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Speech and multimedia Transmission Quality (STQ);
QoS parameters and test scenarios for assessing network capabilities in 5G performance measurements

Reference

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Keywords

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Speech and multimedia Transmission Quality (STQ).

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Introduction

As the industry deploys 5G networks and launches 5G plans and services, it is acknowledged that it will facilitate improved service experience and the enablement of new business and services. This will include a variety of services, applications and use cases ranging from those requiring high data rates through enhanced mobile broadband (eMBB) to those requiring ultra-reliable low latency (uRLLC) as well as those supporting massive machine type communication (mMTC). Many existing applications and services such as voice, data and video will continue to be widely used with the expectation that they will benefit through superior quality, reduced access times and greater reliability. In addition, new use cases, applications and service scenarios, which are facilitated by 5G, will have specific performance requirements that require measurement and evaluation. As operators develop 5G service strategies, establish network requirements and develop networks to meet those requirements, it is important to be able to quantify and qualify the capabilities of the network. To achieve this, it is necessary to examine what QoS parameters should be measured to quantify a networks capability and how the resultant service or application QoS will be assessed. To that end, the purpose of the present document is to identify those QoS parameters and the test scenarios that can evaluate 5G performance and measure the network capability and readiness.

At the current stage of network development, with the focus on data rates, the present document will focus on eMBB and the use cases and services it enables such as ultra-high definition video or virtual reality as primary examples. It should be noted that while the performance requirements will evolve during the lifecycle of the 5G network to meet new use cases and customer expectations, the QoS parameters and test scenarios will continue to provide a means to measure the network capabilities to meet these requirements.

There are many aspects of advanced technology and 5G features to consider when examining the impact on quality of service including MEC, where interactivity requirements influence deployment strategies, to network slicing, where context aware intelligence directs traffic according to application requirements, to radio features such as beam forming and massive MIMO, which provide intelligent management of the air interface and many others. Given the complexity of 5G features, the aim of the present document is to focus on the end to end network capability with reference to 5G feature considerations where required. In this regard, it is necessary to examine performance measurement scenarios [i.2], to determine the network technical parameters and consider the impact on end user service experience [i.6]. In addition, to support QoS parameter measurement, the test scenarios that measure the network capability will be described.

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1 Scope

Given the current stage of 5G deployments and the focus on eMBB, the present document, will primarily concentrate on QoS parameters in relation to eMBB performance scenarios and the most prevalent eMBB related service scenarios. Therefore, the focus will be on QoS parameters that reflect the network capabilities in the case of visual applications such as UHD video and Virtual and Augmented Reality. However, whilst these technologies, are primarily categorized as requiring high data rates, it is necessary to be mindful and examine the relationship and requirements in high data rates and low latency scenarios.

In the scope of this analysis, the term QoS relies on service-related characteristics without knowing any details about the underlying network sections [i.6], the network architecture and the network or application deployment strategies. The scope will concentrate on measuring the network capability, assessed primarily through network QoS parameters, such as data rates, capacity, coverage, latency and continuity measurements. The readiness of the network to support the QoS needs of existing services and applications such as voice, data and video and those newly enabled technologies and use cases mentioned earlier that benefit from the higher data rates associated with eMBB will also be considered.

The approach therefore will be to assess network capabilities by first identifying the performance scenario requirements, then discovering the QoS parameters that will measure those requirements and finally defining the test scenarios to measure those QoS parameters as follows:

1) Identify scenarios in terms of performance, service and user types to determine the performance measurement requirements and the key performance factors that will satisfy those requirements:

   - Performance scenarios [i.2] which are dependent on traffic types, traffic densities and service areas.

   - Service scenarios that consider the use cases, technology and applications that place data service requirements on the network for effective operation.

   - User type scenarios that examine various types of users and how they place different requirements on similar services.

