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Contents

Foreword

This Technical Specification has been produced by the 3rd Generation Partnership Project (3GPP).

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Introduction

The need to support different kinds of UEs (e.g. for the Internet of Things (IoT)), services, and technologies is driving the technology revolution to a high-performance and highly efficient 3GPP system. The drivers include IoT, Virtual Reality (VR), industrial control, ubiquitous on-demand coverage, as well as the opportunity to meet customized market needs. These drivers require enhancements to the devices, services, and technologies well established by 3GPP. The key objective with the 5G system is to be able to support new deployment scenarios to address diverse market segments.

This document compiles requirements that define a 5G system.

The 5G system is characterised, for example, by:

- Support for multiple access technologies
- Scalable and customizable network
- Advanced Key Performance Indicators (KPIs) (e.g. availability, latency, reliability, user experienced data rates, area traffic capacity)
- Flexibility and programmability (e.g. network slicing, diverse mobility management, Network Function Virtualization)
- Resource efficiency (both user plane and control plane)
- Seamless mobility in densely populated and heterogeneous environment
- Support for real time and non-real time multimedia services and applications with advanced Quality of Experience (QoE)

1 Scope

The present document describes the service and operational requirements for a 5G system, including a UE, NG-RAN, and 5G Core network. Requirements for a 5G E-UTRA-NR Dual Connectivity in E-UTRAN connected to EPC are found in TS 22.278 [5].

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] NGMN 5G White Paper v1.0, February 2015.

[3] 3GPP TS 22.011: "Service accessibility".

[4] NGMN, "Perspectives on Vertical Industries and Implications for 5G, v2.0", September 2016.

[5] 3GPP TS 22.278: "Service requirements for the Evolved Packet System (EPS)".

[6] 3GPP TS 22.101: "Service aspects; Service principles".

[7] 3GPP TS 22.146: "Multimedia Broadcast/Multicast Service (MBMS)".

[8] 3GPP TS 22.246: "Multimedia Broadcast/Multicast Service (MBMS) user services".

[9] 3GPP TS 22.186: "Enhancement of 3GPP support for V2X scenarios".

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[19] IEC 61907, "Communication network dependability engineering".

[20] NIST, "Framework for Cyber-Physical Systems", 2016.

[21] 3GPP TS 22.104: "Service requirements for cyber-physical control applications in vertical domains".

[22] 3GPP TS 22.262: "Message Service within the 5G System".

[23] 3GPP TS 22.289: "Mobile Communication System for Railways".

[24] 3GPP TS 22.071: " Location Services".

[25] 3GPP TS 23.122: "Non-Access-Stratum (NAS) functions related to Mobile Station (MS) in idle mode".

[26] 3GPP TS 22.125: "Unmanned Aerial System (UAS) support in 3GPP ".

[27] 3GPP TS 22.468: "Group Communication System Enablers (GCSE) ".

[28] 3GPP TS 22.263: "Service requirements for Video, Imaging and Audio for Professional Applications (VIAPA)".

[29] 3GPP TS 22.263: "Service requirements for Video, Imaging and Audio for Professional Applications".

[30] 3GPP TS 22.179: "Mission Critical Push to Talk (MCPTT)".

[31] 3GPP TS 22.268: "Public Warning System (PWS) requirements".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in 3GPP TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in 3GPP TR 21.905 [1].

5G enhanced positioning area: a subset of the 5G positioning service area that is assumed to be provided with additional infrastructure or deploy a particular set of positioning technologies to enhance positioning services.

NOTE 1: The enhanced positioning service area represents for example a factory plant, a dense urban area, an area along a road or railway track, a tunnel and covers both indoor and outdoor environments.

5G LAN-type service: a service over the 5G system offering private communication using IP and/or non-, i.e. UEs that are members of the same 5G LAN-VN IP type communications.

5G LAN-virtual network: a virtual network capable of supporting 5G LAN-type service.

5G satellite access network: 5G access network using at least one satellite.

5G positioning service area: a service area where positioning services would solely rely on infrastructures and positioning technologies that can be assumed to be present anywhere where 5G is present (e.g. a country-wide operator-supplied 5G network, GNSS, position/motion sensors).

NOTE 2: This includes both indoor and any outdoor environments.

active communication: a UE is in active communication when it has one or more connections established. A UE may have any combination of PS connections (e.g. PDP contexts, active PDN connections).

activity factor: percentage value of the amount of simultaneous active UEs to the total number of UEs where active means the UEs are exchanging data with the network.

area traffic capacity: total traffic throughput served per geographic area.

communication service availability: percentage value of the amount of time the end-to-end communication service is delivered according to a specified QoS, divided by the amount of time the system is expected to deliver the end-to-end service.

