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Fifth Generation Fixed Network (F5G); F5G Measurement Specification for Residential Services Quality Evaluation

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Foreword

This Group Specification (GS) has been produced by ETSI Industry Specification Group (ISG) Fifth Generation Fixed Network (F5G).

Modal verbs terminology

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1 Scope

The present document specifies the measurement methodologies to evaluate the quality of residential network services and network characteristics/functionalities based on the service and network KQIs defined in document ETSI GS F5G 015 [1]. The measurement methodologies include measurement setup, measurement procedure, and measurement recording.

2 References

2.1 Normative 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.

Referenced documents which are not found to be publicly available in the expected location might be found at https://docbox.etsi.org/Reference/.

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 necessary for the application of the present document.

[1] ETSI GS F5G 015: "Fifth Generation Fixed Network (F5G); F5G Residential Services Quality Evaluation and Classification Release 2".

[2] BBF TR-126: "Triple-play Services Quality of Experience (QoE) Requirements".

[3] Recommendation ITU-T G.9976: "Supporting ultra-high-definition video service over G.hn".

[4] BBF TR-398 Issue: 2 Corrigendum 1: "Wi-Fi Residential & SOHO Performance Testing".

[5] Recommendation ITU-T X.509: "Information technology - Open Systems Interconnection - The Directory: Public-key and attribute certificate frameworks".

[6] IETF RFC 2544: "Benchmarking Methodology for Network Interconnect Devices".

[7] Recommendation ITU-T P.863: "Perceptual objective listening quality assessment".

[8] IETF RFC 791: "Internet protocol".

[9] Recommendation ITU-T G.107: "The E-model: a computational model for use in transmission planning".

[10] IETF RFC 793: "Transmission Control Protocol".

[11] IEEE 802.11k™-2008: "IEEE Standard for Information technology -- Local and metropolitan area networks -- Specific requirements -- Part 11: Wireless LAN Medium Access Control (MAC)and Physical Layer (PHY) Specifications Amendment 1: Radio Resource Measurement of Wireless LANs".

[12] IEEE 802.11v™-2011: "IEEE Standard for Information technology -- Local and metropolitan area networks -- Specific requirements -- Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications Amendment 8: IEEE 802.11 Wireless Network Management".

[13] IEEE 802.11ac™-2013: "IEEE Standard for Information technology -- Telecommunications and information exchange between systems-Local and metropolitan area networks -- Specific requirements -- Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications -- Amendment 4: Enhancements for Very High Throughput for Operation in Bands below 6 GHz".

[14] IEEE 802.11ax™-2021: "IEEE Standard for Information Technology -- Telecommunications and Information Exchange between Systems Local and Metropolitan Area Networks -- Specific Requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment 1: Enhancements for High-Efficiency WLAN".

2.2 Informative references

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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] Wikipedia: "Cumulative distribution function".

[i.2] BBF TR-309 (Issue 2 Amendment 1): "XG-PON and XGS-PON TC Layer Interoperability Test Plan".

[i.3] ETSI TS 102 165-2: "Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); Methods and protocols; Part 2: Protocol Framework Definition; Security Counter Measures".

[i.4] ETSI TR 103 733: "Speech and multimedia Transmission Quality (STQ); Best practices of testing the performance of web content delivery".

[i.5] 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.6] ETSI TS 102 250-4: "Speech and multimedia Transmission Quality (STQ); QoS aspects for popular services in mobile networks; Part 4: Requirements for Quality of Service measurement equipment".

[i.7] ETSI TR 101 578: "Speech and multimedia Transmission Quality (STQ); QoS aspects of TCP-based video services like YouTube™".

[i.8] ETSI GS F5G 014: "Fifth Generation Fixed Network (F5G); F5G Network Architecture Release 2".

3 Definition of terms, symbols and abbreviations

3.1 Terms

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

CDF99: value indicating less than or equal to 99 percentage probability of all outcomes

firmware analysis tool: software tool for firmware analysis

NOTE: For firmware security analysis, the encryption status of the binary source code is examined.

render start: time when the browser starts rendering, which is an approximation of the user's perception when the user sees the first content on the screen

security scanning tool: software tool to perform network discovery and security auditing which scans the target host's port and service information

telework: practice of working from home, making use of residential internet, email, telephone, etc.

