



## **Fifth Generation Fixed Network (F5G); F5G-A SME Service and Network Quality Classification**

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# Foreword

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

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# Modal verbs terminology

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# 1 Scope

The present document specifies the evaluation criteria of the SME service quality experience on a per-service base and for aggregated multiple services using F5G-A networks. The present document quantifies and evaluates the services experience, while classifying network performance.

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## 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 in the [ETSI docbox](#).

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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".

### 2.2 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.

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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 GS F5G 005](#): "Fifth Generation Fixed Network (F5G) F5G High-Quality Service Experience Factors Release#1".
- [i.2] BBF TR126: "Triple-play Services Quality of Experience (QoE) Requirements".
- [i.3] ETSI TR 103 702: "Speech and multimedia Transmission Quality (STQ); QoS parameters and test scenarios for assessing network capabilities in 5G performance measurements".
- [i.4] Broadband Development Alliance (BDA) 2022: "White paper: QoE classification of SME network service".
- [i.5] Broadband Development Alliance (BDA) 2021: "White paper: Gigabit high quality service experience and network optimization".
- [i.6] CCSA TC615 2024: "White paper: SME FTTR-B Construction Guide White Paper".
- [i.7] ETSI GR F5G 001: "Fifth generation fixed network (F5G); F5G generation definition release #1".
- [i.8] European Commission 2003: "[Internal Market, Industry, Entrepreneurship and SMEs](#)".

## 3 Definition of terms, symbols and abbreviations

### 3.1 Terms

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

**SME subscriber:** SME person or department signing the contract and responsible for the SME internal network including network management and the relationship with the wide area broadband service provider

**SME User:** SME employees, customers of SME who use an SMEs network for different tasks

**subscribed bandwidth:** contractually promised network bandwidth for the broadband service purchased by the SME enterprise

### 3.2 Symbols

Void.

### 3.3 Abbreviations

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

BBF	Broadband Forum
CAD	Computer Aided Design
CPU	Central Processing Unit
DDoS	Distributed Denial-of-Service
DNS	Domain Name Server
E2E	End-to-End
FFT	Frame Freezing Times
FFTR	Frame Freezing Time Ratio
FTTR	Fiber to the Room
GUI	Graphical User Interface
HD	High Definition
ID	Interaction Delay
iOS	iPhone Operation System
IQ	Interaction Quality
ITU	International Telecommunication Union
KQI	Key Quality Indicator
LAN	Local Area Network
LT	Loading Time
LVDD	Live Video Display Delay
LVFT	Live Video Freezing Times
LWT	Login Waiting Time
MOS	Mean Opinion Score
MRT	Message Reception Time
NAC	Next Generation Firewall
O&M	Operation & Management
ORD	Operation Response Delay
PC	Personal Computer
PON	Passive Optical Network
PSTN	Public Switched Telephone Network
QoE	Quality of Experience
RWV	Relative Weighted Value
SME	Small and Medium Enterprise
TCP	Transmission Control Protocol
TRR	Transmission Rate Ratio
TRRD	Transmission Request Response Delay
UHD	Ultra-High-Definition

VPN            Virtual Private Network  
VQ            Viewing Quality

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## 4 Overview of SME service and network quality classification

### 4.1 Overview

The present document specifies the service Key Quality Indicators (KQIs) for a set of Small and Medium Enterprise (SME) applications and services. Such service KQIs reflect the service quality. To have a quantitative evaluation of the service KQIs, a corresponding MOS calculation and evaluation criteria is specified. To achieve a good service quality, a certain level of F5G network performance and functionality is necessary. Network KQIs are specified to quantify the network in terms of F5G network performance and functionality.

There are a number of service KQIs specified by other organizations or newly defined in the present document:

- a) Telephony is defined in ETSI GS F5G 005 [i.1]: call completion ratio, call setup time, conversational quality, call drop rate.
- b) Web browsing is defined in ETSI GS F5G 005 [i.1]: page response time, first screen display time, full load time.
- c) Instant messaging:
  - 1) message loading, operation response and real-time messaging;
  - 2) loading time, operation response time and message receiving time.
- d) Small file transmission: transmission request response delay, transmission rate ratio.
- e) Video conference: viewing quality including audio quality, interaction delay.
- f) Interactive enterprise live streaming (including audio and video): live video display delay, live video freezing times.
- g) Cloud desktop: login waiting time, operation response time, frame freezing time ratio.
- h) Cloud enabled Design and Rendering: frame freezing times, frame freezing time ratio, interaction quality.

The method to quantify service KQIs is based on MOS values, which reflect the user experience. They are defined in clause 7 of the present document.

A number of network KQIs are used to support the services quality measurement which are as follows:

- a) Throughput: the maximum transmission data rate of SME network.
- b) Latency: the E2E communication time interval between request and response.
- c) Connectivity: the connected number of end user devices to the Wi-Fi<sup>®</sup> access point.
- d) Cloud and networking integration: network supported cloud-based services experience for SME enterprises.
- e) Security: network security of SME network.
- f) Smart O&M: smart operation & management of SME network.

A number of network KQIs (including throughput, latency, connectivity, cloud and networking integration, security, smart O&M) and the key MOS mapping of each KQI are defined in clause 6 and clause 7 respectively.

In general, the staff headcounts of medium-sized, small & micro enterprises are within 250, 50 & 10, respectively which is defined in European Commission 2003 [i.8]. Based on the network demand of the different SME services, the network services have been classified into different levels. SME enterprises need the basic network capability to meet L0 level service requirements, and higher network capability is necessary for L1 and L2 level services. L2 level services have stricter requirements for network:

- a) Level 0 (L0): telephony, web browsing, small file transmission, instant messaging.
- b) Level 1 (L1): video conference, enterprise streaming (HD), cloud desktop.
- c) Level 2 (L2): Cloud enabled Design and Rendering.

The detailed network requirements are specified in clause 8 of the present document.

To achieve the SME user experience evaluation, several aspects are considered as follows:

- 1) The service KQI for SME services listed above are used to estimate the user experience from a user's perspective, (shown in Figure 1).
- 2) MOS value as a quality scoring mechanism is used to quantify the service KQI, shown in Figure 1. Firstly, the MOS value is calculated for each KQI of a dedicated service. Secondly, a comprehensive MOS value is created for the dedicated service. Finally, the MOS value for the SME network could be estimated by the combination of the MOS value of different service.
- 3) To support good user experience as perceived by the users, the network KQI listed above are specified as the basis to ensure sufficient network performance. The detailed network requirements are discussed in the present document for different levels of service classification.