NOTE 3: The end point in "end-to-end" is the communication service interface.

NOTE 4: The communication service is considered unavailable if it does not meet the pertinent QoS requirements. For example, the communication service is unavailable if a message is not correctly received within a specified time, which is the sum of maximum allowed end-to-end latency and survival time.

direct device connection: the connection between two UEs without any network entity in the middle.

direct network connection: one mode of network connection, where there is no relay UE between a UE and the 5G network.

Disaster Condition: This is the condition that a government decides when to initiate and terminate, e.g. a natural disaster. When this condition applies, users may have the opportunity to mitigate service interruptions and failures.

Disaster Inbound Roamer: A user that (a) cannot get service from the PLMN it would normally be served by, due to failure of service during a Disaster Condition, and (b) is able to register with other PLMNs.

Disaster Roaming: This is the special roaming policy that applies during a Disaster Condition.

end-to-end latency: the time that it takes to transfer a given piece of information from a source to a destination, measured at the communication interface, from the moment it is transmitted by the source to the moment it is successfully received at the destination.

Hosted Service: a service containing the operator's own application(s) and/or trusted third-party application(s) in the Service Hosting Environment, which can be accessed by the user.

indirect network connection: one mode of network connection, where there is a relay UE between a UE and the 5G network.

IoT device: a type of UE which is dedicated for a set of specific use cases or services and which is allowed to make use of certain features restricted to this type of UEs.

NOTE 5: An IoT device may be optimized for the specific needs of services and application being executed (e.g. smart home/city, smart utilities, e-Health and smart wearables). Some IoT devices are not intended for human type communications.

network slice: a set of network functions and corresponding resources necessary to provide the required telecommunication services and network capabilities.

NG-RAN: a radio access network connecting to the 5G core network which uses NR, E-UTRA, or both.

non-public network: a network that is intended for non-public use.

NR: the new 5G radio access technology.

positioning service availability: percentage value of the amount of time the positioning service is delivering the required position-related data within the performance requirements, divided by the amount of time the system is expected to deliver the positioning service according to the specification in the targeted service area.

positioning service latency: time elapsed between the event that triggers the determination of the position-related data and the availability of the position-related data at the system interface.

priority service: a service that requires priority treatment based on regional/national or operator policies.

private communication: a communication between two or more UEs belonging to a restricted set of UEs**.**

private network: an isolated network deployment that does not interact with a public network.

private slice: a dedicated network slice deployment for the sole use by a specific third-party.

relative positioning: relative positioning is to estimate position relatively to other network elements or relatively to other UEs.

reliability: in the context of network layer packet transmissions, percentage value of the packets successfully delivered to a given system entity within the time constraint required by the targeted service out of all the packets transmitted.

satellite: a space-borne vehicle embarking a bent pipe payload or a regenerative payload telecommunication transmitter, placed into Low-Earth Orbit (LEO) typically at an altitude between 300 km to 2 000 km, Medium-Earth Orbit (MEO) typically at an altitude between 8 000 to 20 000 k m, or Geostationary satellite Earth Orbit (GEO) at 35 786 km altitude.

satellite access: direct connectivity between the UE and the satellite.

satellite NG-RAN: a NG-RAN which uses NR in providing satellite access to UEs.

service area: geographic region where a 3GPP communication service is accessible.

NOTE 6: The service area can be indoors.

NOTE 7: For some deployments, e.g. in process industry, the vertical dimension of the service area can be considerable.

service continuity: the uninterrupted user experience of a service that is using an active communication when a UE undergoes an access change without, as far as possible, the user noticing the change.

NOTE 8: In particular service continuity encompasses the possibility that after a change the user experience is maintained by a different telecommunication service (e.g. tele- or bearer service) than before the change.

NOTE 9: Examples of access changes include the following. For EPS: CS/PS domain change. For EPS and 5G: radio access change, switching between a direct network connection and an indirect network connection.

Service Hosting Environment: the environment, located inside of 5G network and fully controlled by the operator, where Hosted Services are offered from.

survival time: the time that an application consuming a communication service may continue without an anticipated message.

Time to First Fix (TTFF): time elapsed between the event triggering for the first time the determination of the position-related data and the availability of the position-related data at the positioning system interface.

