institute (ETSI) TC DECT and is referred to as DECT-2020 NR (NR+). DECT-2020 NR meets the ITU requirements of Ultra Reliable Low Latency Communications (URLLC) and massive Machine Type Communication (mMTC) in addition to 3GPP NR Release 15 and beyond.

The RIT DECT-2020 NR component fulfils the technical performance requirements in 2 selected test environments which are Urban Macro - URLLC and Urban Macro - mMTC. DECT-2020 NR utilises the IMT frequency bands below 6 GHz.

DECT-2020 NR is an addition to 3GPP NR and Table 6 below depicts the comparison between 3GPP NR and DECT-2020 NR.

Table 6. Comparison between 3GPP NR and DECT-2020 NR

Specification Development	3GPP	ETSI
Deployment	Public network Non-public network	Indoor or outdoor deployment
Topology	Cellular	Point-to-Point (P2P), Point-to-Multipoint (P2M), star, mesh, tree, cellular

Table 6. Comparison between 3GPP NR and DECT-2020 NR (*continued)*

Specification Development	3GPP	ETSI
Device type	Base station, user equipment	Radio Devices (RD) in context-based roles. Fixed Termination Point (FT) or Portable Termination Point (PT)
Spectrum	Licensed spectrum	Unlicensed 1.9 GHz, IMT bands below 6 GHz
Spectrum management	Planning by MNOs	Local self-organising
Infrastructure	Deployed by MNOs	User deployed RDs
User devices	UE	RD

DECT-2020 NR can be used for the foundation of:

a) Very reliable P2P and P2M wireless links provisioning (e.g. cable replacement solutions).

b) Local area wireless access networks following a star topology as in classical DECT deployment supporting URLLC use cases.

c) Self-organising local area wireless access networks following a mesh network topology, which enables support of mMTC use cases.

Annex A
(informative)

Normative reference

MCMC SRSP MS 700, *Requirements for International Mobile Telecommunications Systems Operating in Frequency Bands of 703 MHz to 743 MHz and 758 MHz to 798 MHz*

MCMC SRSP MS 3500, *Requirements for International Mobile Telecommunications Systems Operating in Frequency Bands of 3400 MHz to 3600 MHz*

MCMC SRSP MS 28000, *Requirements for International Mobile Telecommunications Systems Operating in Frequency Bands of 26.5 GHz to 28.1 GHz*

MCMC MTSFB TC G028, *IMT-2020 (Fifth Generation) - Security Requirements*

Radio Regulations Articles Edition of 2020, ITU

Recommendation ITU-R M.2083-0, *IMT Vision, Framework and overall objectives of the future development of IMT for 2020 and beyond*

Recommendation ITU-R M.2150-1, *Detailed specifications of the terrestrial radio interfaces of International Mobile Telecommunications-2020 (IMT-2020) - M Series Mobile, radiodetermination, amateur and related satellite services*

Recommendation ITU-T Y.3101, *Requirement of the IMT-2020 Network - Global, Information Infrastructure, Internet Protocol Aspects, Next Generation Networks, Internet of Things and Smart Cities*

Recommendation ITU-T Y.3102, *Framework of the IMT-2020 network - Global, Information Infrastructure, Internet Protocol Aspects, Next Generation Networks, Internet of Things and Smart Cities*

Recommendation ITU-T Y.3104, *Architecture of the IMT-2020 network - Global, Information Infrastructure, Internet Protocol Aspects, Next Generation Networks, Internet of Things and Smart Cities*

Recommendation ITU-T Y.3105, *Requirements of capability exposure in the IMT-2020 network - Global, Information Infrastructure, Internet Protocol Aspects, Next Generation Networks, Internet of Things and Smart Cities*

Recommendation ITU-T Y.3106, *Quality of service functional requirements for the IMT-2020 network - Global, Information Infrastructure, Internet Protocol Aspects, Next Generation Networks, Internet of Things and Smart Cities*

Recommendation ITU-T Y.3107, *Functional architecture for QoS assurance management in the IMT-2020 network - Global, Information Infrastructure, Internet Protocol Aspects, Next Generation Networks, Internet of Things and Smart Cities*

Recommendation ITU-T Y.3108, *Capability exposure function in IMT-2020 networks - Global, Information Infrastructure, Internet Protocol Aspects, Next Generation Networks, Internet of Things and Smart Cities*

Recommendation ITU-T Y.3110, *IMT-2020 network management and orchestration requirements - Global, Information Infrastructure, Internet Protocol Aspects, Next Generation Networks, Internet of Things and Smart Cities*

Recommendation ITU-T Y.3111, *IMT-2020 network management and orchestration framework - Global, Information Infrastructure, Internet Protocol Aspects, Next Generation Networks, Internet of Things and Smart Cities*