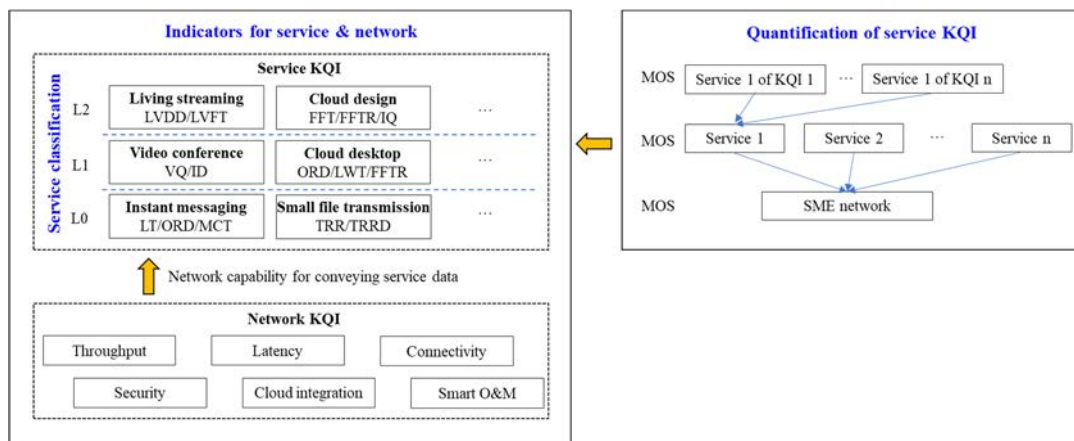


Figure 1: The framework of user experience evaluation

## 4.2 Motivation

The present document may be leveraged by the SME user to evaluate their SME network and thus improve it by updating the network hardware, optimizing networking topology and so on. Depending on the services provided to the end users, the service operator may utilize the present document as a reference to deploy an SME network to enable good user experience. To target a good user experience, the service operator may choose specific technologies to support a good experience. Obviously, further measurement methodology or measurement tool could be developed based on the content of the present document.

## 4.3 Document structure

Clause 4 introduces the context of the present document, including the motivation and framework. Clause 5 specifies the individual service KQIs for specific network services while network KQI are specified in clause 6. The evaluation methodology is described in clause 7 specifying concrete formulas and algorithms for calculating the MOS value for each service KQI. In clause 8, the classification of network service and corresponding network requirements are then discussed based on the network demand of various service.

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## 5 Service KQI

### 5.1 General description

The following is a list of service KQIs discussing in this clause:

- Telephony.
- Web browsing.
- Instant Message.
- Small File Transmission.
- Cloud Desktop.
- Video Conference.
- Interactive Enterprise Live Streaming.
- Cloud enabled Design and Rendering.

The network performance influences the user experience. When determining service quality indicators, consideration is given to how the network affects the user experience. A number of services KQIs are defined in both ETSI and ITU, the present document refers to these relevant standards. Other service KQIs are defined in the present document in order to specify appropriate evaluation methods.

### 5.1 Telephony

#### 5.1.1 Telephony service KQIs overview

Telephony in SME includes different scenarios, such as Private Branch Exchange (PBX) system and telephony over PSTN. Telephony service KQIs includes call completion ratio, call setup time, call drop rate and conversational quality. The corresponding definitions can be referred to the residential scenarios that are defined in ETSI GS F5G 015 [1], more SME-oriented telephony functions are for further study.

### 5.2 Web browsing

#### 5.2.1 Web browsing service KQIs overview

Web browsing is one of the basic Internet applications in SME scenario. SME Employees who do not used cloud based services such as cloud desktops can complete their tasks through web browsing when available in the requested quality. Page response time, first screen display time and full load time are the key indicators defined in ETSI GS F5G 015 [1].

### 5.3 Instant messaging

#### 5.3.1 Instant messaging service KQI overview

The most commonly used messaging tool in SME scenario is instant messaging, allowing multiple colleagues to exchange instant information by text, images, small file, voice or even video.

The basic experience of user in instant messaging includes message loading, operation response and real-time messaging. Therefore, the service KQIs of instant messaging includes loading time, operation response time and message reception time.

### 5.3.2 Loading time

The loading time indicates the duration from the start of loading the message list or message interface to the completion of loading the message list or message interface. The better experience requires short loading time. For the dedicated instant messaging application, the loading time depends on:

- The size of communication list and communication message.
- The capability of end user device.
- The network performance.

NOTE: This indicates that when using short messaging application to interact with people, the messaging application will load the interaction content of both parties at regular intervals or when the messaging application is just connected to the network.

### 5.3.3 Operation response delay

Operation response delay is the time duration between the SME user action and the corresponding received response. The lower the delay, the better the user experience is provided.

EXAMPLE: The SME user action could be hitting a send button, clicking the mouse, type on the keyboard in the messaging application. Then the corresponding received response could show that the message is successfully sent in the messaging application.

### 5.3.4 Message reception time

Message reception time indicates the time between leaving the messaging transmission side and the message reception / appearing on the target receiving side.

## 5.4 Small File Transmission

### 5.4.1 Small file transmission KQIs overview

In Small and Medium Enterprise (SME) office applications, small files such as documents, programs, videos, photos and various other file types are downloaded or uploaded to a cloud server or transferred between employees.

A file less than 50 MBytes is defined as a small file.

The Key Quality Indicators (KQIs) for SME individual user experience in small file transmission include:

- Transmission request response delay.
- Transmission rate ratio.

NOTE: Larger files are transfer over other services not in the scope of this KQI.

### 5.4.2 Transmission request response delay

Transmission request response delay refers to the delay from the time the user initiates a request to transfer a file to the time the file transfer connection is successfully set up, including the DNS lookup and TCP connection setup time to initiate a file transmission.

### 5.4.3 Transmission rate ratio

Transfer rate ratio indicates the ratio of the download rate of the specific remote server to the subscribed bandwidth. This KQI reflects the network transmission capability.

## 5.5 Cloud Desktop

### 5.5.1 Cloud Desktop service KQIs overview

Cloud desktop is a well-established cloud computing application. It centralizes computing and storage resources that are originally distributed on personal computers, laptops or other devices to a data centre implementing virtualization and centralized management. Users can use cloud terminals (low performance PC, software client or Android/iOS mobile client) to access the personal cloud desktop space in the cloud. The cloud desktop service described in the present document is oriented to common office scenarios with medium to low computing needs. The KQIs of cloud desktop experience experienced by users are as follows:

- The login waiting time.
- The operation response time.
- The frame freezing time ratio.