User Equipment: An equipment that allows a user access to network services via 3GPP and/or non-3GPP accesses.

user experienced data rate: the minimum data rate required to achieve a sufficient quality experience, with the exception of scenario for broadcast like services where the given value is the maximum that is needed.

wireless backhaul: a link which provides an interconnection between 5G network nodes and/or transport network using 5G radio access technology**.**

3.2 Abbreviations

For the purposes of the present document, the abbreviations given in 3GPP TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in 3GPP TR 21.905 [1].

5G LAN-VN	5G LAN-Virtual Network
A/S	Actuator/Sensor
eFMSS	Enhancement to Flexible Mobile Service Steering
eV2X	Enhanced V2X
FMSS	Flexible Mobile Service Steering
GEO	Geostationary satellite Earth Orbit
ICP	Internet Content Provider
ID	Identification
IMU	Inertial Measurement Unit
IOPS	Isolated E-UTRAN Operation for Public Safety

LEO	Low-Earth Orbit
MCS	Mission Critical Services
MCX	Mission Critical X, with X = PTT or X = Video or X = Data
MEO	Medium-Earth Orbit
MIoT	Massive Internet of Things
MMTEL	Multimedia Telephony
MPS	Multimedia Priority Service
MSGin5G	Message Service Within the 5G System
NPN	Non-Public Network
RSTP	Rapid Spanning Tree Protocol
SEES	Service Exposure and Enablement S
SST	Slice/Service Type
TTFF	Time To First Fix
UAV	Uncrewed Aerial Vehicle

4 Overview

Unlike previous 3GPP systems that attempted to provide a 'one size fits all' system, the 5G system is expected to be able to provide optimized support for a variety of different services, different traffic loads, and different end user communities. Various industry white papers, most notably, the NGMN 5G White Paper [2], describe a multi-faceted 5G system capable of simultaneously supporting multiple combinations of reliability, latency, throughput, positioning, and availability. This technology revolution is achievable with the introduction of new technologies, both in access and the core, such as flexible, scalable assignment of network resources. In addition to increased flexibility and optimization, a 5G system needs to support stringent KPIs for latency, reliability, throughput, etc. Enhancements in the radio interface contribute to meeting these KPIs as do enhancements in the core network, such as network slicing, in-network caching and hosting services closer to the end points.

A 5G system also supports new business models such as those for IoT and enterprise managed networks. Drivers for the 5G KPIs include services such as Uncrewed Aerial Vehicle (UAV) control, Augmented Reality (AR), and factory automation. Network flexibility enhancements support self-contained enterprise networks, installed and maintained by network operators while being managed by the enterprise. Enhanced connection modes and evolved security facilitate support of massive IoT, expected to include tens of millions of UEs sending and receiving data over the 5G network.

Flexible network operations are the mainstay of the 5G system. The capabilities to provide this flexibility include network slicing, network capability exposure, scalability, and diverse mobility. Other network operations requirements address the necessary control and data plane resource efficiencies, as well as network configurations that optimize service delivery by minimizing routing between end users and application servers. Enhanced charging and security mechanisms handle new types of UEs connecting to the network in different ways.

Mobile Broadband (MBB) enhancements aim to meet a number of new KPIs. These pertain to high data rates, high user density, high user mobility, highly variable data rates, deployment, and coverage. High data rates are driven by the increasing use of data for services such as streaming (e.g. video, music, and user generated content), interactive services (e.g. AR), and IoT. These services come with stringent requirements for user experienced data rates as well as associated requirements for latency to meet service requirements. Additionally, increased coverage in densely populated areas such as sports arenas, urban areas, and transportation hubs has become essential for pedestrians and users in urban vehicles. New KPIs on traffic and connection density enable both the transport of high volumes of data traffic per area (traffic density) and transport of data for a high number of connections (e.g. UE density or connection density). Many UEs are expected to support a variety of services which exchange either a very large (e.g. streaming video) or very small (e.g. data burst) amount of data. The 5G system will handle this variability in a resource efficient manner. All of these cases introduce new deployment requirements for indoor and outdoor, local area connectivity, high user density, wide area connectivity, and UEs travelling at high speeds.

Another aspect of 5G KPIs includes requirements for various combinations of latency and reliability, as well as higher accuracy for positioning. These KPIs are driven by support for both commercial and public safety services. On the commercial side, industrial control, industrial automation, UAV control, and AR are examples of those services. Services such as UAV control will require more precise positioning information that includes altitude, speed, and direction, in addition to horizontal coordinates.

Support for Massive Internet of Things (MIoT) brings many new requirements in addition to those for the enhanced KPIs. The expansion of connected things introduces a need for significant improvements in resource efficiency in all system components (e.g. UEs, IoT devices, radio, access network, core network).