3.2 Symbols

Void.

3.3 Abbreviations

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

AC	Alternating Current
ACK	Acknowledge
AES	Advanced Encryption Standard
AP	Access Point
APBEA	Average Percentage of the black Edge Area
APFF	Average Percentage of Frame Freezing
APP	Application
APTQIA	Average Percentage of The low-Quality Image Area
BNG	Broadband Network Gateway
BRAS	Broadband Remote Access Server
CDF99	99 % of Cumulated Distribution Function
CDN	Content Delivery Network
CP	Content Provider
CPU	Central Processing Unit
CSMA	Carrier Sense Multiple Access
dBm	dB relative to 1 milliwatt
DC	Direct Current
DDoS	Distributed Denial of Service
DHCP	Dynamic Host Configuration Protocol
DNS	Domain Name Server
DoS	Denial of Service
DRR	Download Rate Ratio
DTR	Desynchronization Time Ratio
E2E	End to End
E-ONU	Edge-ONU
FFT	Frame Freezing Times
FFTR	Frame Freezing Time Ratio
FLT	Full Load Time
FSDT	First Screen Display Time
FSPL	Free Space Path Loss
FTTR	Fibre-To-The-Room
GB	Gigabyte
GHz	Giga Hertz
HTML	Hypertext Markup Language
HTTP	Hypertext Transfer Protocol
IBD	Initial Buffering Duration
ICMP	Internet Control Message Protocol
ID	Identifier
IGMP	Internet Group Management Protocol
IP	Internet Protocol
IPTV	Internet Protocol Television
KQI	Key Quality Indicator
LAN	Local Area Network
MAC	Medium Access Control
MOS	Mean Opinion Score
MTU	Maximum Transmission Unit
NBI	North Bound Interface
NIC	Network Interface Card
NST	Network Start-up Time
O&M	Operation & Management

OLT Optical Line Termination
ONU Optical Network Unit
ORD Operation Response Delay
OTT Over The Top
PBED Percentage of the Black Edge Duration
PC Personal Computer
PID Protocol Identifier
PING Packet Internet Groper
PLQID Percentage of Low-Quality Image Duration
POLQA Perceptual Objective Listening Quality Analysis
PON Passive Optical Network
P-ONU Primary ONU
POTS Plain Old Telephone Service
PRT Page Response Time
QoE Quality of Experience
RFC Request for Comments
RSSI Received Signal Strength Indication
RTP Real-time Transport Protocol
RTT Round Trip Time
SLA Service Level Agreement
SP Service Provider
SSID Service Set Identifier
STB Set-Top Box
SYN Synchronization
TCP Transmission Control Protocol
TV Television
UDP User Datagram Protocol
URR Upload Rate Ratio
VLAN Virtual Local Area Network
VOD Video On Demand
VR Virtual Reality
WAN Wide Area Network
WPA2 Wi-Fi® Protected Access 2
xPON (x = G, XG, XGS) PON

4 Introduction

4.1 Overview

ETSI GS F5G 015 [1] specifies the service KQIs, experience evaluation methodology with MOS value, and corresponding network KQIs. The overview of the service KQIs and network KQIs is shown in Figure 1.

The services specified in ETSI GS F5G 015 [1] include voice, web browsing, data upload/download, IPTV, terminal-based rendered game, cloud-based rendered game, internet video, on-line Education/Telework, cloud VR video, cloud VR game.

The network KQI contains six dimensions, which are: throughput, latency, connectivity, handover, green & security and smart O&M.

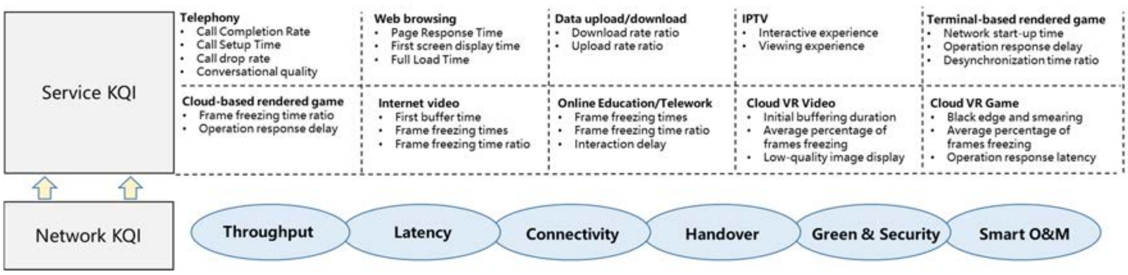

Figure 1: Overview of service KQIs and network KQIs

The detailed service KQIs are listed below each service, as shown in Figure 1. For example, the KQIs of Telephony service include: call completion rate, call setup time, call drop rate and conversational quality.