### 5.5.2 Login waiting time

Login waiting time indicates the time duration from when the user initiates a login operation to the time the user can use the virtual desktop.

### 5.5.3 Operation response delay

Operation response delay refers to the time between a user completing a keyboard or mouse input operation to the cloud desktop terminal updating the corresponding screen frame.

### 5.5.4 Frame freezing time ratio

The frame freezing time ratio refers to the ratio of the freezing duration to the total usage period when users use the cloud terminals for office work.

## 5.6 Video Conference

### 5.6.1 Video Conference service KQIs overview

A video conference uses technologies such as remote control and audio (i.e. speaking) and video interaction (i.e. live video streaming or slides sharing) to implement information sharing and interaction between participants located in different places.

**EXAMPLE:** Video conferencing, applications such as remote office and remote assistance have developed rapidly.

Video conference KQIs include:

- Viewing quality.
- Interaction quality, which includes audio and video quality.

### 5.6.2 Viewing quality

The viewing quality refers to the signal quality of an image during video transmission, that is, whether the video image is discontinuous or abnormal. Two factors are used: number of frames freezing times during viewing and frame freezing time ratio.

### 5.6.3 Interaction quality

Interaction delay is the main factor affecting interaction quality. Interaction delay refers to the delay from speaking to listening or displaying slides or files during a video conference. The evaluation is usually based on the voice delay time between users.

## 5.7 Interactive enterprise live streaming

### 5.7.1 Enterprise live streaming service KQIs overview

Interactive enterprise live streaming refers to the use of internet and streaming media technologies for live sales presentation broadcasts. Viewers can send comments and ask questions in real-time while watching the live streaming, and speakers or hosts can respond to this feedback in real time. Interactive Enterprise live streaming has strong immediacy and interactivity. The interactive live streaming video integrates rich elements which includes images, text, and sound, offering a vivid and excellent effect, which is gradually becoming a mainstream mode of expression on the internet. This form of expression has gained prominence as a mainstream method within the digital landscape. An enterprise live stream is categorized as an Enterprise High Definition (HD) broadcast when its video resolution reaches 1080P. Enterprise live streaming achieving resolutions of 4K or 8K are designated as Enterprise Ultra High Definition (UHD) (4K/8K) live streams.

Key Quality Indicators (KQIs) for user experience in enterprise live streaming include:

- Live video display delay.
- Live video freezing times.

### 5.7.2 Live video display delay

Enterprise live streaming is an interactive form of real-time enterprise content sharing. If there is a large delay during the live video display, the participants will wait for each other or repeat their words, which will lead to confusion and affect the user experience.

**NOTE:** Network issues may lead to issues with the audience and the content of the live broadcast not being guaranteed to be real-time during the live broadcast process. When an audience asks a question, the problem cannot be immediately reported to the host, resulting in a situation where the audience is waiting.

**EXAMPLE:** During the process of live streaming sales of a certain product, if the audience raises questions about some of the content of the live broadcast and the questions are not displayed on the host's screen in a timely manner, and the host receives the questions after continuing his speech for a period of time, the content spoken when answering the questions will no longer be the same as when the questions were asked, which will cause confusion for new listeners.

### 5.7.3 Live video freezing times

For enterprise live streaming, live video freezing times is defined as the number of times the viewer observed instances that the live video had no visual content change, no sound or poor quality sound within the measurement period. Generally, only 0 live video freezing time satisfies the requirements of good experience.

## 5.8 Cloud enabled Design and Rendering

### 5.8.1 Cloud enabled Design and Rendering service KQIs overview

Cloud enabled design and rendering in the office environment of SMEs refers to design type where the SMEs that deploy the design environment in the cloud to enable designers to realize functions including multi-user collaboration, cross device access and data security through cloud technology.

Cloud enabled design is based on cloud computing capability to integrate design tools and activities into the cloud resource pool to maximize efficiency. Sufficient bandwidth is needed to upload large design files or download updated content, especially when it involves high-resolution images or complex models, the amount of data can be extremely large. Cloud enabled rendering is also used for cloud computing capability to put the rendering function in the cloud, and the user terminal may access the cloud resource through a high-speed network work station. The cloud side executes the corresponding rendering task according to the user's instructions and transmits the rendering image back to the user terminal, therefore, sufficient bandwidth is important for ensuring efficient data transmission. When it comes to real-time rendering or collaborative environments, low latency is also very important.

Key Quality Indicators (KQIs) for user experience in cloud enabled design and rendering include:

- The frame freezing times.
- The frame freezing time ratio.
- The interaction quality.

## 5.8.2 Frame freezing times

For cloud enabled design and rendering, the frame freezing times is defined as the number of times that the cloud enabled designer's desktop cannot be refreshed in time due to poor network conditions on the user side, frame freezing, screen flicker, or skipping occurs during loading on the GUI within a measurement period.

NOTE: Interruptions caused by the user or high CPU load in both locally and in cloud are not considered.

## 5.8.3 Frame freezing time ratio

For cloud enabled design and rendering service, the frame freezing time ratio is defined as the ratio of the frame freezing time observed on the user side to the total measurement period.

NOTE: Interruptions caused by the user or high CPU load are not considered.

## 5.8.4 Interaction quality

The interaction quality is measured by the operational response time which is described in BBF TR126 [i.2]. In cloud enabled design and rendering service, users may achieve accurate and fast response when a user action is performed, which may provide good user interactive experience. Therefore, the interaction quality is usually evaluated by the operational response time.

EXAMPLE: To implement CAD (Computer-Aided Design), 3D modelling, and other functions in the cloud, designers need to perform real-time editing or collaborate with multiple people on their projects in a cloud environment. This requires the network to provide more agile operation responses.

# 5.9 Surveillance

## 5.9.1 Surveillance service KQIs overview

A complete surveillance system consists of camera, transmission, control, display, and recording registration part. The cameras connect to the network to transmit video images to the control host, which distributes the video signals to monitors and recording devices. At the same time, it can synchronize and record necessary audio signals into the recorder. Through the control host, operators can issue commands to control the up, down, left, and right movements of the cameras as well as perform zoom and focus adjustments on the lenses. Specialized recording processing modes allow for operations such as image recording, playback, retrieval, and storage.

The real-time performance of surveillance service determines the demand for a highly reliable network, which have higher requirements on network bandwidth, latency. The main user experience Key Quality Indicators (KQIs) for surveillance in SME is the video quality of the surveillance.