Recommendation ITU-T Y.3112, *Framework for the support of network slicing in the IMT-2020 network - Global, Information Infrastructure, Internet Protocol Aspects, Next Generation Networks, Internet of Things and Smart Cities*

Recommendation ITU-T Y.3130, *Requirements of IMT-2020 fixed mobile convergence - Global, Information Infrastructure, Internet Protocol Aspects, Next Generation Networks, Internet of Things and Smart Cities*

Recommendation ITU-T Y.3131, *Functional architecture for supporting fixed mobile convergence in IMT-2020 networks - Global, Information Infrastructure, Internet Protocol Aspects, Next Generation Networks, Internet of Things and Smart Cities*

Recommendation ITU-T Y.3153, *Network slice orchestration and management for providing network services to 3rd party in the IMT-2020 network - Global, Information Infrastructure, Internet Protocol Aspects, Next Generation Networks, Internet of Things and Smart Cities*

Report ITU-R M.2320-0, *Future technology trends of terrestrial IMT systems*

Report ITU-R M.2410-0, *Minimum requirements related to technical performance for IMT-2020 radio interface(s)*

Report ITU-R M.2412-0, *Guidelines for evaluation of radio interface technologies for IMT-2020*

3GPP Release 14: TR 38.801, *3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Study on New Radio Access Technology: Radio Access Architecture and Interface*

3GPP Release 15: TR 21.915*, 3rd Generation Partnership Project; Technical Specification Group Services and system Aspects; Release 15 Description; Summary of Rel-15 Work Items*

3GPP Release 16: TR 21.916*, 3rd Generation Partnership Project; Technical Specification Group Services and system Aspects; Release 16 Description; Summary of Rel-16 Work Items*

3GPP Release 17: TR 21.917*, 3rd Generation Partnership Project; Technical Specification Group Services and system Aspects; Release 17 Description; Summary of Rel-17 Work Items*

3GPP Release 17: TS 23.247*, 3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Release 17 Description; Architectural enhancements for 5G multicast-broadcast services*

3GPP Release 17: TS 23.288*, 3rd Generation Partnership Project; Technical Specification Group Services and system Aspects; Release 17 Description; Architecture enhancements for 5G System (5GS) to support network data analytics services*

3GPP Release 17: TS 23.316*, 3rd Generation Partnership Project; Technical Specification Group Services and system Aspects; Release 17 Description; Wireless and wireline convergence access support for the 5G System (5GS)*

3GPP Release 17: TS 23.402*, 3rd Generation Partnership Project; Technical Specification Group Services and system Aspects; Release 17 Description; Architecture enhancements for non-3GPP accesses*

3GPP Release 17: TS 23.501, *3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; System architecture for the 5G system (5GS); Stage 2*

3GPP Release 17: TS 29.504, *3rd Generation Partnership Project; Technical Specification Group Core Network and Terminal; 5G System; Unified Data Repository Services; Stage 3*

3GPP Release 17: TS 33.501, *3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Security architecture and procedures for 5G system*

3GPP Release 17: TS 37.340, *3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA) and NR; Multi-connectivity; Stage 2*

3GPP Release 17: TS 38.104, *3rd Generation Partnership Project; Technical Specification Group Radio Access Network; NR; Base Station (BS) radio transmission and reception*

3GPP Release 17: TS 38.211, *3rd Generation Partnership Project; Technical Specification Group Radio Access Network; 5G; NR; Physical channels and modulation*

3GPP Release 17: TS 38.300, *3rd Generation Partnership Project; Technical Specification Group Radio Access Network; NR; NR and NG-RAN Overall Description; Stage 2*

3GPP Release 17: TS 38.401, *3rd Generation Partnership Project; Technical Specification Group Radio Access Network; NG-RAN; Architecture description*

IEEE 802.1AS-2020, *IEEE Standard for Local and Metropolitan Area Networks--Timing and Synchronization for Time-Sensitive Applications*

IEEE 1588-2019*, IEEE Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems*

GSM Association, NG.113, *5G Roaming Guidelines v1.0,* December 2019

GSM Association, Report, *Infrastructure Sharing: An Overview*, June 2019

Annex B
(informative)

Abbreviations

For the purposes of this Technical Code, the following abbreviations apply.