2) QoS parameter discovery to identify and define the parameters that represent the key performance factors and scenario requirements. The QoS parameters will define how to effectively measure the network technical performance as well as examining how a use case or application might be affected by those network conditions. The QoS parameters in as much as possible will refer to existing definitions and best practises.

3) Provide test scenario analysis to detail the types of tests to be executed to verify the network capability. Define how to represent the measurement scenarios and where to collect data to calculate the QoS parameters. The test scenarios will reproduce typical service activities to derive quality measures and will identify the measurement points and the expected data sources.

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The aim therefore is to identify the QoS parameters of interest, based on the identified scenarios, referencing existing specifications and technical reports where available. There are already significant relevant references available from a number of bodies to identify QoS aspects for a number 5G scenarios, which are at various stages of maturity. This includes analysis of primary use case scenarios, identification of performance measurement scenarios and definitions of quality measurement indicators. The expectation is that, the present document, through its analysis will put in place a means to assess 5G network capabilities and readiness of the network to support those aforementioned prevalent eMBB applications and use cases.

2 References

2.1 Normative references

Normative references are not applicable in the present document.

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ETSI TS 102 250-2: "Speech and multimedia Transmission Quality (STQ); QoS aspects for popular services in mobile networks; Part 2: Definition of Quality of Service parameters and their computation".

[i.2] ETSI TS 122 261: "5G; Service requirements for the 5G system (3GPP TS 22.261)".

[i.3] ETSI TR 101 578: "Speech and multimedia Transmission Quality (STQ); QoS aspects of TCP-based video services like YouTube™".

[i.4] ETSI TR 126 918: "Universal Mobile Telecommunications System (UMTS); LTE; Virtual Reality (VR) media services over 3GPP (3GPP TR 26.918)".

[i.5] ETSI TR 126 929: "5G; QoE parameters and metrics relevant to the Virtual Reality (VR) user experience (3GPP TR 26.929)".

[i.6] ETSI TS 102 250-1: "Speech and multimedia Transmission Quality (STQ); QoS aspects for popular services in mobile networks; Part 1: Assessment of Quality of Service".

[i.7] Recommendation ITU-T G.QOE-VR: "Influencing Factors on Quality of Experience (QoE) for Virtual Reality Services".

[i.8] Recommendation ITU-R M.2083-0: "IMT Vision - Framework and overall objectives of the future development of IMT for 2020 and beyond".

[i.9] ETSI TS 103 222-2: "Speech and multimedia Transmission Quality (STQ); Reference benchmarking, background traffic profiles and KPIs; Part 2: Reference benchmarking and KPIs for High speed internet".

[i.10] ETSI TS 102 250-3: "Speech and multimedia Transmission Quality (STQ); QoS aspects for popular services in mobile networks; Part 3: Typical Procedures for Quality of Service measurement equipment".

[i.11] ETSI TS 102 250-5: "Speech and multimedia Transmission Quality (STQ); QoS aspects for popular services in mobile networks; Part 5: Definition of typical measurement profiles".

[i.12] ETSI TR 103 468: "Speech and multimedia Transmission Quality (STQ); Quality of Service aspects for 5G; Discussion of QoS aspects of services related to the 5G ecosystem".

[i.13] "5G Service Experience-Based Network Planning Criteria", Ovum in partnership with Huawei, Copyright Ovum 2019©.

[i.14] 3GPP TS 26.186: "Enhancement of 3GPP support for V2X scenarios; Stage 1; Release 16".

[i.15] 3GPP TR 29.893: "Study on IETF QUIC Transport for 5GC Service Based Interfaces (Release 16)".

[i.16] Recommendation ITU-T Y.1540: "Internet protocol data communication service - IP packet transfer and availability performance parameters".

[i.17] IETF RFC 5357: "A Two-Way Active Measurement Protocol (TWAMP)".

[i.18] Recommendation ITU-T P.1204: "Video quality assessment of streaming services over reliable transport for resolutions up to 4K".

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[i.19] ETSI TR 103 559: "Speech and multimedia Transmission Quality (STQ); Best practices for robust network QoS benchmark testing and scoring".