## 5.9.2 Video Quality

The video quality of surveillance refers to the quality of the surveillance video during playback, whether there is any quality degradation such as discontinuous video images or any abnormal conditions that degrade the quality. It is typically evaluated using two indicators: Frame freezing times during viewing and the proportion of Frame freezing time ratio.

- Frame freezing times refer to the number of times during the measurement period that surveillance video cannot be played in time due to poor network conditions, frame freezing, screen flicker and other reasons. within a measurement period.

NOTE 1: Interruptions caused by the user or hardware failures are not considered.

- Frame freezing time ratio refer to the ratio of the frame freezing time observed on the user side to the total measurement period.

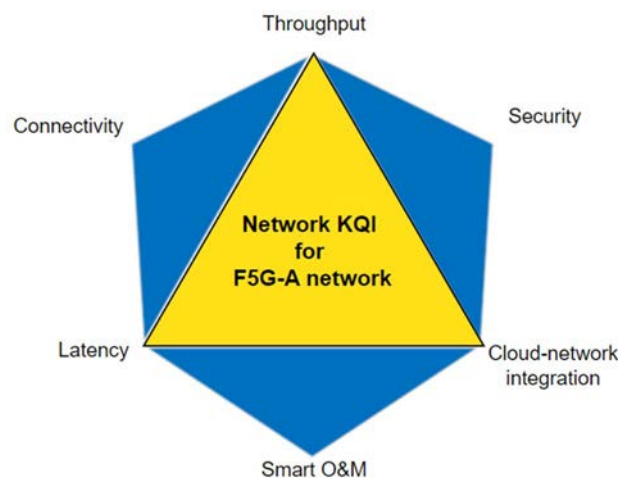
NOTE 2: Interruptions caused by the user or hardware failures are not considered.

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# 6 Network KQI

## 6.1 Overview

To improve the Quality of Experience (QoE) for SME network services, the F5G-A network shall provide high network functionality and performance to carry SME service and application data. Six dimensions as defined in ETSI TR 103 702 [i.3] are used to categorize the network KQIs. These six dimensions are Throughput, latency, connectivity, cloud-network integration, security and smart O&M as illustrated in Figure 2.



**Figure 2: Network KQI Dimensions**

The network KQI dimensions are either network performance related or network functionality related.

The network KQI quantifies the network characteristic from different angles to support specific application services. The Mean Opinion Score (MOS) value quantifies the user experience. To achieve a high MOS value, an application service specific network performance is required. The requirements are defined in terms of the six network-level KQI dimensions discussed in following clauses so as to support at a minimum good user experience, which means a MOS value of 3,5 or above (see clause 7 in the present document on the concept of a MOS value).

NOTE: Network reliability is for further study.

## 6.2 Throughput

Table 1 lists the recommended throughput requirements for various SME broadband services to enable the end users within the SME to have a good experience.

**Table 1: Recommended throughput requirements per service and user (defined in Broadband Development Alliance (BDA) 2022 [i.4] and Broadband Development Alliance (BDA) 2021 [i.5])**

Service Type	Downlink throughput Requirements	Upstream throughput Requirements
Voice	≥ 64 Kbps	≥ 64 Kbps
Web browsing	≥ 18 Mbps	≥ 2 Mbps
Instant messaging	≥ 3,7 Mbps	≥ 2 Mbps
Small file transfer	≥ 10 Mbps	≥ 5 Mbps
Cloud desktop	≥ 15 Mbps	≥ 6 Mbps
Video conference	≥ 10 Mbps	≥ 7 Mbps
Enterprise HD live streaming	≥ 20 Mbps	≥ 10 Mbps
Enterprise Ultra HD Live Broadcast	≥ 100 Mbps	≥ 50 Mbps
Cloud enabled Design and Rendering	≥ 56 Mbps	≥ 10 Mbps

It is assumed that there are  $k$  ( $k \geq 1$ ) different services, where the  $i$ -th services  $m_i$  ( $1 \leq i \leq k$ ) has  $m$  instances, and a throughput requirement is  $BW_i$ . A theoretical model of a total throughput requirement is shown in formula (1):

$$BW_{Total} = \sum_{i=1}^k (m_i \times BW_i) \quad (1)$$

$BW_i$  is a throughput requirement of the  $i$ -th service.

### 6.3 Latency

Table 2 lists the round-trip latency requirements for various SME services. To ensure an acceptable level of user experience for the various types of services, the total latency of each type of service shall meet Table 2 values. The requirement delineation of SME network and access network are also listed.

**Table 2: Latency requirements for different network segments per service per user (see [i.4] and [i.5])**

Service Type	Total latency Requirement	Latency requirement for SME network	Latency requirement for Access network
Voice	≤ 150 ms	≤ 55 ms	≤ 15ms
Web browsing	≤ 100 ms	≤ 35 ms	≤ 10ms
Instant messaging	≤ 150 ms	≤ 55 ms	≤ 15ms
Small file transfer	≤ 150 ms	≤ 55 ms	≤ 15ms
Cloud desktop	≤ 50 ms	≤ 15 ms	≤ 5ms
Video conference	≤ 50 ms	≤ 15 ms	≤ 5ms
Enterprise HD live streaming	≤ 50 ms	≤ 15 ms	≤ 5ms
Enterprise Ultra HD Live Broadcast	≤ 15 ms	≤ 6 ms	≤ 2ms
Cloud enabled Design and Rendering	≤ 20 ms	≤ 7 ms	≤ 2ms

NOTE: The latency indicators in this Table are Round Trip Time (RTT) latencies. The latency of the SME network and the Access network leaves some remaining latency budget for the aggregation and the core network.

Because the SME network is located on the end user side of the access network, the network delay on the SME network is mainly the delay from the end user to the PON port on the enterprise network. This latency includes a latency of medium transmission between the user equipment, the gateway/router and a delay of packet processing by the gateway/router. For devices connected to LAN interfaces, the transmission distance is short because they use a hardware media. Gateways and routers support hardware packet forwarding, and the delay is generally less than 1 ms so users are unaware of the latency. Latency on the SME network is caused by Wi-Fi connections inside the SME and Wi-Fi packet processing by gateways and routers.

## 6.4 Connectivity

Multi-service concurrency is the core typical feature of SME network service requirements. Concurrent connections in an SME are reflected in multiple dimensions, including the number of connected users and the number of concurrent users:

- Number of connected users: maximum number of users that may access the network.
- Number of concurrent users: indicates the number of users who use the services at the same time.