5G-EIR	5G-Equipment Identity Register
AAA	Authentication and Authorisation
ADRF	Analytics Data Repository Function
AKA	Authentication and Key Agreement
AKAAC	Authentication and Key Agreement Access Network
AMF	Access and Mobility Management Function
AN	Access Network
API	Application Programming Interface
ARPF	Authentication Credential Repository and Processing Function
AUSF	Authentication Server Function
CN	Core Network
CP	Cyclic Prefix
CU	Central Unit
DCCF	Data Collection Coordination Function
DFT-s-OFDM	Discrete Fourier Transform precoding
DL	Downlink
DU	Distributed Unit
DNS	Domain Name System
DRX	Discontinuous Reception
eMBB	Enhanced Mobile Broadband
eMTC	Enhanced Machine Type Communication
EASDF	Edge Application Server Discovery Function
EN-DC	Evolved Universal Terrestrial Radio Access New Radio Dual Connectivity
EPC	Evolved Packet Core
E-UTRA	Evolved Universal Terrestrial Radio Access
FEC	Forward Error Control
FDD	Frequency Division Duplex
FMSS	Flexible Mobile Service Steering
FR	Frequency Range
GBR	Guaranteed Bit Rate
gNB	G-Node B
gNB-CU	gNB-Central Unit

gNB-DU	gNB-Distributed Unit
GSMA	GSM Association
HPLMN	Home Public Land Mobile Network
HSS	Home Subscriber Server
IMS	IP-Multimedia Subsystem
IMT-2020	International Mobile Telecommunications 2020
IP	Internet Protocol
IPSec	IP Security
IPv4	Internet Protocol version 4
IPv4v6	Internet Protocol version 4 version 6
IPv6	Internet Protocol version 6
LTE	Long Term Evolution
LTE-M	Long Term Evolution for Machine
MB-UPF	Multicast Broadcast User Plane Function
MB-SMF	Multicast Broadcast Session Management Function
MBSF	Multicast Broadcast Service Function
MBSTF	Multicast Broadcast Service Transport Function
MCPTT	Mission Critical Push to Talk
MCVideo	Mission Critical Video
MEC	Multi-access Edge Computing
MFAF	Messaging Framework Adaptor Function
MIMO	Multiple-Input and Multiple-Output
mIoT	Massive Internet of Things
MME	Mobility Management Entity
mMTC	Massive Machine Type Communications
MOCN	Multi-Operator Core Network
MORAN	Multi-Operator Radio Access Network
MR-DC	Multi-Radio Dual Connectivity
N5CW	Non-5G-Capable over WLAN
NAS	Network Attached Storage
NB-IoT	Narrowband Internet of Things
NEF	Network Exposure Function
NE-DC	New Radio Evolved Universal Terrestrial Radio Access Dual Connectivity
NF	Network Functions
NGEN-DC	Next Generation Radio Access Network Evolved Universal Terrestrial Radio Access-New Radio Dual Connectivity
ng-eNB	Next Generation E-Node B
NR	New Radio

NRF	Network Repository Function
NR-DC	New-Radio Dual Connectivity
NS	Network Slices
NSA	Non-standalone
NSACF	Network Slice Admission Control Function
NSSAAF	Network Slice Specific Authentication and Authorisation Function
NSSAI	Network Slice Selection Assistance Information
NSSF	Network Slice Selection Function
NSWOF	Non-Seamless Wireless Local Area Network (WLAN) Offload Function
NWDAF	Network Data Analytics Function
OAM	Operations, Administration and Maintenance
OFDM	Orthogonal Frequency Division Multiplexing
PCEF	Policy and Charging Enforcement Function
PCF	Policy Control Function
PDU	Protocol Data Unit
PDR	Packet Detection Rule
PEI	Permanent Equipment Identifier
PGW-C	Packet Data Network Gateway Control
PLMN	Public Land Mobile Network
QCI	QoS Class Identifier
QFI	QoS Flow Identifier
QoS	Quality of Service
RAT	Radio Access Technology
RG	Residential Gateway
RIT	Radio Interface Technologies
RRC	Radio Resource Control
SA	Standalone
SBA	Service-Base Architecture
SBI	Service Based Interface
SCP	Service Communication Proxy
SDF	Service Data Flow
SEAF	Security Anchor Function
SEES	Service Exposure and Enablement Support
SEPP	Security Edge Protection Proxy
SGW-C	Serving Gateway Control
SIDF	Subscription Identifier De-Concealing Function
SM	Session Management
SMF	Session Management Function

SMS	Short Message Service
SNPN	Stand-alone Non-Public Networks
SRIT	Set of Radio Interface Technologies
SUCI	Subscription Concealed Identifier
SUL	Supplementary Uplink
SUPI	Subscription Permanent Identifier
TDD	Time Division Duplex
TNAN	Trusted Non-3GPP Access Network
TNGF	Trusted Non-3GPP Gateway Function
TPC	Transmit Power Control
TSNTSF	Time Sensitive Networking (TSN) Time Synchronisation Function
TSN	Time Sensitive Networking
TWIF	Trusted WLAN Interworking Function
TXRU	Transceiver Unit
UCMF	UE radio Capability Management Function
UDM	Unified Data Management
UDR	Unified Data Repository
UDSF	Unstructured Data Storage Function
UE	User Equipment
UL	Uplink
UPF	User Plane Functions
URLLC	Ultra-Reliable Low Latency Communications
V2X	Vehicle-to-everything
VPLMN	Visited Public Land Mobile Network
W-AGF	Wireline Access Gateway Function
WLAN	Wireless Local Area Network

Annex C
(normative)

IMT-2020 radio interface technical performance

C.1 Requirements of technical performance for IMT-2020 radio interfaces

The requirements of technical performance for IMT-2020 radio interfaces are stipulated in ITU-R M.2410-0 as shown in Table C.1.