In general, the service KQIs quantify the user experience from different aspects while the network KQIs reflect the network capabilities (shown in Figure 1) and can significantly influences the service KQIs.

Figure 2 shows the general E2E measurement setup for service KQI.

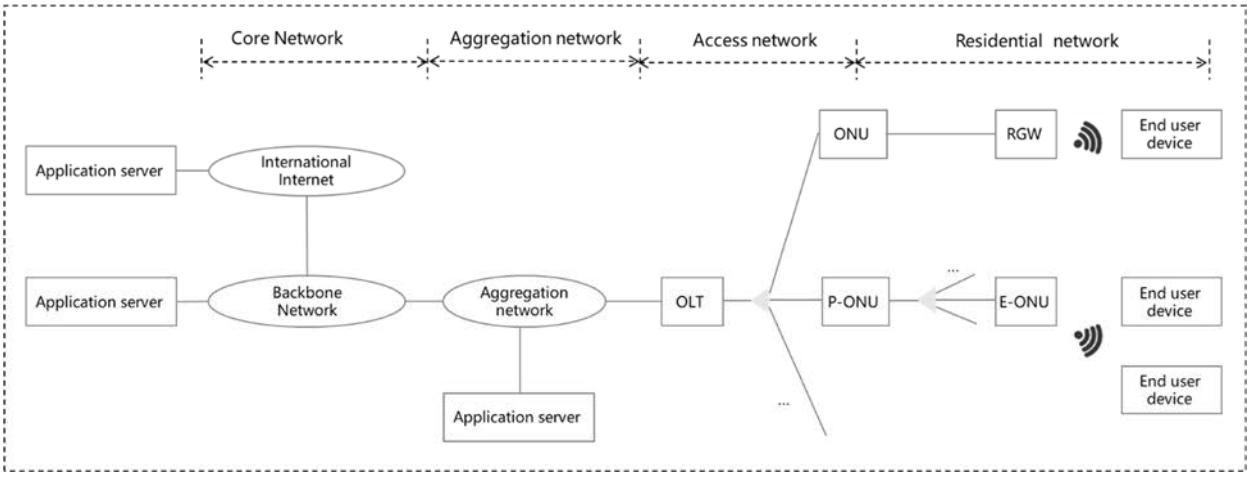

Figure 2: E2E measurement setup for service KQIs

The E2E network is composed of the following network segments:

1) Residential network: from the end user device to the access network terminal.

NOTE: The residential network is grouped under the general term Customer Premises Network in ETSI GS F5G 014 [i.8]. The type of access network terminal depends on the residential network. In a FTTR network, the P-ONU is the access network terminal. In another case, an ONU can be the termination of the access network.

2) Access network: from the access network terminal to the access network central office. In F5G, the access network is PON, and the central office equipment is an OLT.

3) Aggregation network: from central office of access network to the aggregation network egressing port (Aggregation edge node).

4) Core network: from the Aggregation Edge network node egress port to the server.

4.2 Measurement methodologies

4.2.1 Measurement methodology for the service KQIs

The measurement of the service KQIs shall be performed in one of two ways using the following methodologies:

- Methodology 1: Embed measurement code in the end user device for broadband services. When the broadband services are subscribed to by the end user, the end user device automatically runs the dedicated measurement suit and report the measurement result to the server of the service provider. This methodology is suitable for the CP/SP (content/service provider) to collect measurement data.

- Methodology 2: The user proactively initiates the measurement for a dedicated service through the end user device (including mobile phone, PC, IPTV set-top box, helmets). The measurement procedure can be performed by measurement software installed on the end user device. This methodology is suitable for broadband users, which enables the service operator to evaluate the user experience.