The more the number of concurrent users, the more competition conflicts and the worse the service experience will be.

## 6.5 Cloud and networking integration

In SME scenarios, the internal network is more closely related to the cloud network architecture and cloud service applications. Cloud-network integration is mainly used to ensure the best experience from enterprise cloud services. Therefore, the gateway should be capable of service awareness and identification, and the service identification result should be used to distribute traffic to the cloud on demand. After services are migrated to the cloud, the performance of the VPN channel between the SME gateway and the cloud network is the key to good network performance. Therefore, cloud-network integration needs to provide architecture capabilities to support high-quality integrated development of enterprise cloud-network services. Table 3 lists the recommended capability indicators.

**Table 3: Performance specifications for cloud-network integration**

Capability Indicator	Indicator requirements
Service application identification capability	20+ categories of mainstream office and live broadcast applications
Cloud-network acceleration channel selection capability	Forwarding performance of the L1 cloud-network VPN channel $\geq 1$ Gbit/s L2 Cloud-network VPN channel forwarding performance $\geq 2$ Gbit/s
Cloud-network integration provisioning capability	Automatic service handling, automatic service orchestration, automatic cloud resource service handling, automatic provisioning of PON private lines, and automatic provisioning of cloud private lines

## 6.6 Security

The SME intranet should establish a security system and have security responsibilities for multiple roles and services of the SME. Multiple roles include SME employees, business owners, and service providers. Multiple services include public Internet access, intranet access and extranet access. The SME intranet needs to establish a security system based on the cross matrix of roles and services, including employee authentication, authorization, isolation, data security and privacy control.

Basic security requirements shall be met for SME devices. More security mechanisms and encryption modes shall be supported to prevent intruders from creating their own encryption keys to match the encryption keys used on the secure SME intranet. Message integrity check shall be supported to prevent unauthorized modification of data packets.

End-to-end encryption is required for video conference services. SME devices shall support access control in the access security field. Security requirements for cloud migration of office systems mainly involve channel security, device security, and SME intranet security functions.

Channel security shall be encrypted for Wi-Fi, tunnels, and physical optical paths. Device security shall support:

- chip secure boot;
- CPU overload protection;
- flash scrambling;
- firmware encryption.

The SME intranet shall be divided into zones to minimize intranet access rights violations, control internal and external traffic access, and ensure that the intranet meets the SME intranet requirements.

As more and more services are cloud based, (including but not limited to 4K/8K live broadcast, cloud enabled design, and cloud rendering) SMEs need to properly use and configure cloud service capabilities based on service requirements and build a security protection system with stronger security capabilities. Enterprise cloud services have security requirements. In addition to the L1 level, the SME intranet needs to support:

- Anti-intrusion detection in terms of access security,
- Anti-virus detection in terms of application security,
- Security situational awareness in terms of device security O&M.

Security reports may be generated based on security views. The encryption capability of channel security should support regional encryption algorithms.

NOTE: The 'security view' refers to a comprehensive perspective or understanding of the overall information security situation

## 6.7 Smart O&M

The goal of smart O&M is to enable new service in agility for ultimate customer experience through intelligent networking. Smart O&M achieves more efficient resource and energy utilization. Network automation, self-optimization, and self-healing are supported by smart O&M so the network should evolve to be an autonomous network:

- Automatic: Automatically deploy services based on user intentions and automatically deploy the final service.
- Self-healing, predicting and preventing faults and self-recovery based on events. The ultimate goal is automatic O&M.
- Self-optimization, adaptive adjustment and optimization based on user experience, and the ultimate goal is automatic optimization.
- Autonomous network function self-evolution is implemented on the basis of automatic, self-healing, and self-optimization.

The capability of smart O&M is described by several level of sophistication, shown in Table 4.

**Table 4: Smart O&M definition of functionality**

Dimension	L0	L1	L2
User experience	<ul style="list-style-type: none"> <li>• Service provisioning duration</li> <li>• Precise door-to-door</li> <li>• Services without interruption</li> </ul>	<ul style="list-style-type: none"> <li>• Predictable duration</li> <li>• Self-service</li> <li>• Guaranteed quality</li> </ul>	<ul style="list-style-type: none"> <li>• Duration can be committed</li> <li>• Smart User Experience upgrade strategy Recommendation</li> <li>• Experience beyond expectations</li> </ul>
Network O&M	<ul style="list-style-type: none"> <li>• Device self-management</li> <li>• Automatic fault identification</li> <li>• Offline self-optimization</li> </ul>	<ul style="list-style-type: none"> <li>• Network self-provisioning</li> <li>• Fault self-diagnosis</li> <li>• Scenario self-optimization</li> </ul>	<ul style="list-style-type: none"> <li>• Upgrade and continuous service</li> <li>• Fault self-recovery</li> <li>• Collaborative self-optimization</li> </ul>

## 7 User experience evaluation

### 7.1 General description

#### 7.1.1 Introduction

User experience evaluation identifies the service quality as perceived by the user within the SME, collects service data, and identifies network failure. The result of the user experience evaluation is utilized by the service operator to improve the network service. The following sub-clauses specify the quantification methodology used to determine the service KQI. The method is using the concept of Mean Opinion Score (MOS) values. MOS value and corresponding MOS formulas are provided to score the service KQIs on a per-KQI, and per-service level.

#### 7.1.2 The Concept of a MOS value

The concept of the MOS value is defined in ETSI GS F5G 015 [1].

### 7.2 Telephony

Telephony is one of the basic Internet applications in SME scenario. For simplicity, the service KQI deals with the voice communication quality of plain telephony, but no SME-specific telephony services. Service KQIs of Telephony includes call completion ratio, call setup time, call drop rate and conversational quality. The corresponding definitions are defined in clause 5.1 of the present document. The key MOS mapping of each KQI is defined in ETSI GS F5G 015 [1].

### 7.3 Web browsing

Web browsing is one of the basic Internet applications in SME scenario. Service KQIs of web browsing includes page response time, first screen display time and full load time. The corresponding definitions are defined in clause 5.2 of the present document. The MOS mapping of each KQI is defined in ETSI GS F5G 015 [1].