Table C.1. IMT-2020 radio interface technical requirements

Parameter	Indoor hotspot (eMBB)	Dense urban (eMBB)	Rural (eMBB)	Urban macro (mMTC)	Urban macro (URLLC)	Evaluation methodology
Peak data rate	Downlink: 20 Gbps Uplink: 10 Gbps			N/A	N/A	Analytical
Peak spectral efficiency	Downlink: 30 bps/Hz Uplink: 15 bps/Hz			N/A	N/A	Analytical
User experience data rate	N/A	Downlink: 100 Mbps Uplink: 50 Mbps	N/A	N/A	N/A	Analytical for single band and single layer cell layout. Simulation for multilayer cell layout
5th percentile user spectral efficiency	Downlink: 0.3 bps/Hz Uplink: 0.21 bps/Hz	Downlink: 0.225 bps/Hz Uplink: 0.15 bps/Hz	Downlink: 0.12 bps/Hz Uplink: 0.445 bps/Hz	N/A	N/A	Simulation
Average spectral efficiency	Downlink: 9 bps/Hz Uplink: 6.75 bps/Hz	Downlink: 7.8 bps/Hz Uplink: 5.4 bps/Hz	Downlink: 3.3 bps/Hz Uplink: 1.6 bps/Hz	N/A	N/A	Simulation
Area traffic capacity	10 $Mbps/m^2$	N/A	N/A	N/A	N/A	Analytical
Latency user plane	4 ms			N/A	1 ms	Analytical
Latency control plane	20 ms			N/A	20 ms	
Connection density	N/A	N/A	N/A	1,000,000 $device/km^2$	N/A	Analytical

Table C.1. IMT-2020 radio interface technical requirements *(continued)*

Parameter	Indoor hotspot (eMBB)	Dense urban (eMBB)	Rural (eMBB)	Urban macro (mMTC)	Urban macro (URLLC)	Evaluation methodology
Energy efficiency	Shall have the capability to support a high sleep ratio and long sleep duration			N/A	N/A	Simulation
Reliability	N/A	N/A	N/A	N/A	1 - 10^{-5} success probability of transmitting a layer 2 PDU of 32 bytes within 1 ms	Inspection
Mobility	Normalised traffic channel link data rates of 1.5 bps/Hz at 10 km/h in the uplink	Normalised traffic channel link data rates of 1.12 bps/Hz at 30 km/h in the uplink	Normalised traffic channel link data rates of 0.8 and 0.45 bps/Hz at 120 km/h and 500 km/h respectively in the uplink	N/A	N/A	Simulation
Mobility interruption time	0 ms			N/A	0 ms	Analytical
Bandwidth	Minimum of 100 MHz for operation in FR1 Minimum of 1 GHz for operation in higher frequency bands (FR2)					Inspection

C.2 User plane procedure for evaluation of user plane latency

The user plane procedure for evaluation of latency is shown in Figure C.1

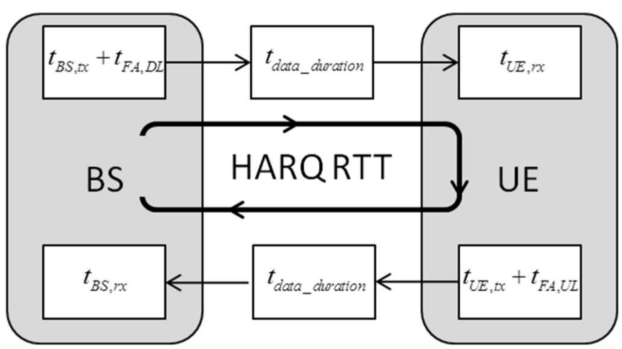

Figure C.1. User plane procedure for evaluation of user plane latency

Bibliography

[1] 3GPP Release 15: TS 23.501, *3rd Generation Partnership Project; 5G: System Architecture for the 5G System; Technical Specification (Release 15)*

[2] 3GPP Release 15: TS 23.502, *3rd Generation Partnership Project; 5G: Procedures for the 5G System (5GS); Technical Specification (Release 15)*

[3] 3GPP Release 15: TS 38.410, *3rd Generation Partnership Project; 5G; NG-RAN; NG general aspects and principles; Technical Specification (Release 15)*

[4] GSM Association, Report, Road to 5G: Introduction and Migration, April 2018

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