[i.20] IETF RFC 5481: "Packet Delay Variation Applicability Statement".

[i.21] IETF RFC 6038: "Two-Way Active Measurement Protocol (TWAMP) reflects Octets and symmetrical size features".

[i.22] ETSI TS 123 501: "5G; System architecture for the 5G System (5GS) (3GPP TS 23.501 Release 16)".

3 Definition of terms, symbols and abbreviations

3.1 Terms

Void.

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AI	Artificial Intelligence
AR	Augmented Reality
CSI	Channel State Information
DL	DownLink
DNS	Domain Name System
eMBB	enhanced Mobile BroadBand
EN-DC	E-UTRAN New Radio Dual Connectivity
FOV	Field Of View
HD	High Definition
HTTP	HyperText Transfer Protocol
HTTPS	HyperText Transfer Protocol Secure
ICMP	Internet Control Message Protocol
IETF	Internet Engineering Task Force
IMAX	Image MAXimum
IMT	International Mobile Telecommunications
IP	Internet Protocol
ITU	International Telecommunication Union
ITU-T	ITU - Telecommunication Standardization Sector
KPI	Key Performance Indicator
LQO	Listening Quality Objective
MEC	Multi-Access Edge Computing
MIMO	Multiple Input Multiple Output
ML	Machine Learning
mMTC	massive Machine Type Communication
MOS	Mean Opinion Score
MTP	Motion to Photon
NR	New Radio
OSS	Operations Support System
OTT	Over The Top
PDV	Packet Delay Variation
QoS	Quality of Service
QUIC	Quick UDP Internet Connections
RSCP	Received Signal Code Power

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RSRP	Reference Signal Receive Power
RTT	Round Trip Time
SDK	Software Development Kit
SINR	Signal to Interference plus Noise Ratio
TCP	Transmission Control Protocol
TLS	Transport Layer Security
TWAMP	Two Way Active Measurement Protocol
UDP	User Datagram Protocol
UE	User Equipment
UHD	Ultra High Definition
UL	UpLink
URL	Uniform Resource Locator
uRLLC	ultra Reliable Low Latency Connection
VoNR	Voice over New Radio
VR	Virtual Reality

4 5G Performance measurement criteria

4.1 Overview

5G is an evolution of existing mobile technologies, which initially leverages existing LTE networks through EN-DC and on towards NR deployments. The types of scenarios which require higher data rates through eMBB, reliable low latencies through uRLLC and the low energy, high coverage associated with mMTC will each have their own performance characteristics.

IMT 2020, envisions a broad variety of capabilities, tightly coupled with intended usage scenarios and applications [i.8]. The intention being that for different usage scenarios, these capabilities will have varying degrees of relevance and significance. Therefore, this clause identifies the performance measurement criteria for the identified scenarios.

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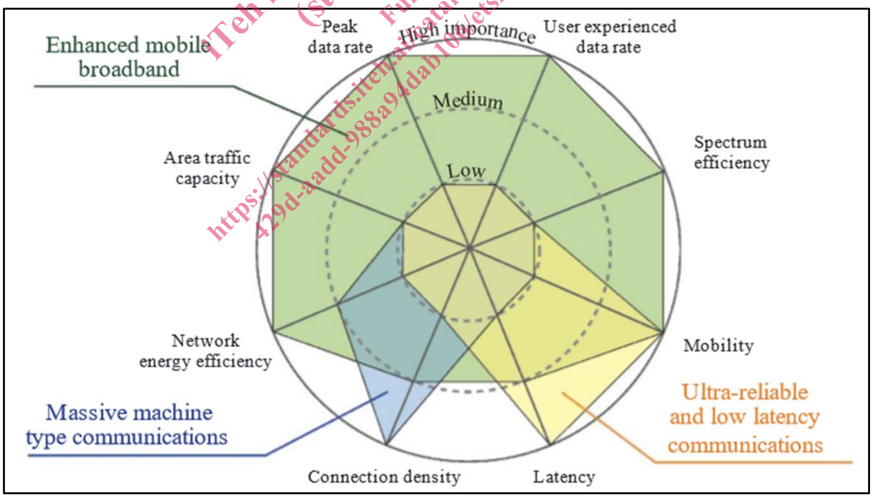