### 7.4 Instant messaging

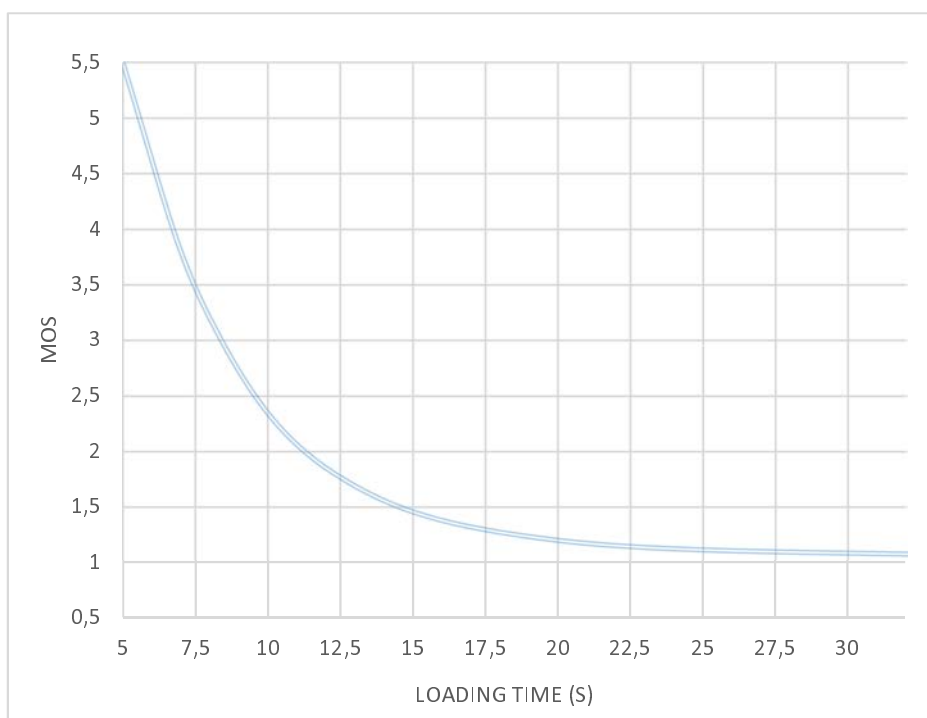
#### 7.4.1 MOS mapping of Loading Time (LT)

See clause 5.3.2 of the present document for the definition of Loading Time (LT). Table 5 lists the mapping between the loading time and the MOS value of the instant message.

**Table 5: Mapping between loading time and the MOS value**

Loading Time (s)	MOS
5,5	5
6,5	4
8,5	3
11,5	2
30	1

The mapping relationship between MOS and LT is depicted in Figure 3. The MOS value decreases as the loading time increases.



**Figure 3: Mapping between loading time and MOS**

By fitting the mathematical model, formula (2) shows the mapping between MOS and LT:

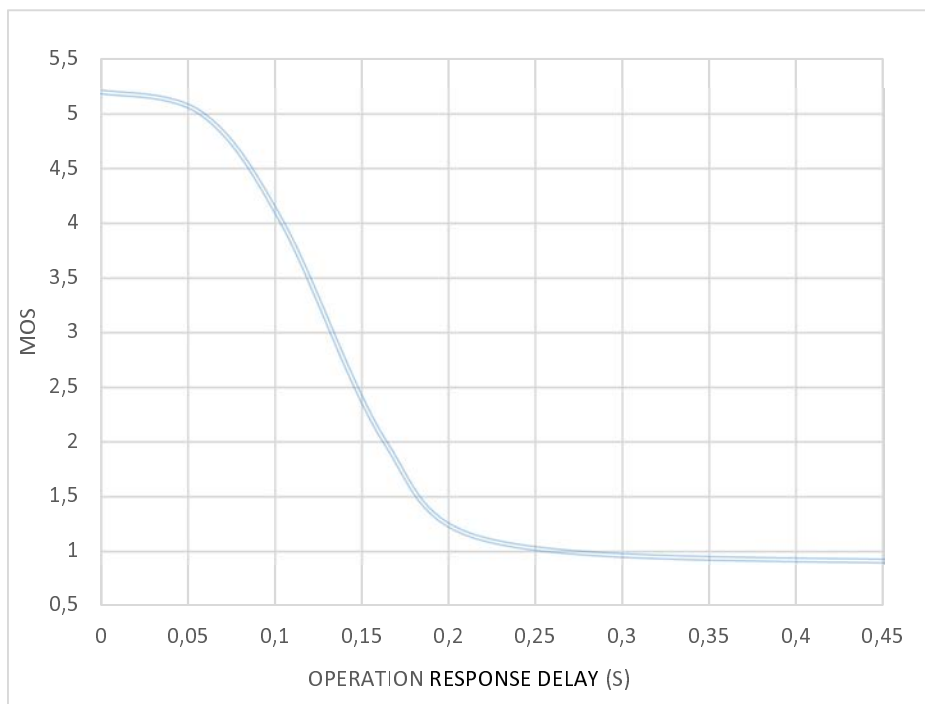
$$MOS_{LT} = 18,74 \times (\exp - 0,3271 \times KQI_{LT} + 0,09648) \quad (2)$$

## 7.4.2 MOS mapping of Operation Response Delay (ORD)

See clause 5.3.3 of the present document for the definition of Operation Response Delay (ORD). Table 6 lists the mapping between the MOS value and the operation response delay. The mapping relationship between MOS and ORD is depicted in Figure 4.

**Table 6: Mapping between the MOS value and the operation response delay**

Operation Response Delay (s)	MOS
0,055	5
0,11	4
0,135	3
0,16	2
0,22	1



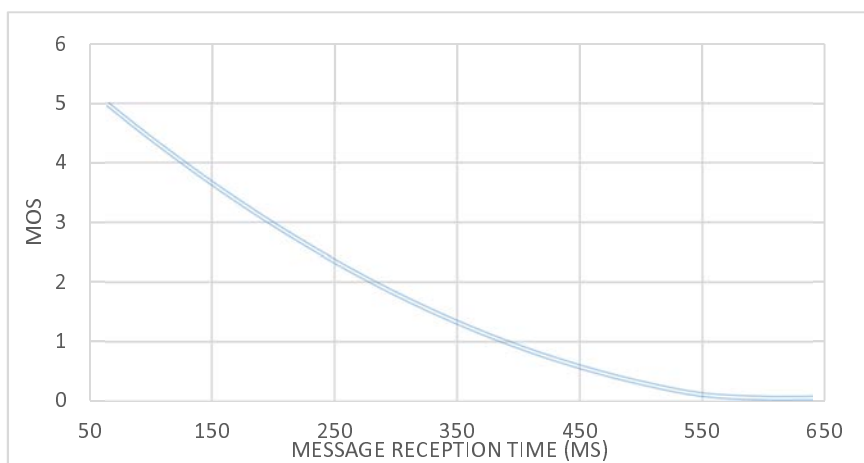
**Figure 4: Mapping between operation response delay and MOS**

By fitting the mathematical model, formula (3) shows the mapping between MOS and ORD:

$$MOS_{ORD} = \frac{4,293}{1 + 0,007035 \times \exp(37.4) \times ORD} + 0,9256 \quad (3)$$

### 7.4.3 MOS mapping of Message reception time (MRT)

See clause 5.3.4 of the present document for the definition of Message Reception Time (MRT). For Message Receiving Delay, a MOS value of 5 is assigned to within 63 ms of message receiving delay, while MOS value of 3 is assigned to around 120 ms. The MOS value of 0 is assigned to more than 580 ms or test failure. Figure 5 shows the mapping relationship.