The 5G system also aims to enhance its capability to meet KPIs that emerging V2X applications require. For these advanced applications, the requirements, such as data rate, reliability, latency, communication range and speed, are made more stringent.

5 High-level requirements

5.1 Migration to 5G

5.1.1 Description

The 5G system supports most of the existing EPS services, in addition to many new services. The existing EPS services may be accessed using the new 5G access technologies even where the EPS specifications might indicate E-UTRA(N) only. Only new or changed service requirements for new or changed services are specified in this TS. The few EPS capabilities that are not supported by the 5G system are identified in clause 5.1.2.2 below.

5.1.2 Requirements

5.1.2.1 Interworking between 5G systems

The 5G system shall support a UE with a 5G subscription roaming into a 5G Visited Mobile Network which has a roaming agreement with the UE's 5G Home Mobile Network.

The 5G system shall enable a Visited Mobile Network to provide support for establishing home network provided data connectivity as well as visited network provided data connectivity.

The 5G system shall enable a Visited Mobile Network to provide support for services provided in the home network as well as provide services in the visited network. Whether a service is provided in the visited network or in the home network is determined on a service by service basis.

The 5G system shall provide a mechanism for a network operator to limit access to its services for a roaming UE, (e.g. based on roaming agreement).

The 5G system shall provide a mechanism for a network operator to direct a UE onto a partnership network for routing all or some of the UE user plane and associated control plane traffic over the partnership network, subject to an agreement between the operators.

5.1.2.2 Legacy service support

In principle, the 5G system shall support all EPS capabilities (e.g. from TSs 22.011, 22.101, 22.278, 22.185, 22.071, 22.115, 22.153, 22.173, 22.468). However,

- voice service continuity from NG-RAN to GERAN shall not be supported,
- voice service continuity from NG-RAN to UTRAN CS should be supported (see Note),
- voice service continuity from GERAN to NG-RAN shall not be supported,
- voice service continuity from UTRAN to NG-RAN shall not be supported,
- CS fallback from NG-RAN to GERAN shall not be supported,
- CS fallback from NG-RAN to UTRAN shall not be supported,
- seamless handover between NG-RAN and GERAN shall not be supported,
- seamless handover between NG-RAN and UTRAN shall not be supported,
- access to a 5G core network via GERAN or UTRAN shall not be supported,
- video service continuity between 5GS and UMTS shall not be supported,

- IP address preservation for PS service when UE moves between 5GS and GSM/UMTS shall not be supported, and

- Service continuity between 5GS and CDMA2000 shall not be supported.

NOTE: Architectural or protocol changes needed to support voice service continuity from NG-RAN to UTRAN CS are expected to have minimum impact on architecture, specifications, or the development of the 5G New Core and New Radio.

5.1.2.3 Interoperability with legacy 3GPP systems

The 5G system shall support mobility procedures between a 5G core network and an EPC with minimum impact to the user experience (e.g. QoS, QoE).

6 Basic capabilities

6.1 Network slicing

6.1.1 Description

Network slicing allows the operator to provide customised networks. For example, there can be different requirements on functionality (e.g. priority, charging, policy control, security, and mobility), differences in performance requirements (e.g. latency, mobility, availability, reliability and data rates), or they can serve only specific users (e.g. MPS users, Public Safety users, corporate customers, roamers, or hosting an MVNO).

A network slice can provide the functionality of a complete network, including radio access network functions, core network functions (e.g. potentially from different vendors) and IMS functions. One network can support one or several network slices.

6.1.2 Requirements

6.1.2.1 General

The serving 5G network shall support providing connectivity to home and roaming users in the same network slice.

In shared 5G network configuration, each operator shall be able to apply all the requirements from this clause to their allocated network resources.

The 5G system shall be able to support IMS as part of a network slice.

The 5G system shall be able to support IMS independent of network slices.

6.1.2.2 Management

The 5G system shall allow the operator to create, modify, and delete a network slice.

The 5G system shall allow the operator to define and update the set of services and capabilities supported in a network slice.

The 5G system shall allow the operator to configure the information which associates a UE to a network slice.

The 5G system shall allow the operator to configure the information which associates a service to a network slice.

The 5G system shall allow the operator to assign a UE to a network slice, to move a UE from one network slice to another, and to remove a UE from a network slice based on subscription, UE capabilities, the access technology being used by the UE, operator's policies and services provided by the network slice.

The 5G system shall support a mechanism for the VPLMN, as authorized by the HPLMN, to assign a UE to a network slice with the needed services or to a default network slice.