Figure 1: The importance of key capabilities in different usage scenarios

The 5G system is expected to provide optimized support for a variety of different services, different traffic loads and different end user communities [i.2]. In this regard, 5G performance measurement requirements are examined based on the expected scenarios, which can be categorized as:

- Traffic Scenarios.
- Service Usage Scenarios.
- User Type Scenarios.

The parameters to measure the performance to meet the needs of the discovered scenarios are identified, along with the expected and best practise performance levels.

4.2 Traffic Scenarios

4.2.1 Overview

Performance is highly dependent on traffic scenarios, which are identified for specific service areas e.g. urban and rural, where an urban scenario, needs to provide high data rates and high capacity whereas for a rural scenario, the main priority is to provide coverage with a minimum useful data rate. This will support services such as high definition video, cloud gaming and virtual reality in an urban setting whereas browsing and video may be more important in a rural environment.

4.2.2 Key capability parameters

The following parameters are considered to be key capabilities, within the scope of the present document, with regard to performance of traffic scenarios:

- **User experienced data rate:** achievable data rate that is available across the coverage area to a mobile user/device (in Mbit/s or Gbit/s) at the application layer.
- **Peak Data Rate:** maximum achievable data rate under ideal conditions (in Mbit/s or Gbit/s).
- **Latency:** the time from when the source sends a packet to when the destination receives it (in ms).
- **Mobility:** maximum speed at which a defined QoS can be achieved (in km/h).
- **Area traffic capacity:** total traffic throughput served per geographic area (in Mbit/s/m2).
- **Coverage:** in this instance, defined as network coverage, which is the total land area covered by 5G signal divided by total land area.

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4.2.3 High data rates and traffic densities

Scenarios which need high data rates and traffic densities as illustrated in Figure 2, demand, high UL and DL traffic capacity (50 - 100 Gbps/km^2) and high user experienced UL and DL data rates (25 - 50 Mbps) as identified in clause A.1 of the present document. Coverage requirements range from full network in urban and rural regions to specific areas in Indoor and Dense Urban regions and along traffic routes such as roads and railways. Mobility requirements range from pedestrians to high speed vehicles, trains and aircraft.

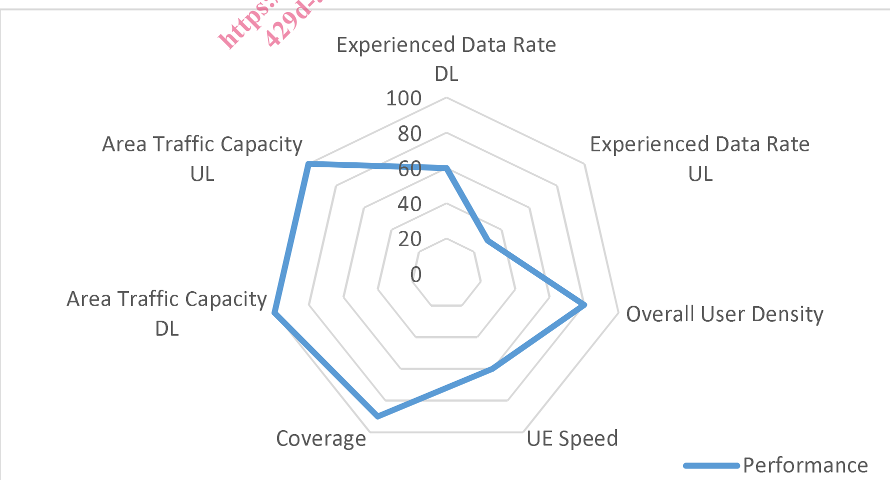

Figure 2: High data rate and traffic density performance capabilities

Several scenarios need the support of very high data rates or traffic densities of the 5G system [i.2]:

- Urban macro - The general wide-area scenario in urban area.
- Rural macro - The general wide-area scenario in rural area.