**Figure 5: Mapping relationship between message reception time and the MOS value**

By fitting the mathematical model, formula (4) shows the mapping between MOS and MRT:

$$MOS_{MRD} = \begin{cases} 5, & MRT \leq 0,1 \\ 0,0000139 \times (MRT)^2 - 0,0186 \times MRT + 6,132, & 63 < MRT < 580 \\ 0, & MRT \geq 580 \\ 0, & \text{Test failure} \end{cases} \quad (4)$$

## 7.4.4 Comprehensive service score

The loading time, operation response delay, and message reception time are the key factors, for evaluating user experience of instant messaging. To have a quantitative evaluation through MOS value, a weighted formula (5) is used:

$$MOS_{instant\ messaging} = (MOS_{LT}^{w1} \times MOS_{ORD}^{w2} \times MOS_{MRT}^{w3}) / (5^{(w1 + w2 + w3 - 1)}) \quad (5)$$

The exact weight value ( $w1$ ,  $w2$ ,  $w3$ ) can be determined by the service operator. The recommended values are  $w1 = 10\%$ ,  $w2 = 50\%$ ,  $w3 = 40\%$ . A large weight indicates great impact on user experience. The value of  $MOS_{instant\ messaging}$  could be used to reflect overall user experience of instant messaging service.

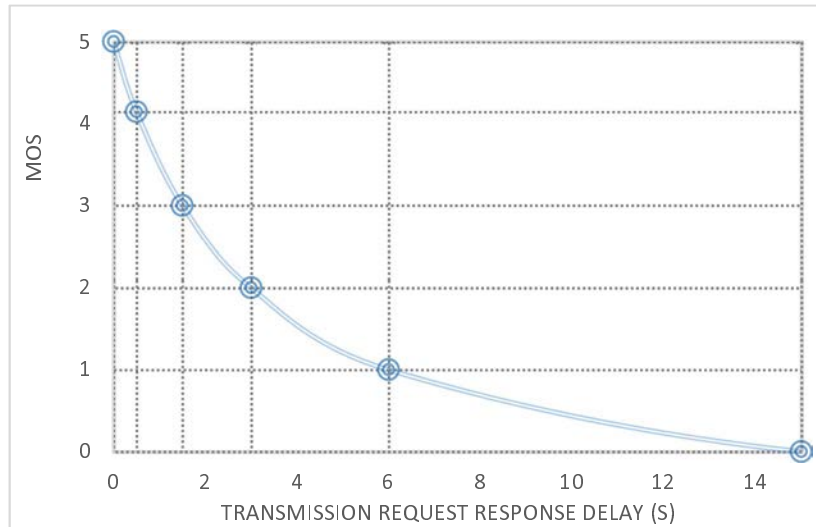
## 7.5 Small File Transmission

### 7.5.1 MOS mapping of Transmission Request Response Delay (TRRD)

See clause 5.4.2 of the present document for the definition of Transmission Request Response Delay (TRRD). The key reference points for MOS mapping of the transmission request response delay are as follows:

- $< 0,1$  s as the MOS score 5: Excellent
- $\sim 1,5$  s as the MOS score 3: Fair
- $\sim 15$  s as the MOS score 0: Bad

The mapping relationship between MOS and TRRD is depicted in Figure 6 and the mapping function is described by formula (6).



**Figure 6: Mapping between transmission request response delay and MOS**

The mapping function between a KQI value of TRRD and MOS is shown in formula (6):

$$MOS_{TRRD} = \begin{cases} 5, & 0 < TRRD < 0,1 \\ \frac{18}{TRRD + 3} - 1, & 0,1 \leq TRRD \leq 15 \\ 0, & TRRD > 15, Test\ failure \end{cases} \quad (6)$$

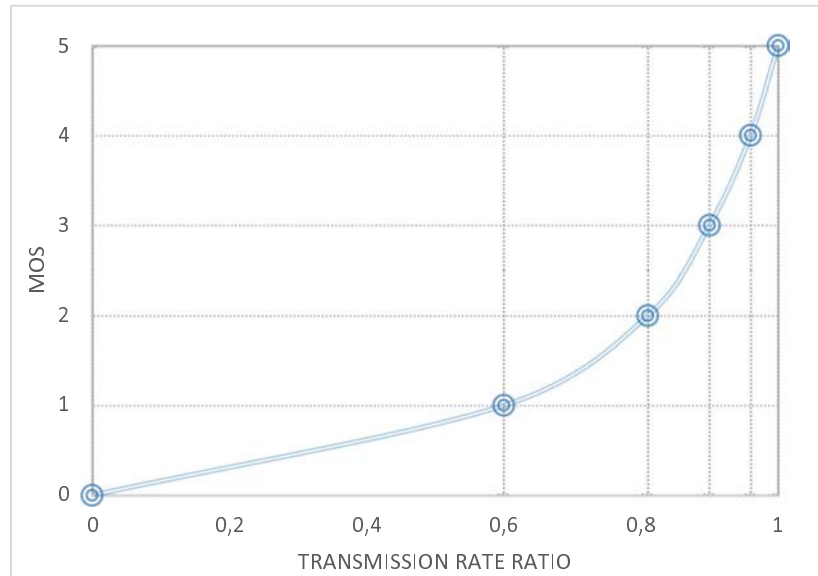
### 7.5.2 MOS mapping of Transmission Rate Ratio (TRR)

See clause 5.4.3 of the present document for the definition of Transmission Rate Ratio (TRR). The key reference point for the MOS mapping of the small file transmission rate ratio is following:

- 100 % as the MOS score 5: Excellent

- ~90 % as the MOS score 3: Fair
- ~0 % as the MOS score 0: Bad

The mapping relationship between MOS and TRR is depicted in Figure 7 and the mapping function is described by formula (7).