NOTE: The measurement software could be a mobile App.

The chosen method shall be recorded in the report (see Annex A).

4.2.2 Measurement methodology for the network KQIs

4.2.2.1 Measurement methodology of the detailed network evaluation

Detailed network evaluation is a comprehensive approach to quantify the residential network capabilities for the different classification levels for the residential services. The measurement shall leverage professional test equipment or measurement software to perform the detailed network evaluation. These measurements are performed either by third-party testing institutions or the network providers.

NOTE: These measurements should be performed by professional network testing personnel.

4.2.2.2 Measurement methodology of the basic network evaluation

Basic network evaluation is an E2E measurement and shall be performed using one of the following methodologies:

- Methodology 1: The user initiates the measurement using an application installed on the end user device to collect the network KQIs.
- Methodology 2: The network monitoring platform collects the network KQIs. The result can be used for performance monitoring or diagnostics of the residential network.

The chosen method shall be recorded in the report (see Annex A).

5 Measurement methodology of service KQIs

5.1 Measurement requirements

5.1.1 Requirements of the end user device

The performance of the end user device may impact the measurement and evaluation of the user experience. The measurement shall be performed according to dedicated hardware requirements. If a laptop is used the hardware requirement shall comply with the requirement specified in reference [2]. If a mobile phone is used the hardware requirements shall be as follows:

- Number of CPU core: at least 8.
- CPU frequency: ≥ 1,7 GHz.
- Mobile phone memory: ≥ 8 GB.
- The end user device supports at least Wi-Fi® 6.

NOTE: If the available Wi-Fi® generation does not match between the end user device and the access point, then the measurement can use a previous Wi-Fi® generation. This will be recorded in the report (see Annex A).

5.1.2 Additional Measurement requirements

Measurement time period requirement: the measurement shall be conducted during network peak time.

Measurement location requirement: the measurement should be conducted in the location where the end user frequently utilizes the network. This is a requirement for basic network evaluation when the end user performs the measurement.

5.1.3 Data record requirements

The evaluation of the user experience over a dedicated E2E network may be affected by the E2E network components, including the end user device, the network segments, and the servers involved. Specifically, differences in the device capability used shall be avoided in the measurement mentioned in the present document, to eliminate inconsistences in the measurements. It is mandatory to record the measurement environment, equipment used and any conditions that influence the user experience as part of the test procedure. For the detailed format of the record, see Annex A.

Every time the end user device initiates a service request, the end user device or server shall record the following information:

1) User account/MAC address. It is required that the end user's personal information is protected.
2) Network connection interface (Wi-Fi®, Ethernet).
3) Wi-Fi® generation (Wi-Fi®5, Wi-Fi®6, Wi-Fi®7), frequency band in uses (2,4 GHz/5 GHz/6 GHz), negotiated transmission rate, received signal power, number and strength of interference sources, number of spatial streams, frequency channel in use.
4) F5G broadband network provider.
5) User location (accurate to the city/region). It is required that the end user's personal information is protected guaranteeing end-user privacy.
6) Record time (accurate to ms).
7) Status of the subscribed broadband network service (success or failure).

The record may include other service relevant information:

1) Type of end user device.
2) Model number of end user device.
3) Operating system and version.
4) NIC driver information (including version number) of end user device if a laptop is used.
5) The server information of data source.

5.2 Measurement of service KQIs

5.2.1 Telephony

5.2.1.1 Measurement environment

The measurement defined in the present clause focuses on the widely used telephony services based on IP networks. The measurement set up is shown in Figure 3:

1) A telephone simulator connects to the access network terminal of the access network through an Ethernet or POTS interface. The digitized voice signals are transmitted from one telephone simulator to another telephone simulator. The telephone simulator is the test equipment used to complete the measurements autonomously (see for example the telephone simulator in ETSI TS 102 250-4 [i.6]).

NOTE 1: When the telephone simulator is connected to the access network terminal via a POTS interface, the analogue signals are digitalized in the access network terminal and encapsulated as packets. The access network terminal is an independent gateway or voice modem.

2) The access network terminals connect to the public internet through a Wide Areas Network (WAN) interface.
3) The measurement provides the ability to determine the voice quality in an E2E network.