- Indoor hotspot - The scenario for offices and homes, and residential deployments.
- Broadband access in a crowd - The scenario for very dense crowds, for example, at stadiums or concerts.
- Dense urban - The scenario for pedestrian users, and users in urban vehicles, for example, in offices, city centres, shopping centres, and residential areas.
- Broadcast-like services - The scenario for stationary users, pedestrian users, and users in vehicles, for example, in offices, city centres, shopping centres, residential areas, rural areas and in high speed trains.
- High-speed train - The scenario for users in trains.
- High-speed vehicle - The scenario for users in road vehicles.
- Airplanes connectivity - The scenario for users in airplanes.

4.2.4 High data rate and low latency

Scenarios which need high data rates and low latencies as illustrated in Figure 3, demand, maximum allowed end to end latencies (5 - 10 ms) and relatively high data rates (100 Mbps - 1 Gbps) as identified in clause A.1 of the present document. Coverage requirements range from countrywide to small geographical areas. Due to the nature of use cases reliant on this type of scenario the mobility requirements are primarily stationary or pedestrian. This scenario has reliability requirements in the uplink (99,90 %) and downlink direction (99,9 %) and support for a relatively small number of UEs (< 10). The end to end latency depends not only on the connectivity delay which includes the radio interface and network transmission but also delays which may be outside the 5G system.

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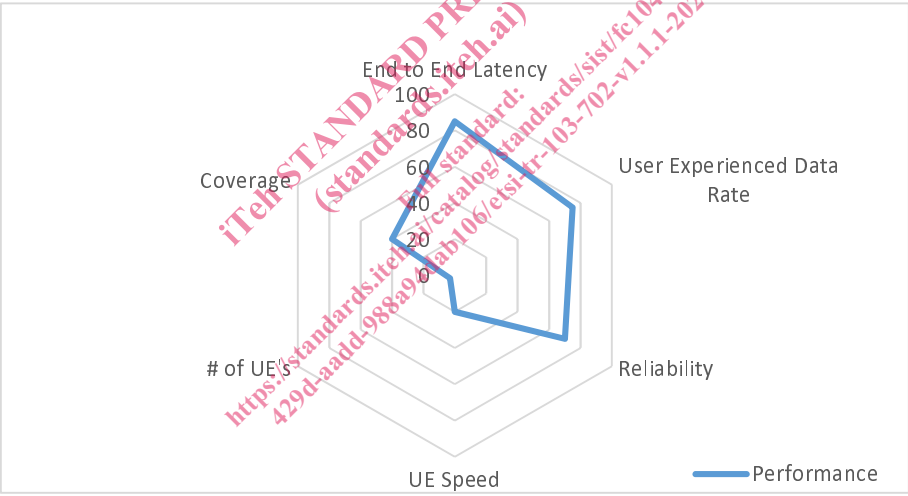

Figure 3: High data rate low latency performance capabilities

Several interactive services need the support of very high data rates, and low latency [i.2]:

- Cloud/Edge/Split Rendering - characterized by transmitting and exchanging the rendering data between the rendering server and device.
- Gaming or Training Data Exchanging - characterized by exchanging the gaming or training service data between two AR/VR devices.
- Consume VR content via tethered VR headset - tethered VR headset receiving VR content via a connected UE.

The type of use cases and technologies supported by these performance criteria include Augmented Reality, Virtual Reality, Gaming and Training. Audio-visual interaction defined in [i.2], focuses on the requirements for audio-visual feedback where the VR environment interaction requires the 5G system to support low motion-to-photon capabilities from the physical movement of a user's head to the updated picture in the VR headset.