**Figure 7: Mapping between transmission rate ratio and MOS**

The mapping function between KQI value of transmission rate ratio and MOS value of transmission rate ratio is calculated using formula (7).

$$MOS_{TRR} = \begin{cases} \frac{120}{120 - 100 \times TRR} - 1, & TRR < 100 \% \\ 5, & TRR = 100 \% \\ 0, & \text{Test failure} \end{cases} \quad (7)$$

### 7.5.3 Comprehensive service score

The transmission request response delay, and transmission rate ratio are the key factors, for evaluating user experience of small file transmission. To have a quantitative evaluation through MOS value, a weighted formula (8) is used:

$$MOS_{small\ file\ transmission} = (MOS_{TRRD}^{w1} \times MOS_{TRR}^{w2}) / (5^{(w1 + w2 - 1)}) \quad (8)$$

The exact weight value ( $w1$ ,  $w2$ ) can be determined by the service operator. The recommended values are  $w1 = 40\%$ ,  $w2 = 60\%$ . A large weight indicates great impact on user experience. The value of  $MOS_{small\ file\ transmission}$  could be used to reflect overall user experience of small file transmission service.

## 7.6 Cloud Desktop

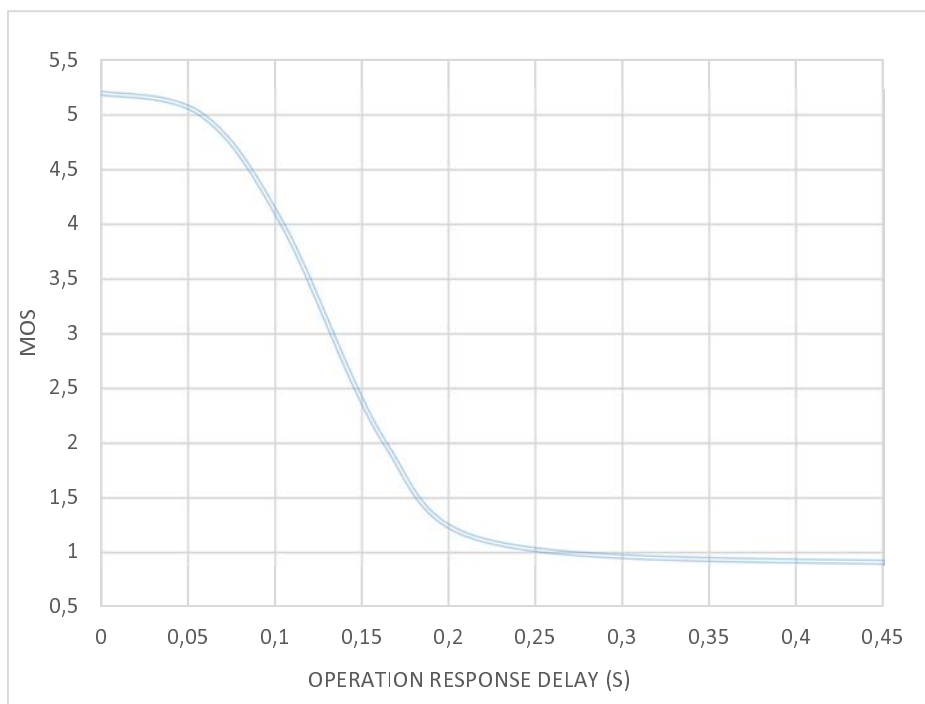
### 7.6.1 MOS mapping of Operation Response Delay (ORD)

See clause 5.5.3 of the present document for the definition of Operation Response Delay (ORD). Table 7 describes the mapping between the MOS value and the operation response delay.

**Table 7: Mapping between the MOS value and the operation response delay**

MOS value	Operation response delay (s)
5	0,055
4	0,11
3	0,135
2	0,16
1	0,22

The mapping relationship between MOS and ORD is depicted in Figure 8.

**Figure 8: Mapping between operation response delay and MOS**

A mapping function between KQI value of the operation response delay and MOS value is shown in formula (9).

$$MOS_{ORD} = \frac{4,293}{1 + 0,007035 \times \exp(37,4) \times ORD} + 0,9256 \quad (9)$$

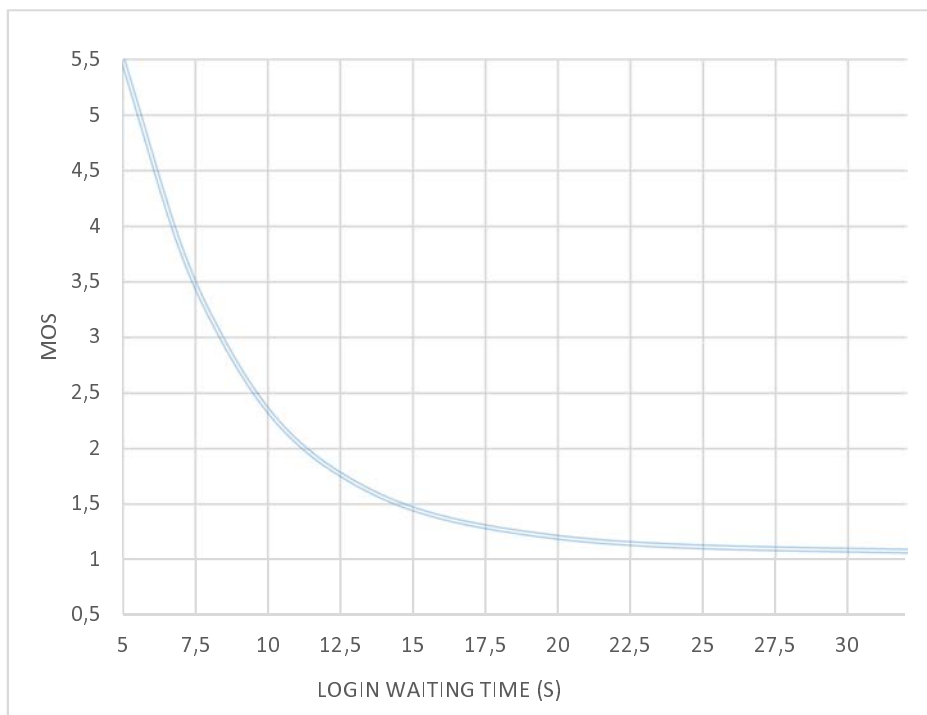
## 7.6.2 MOS mapping of Login Waiting Time (LWT)

See clause 5.5.2 for the definition of Transmission Rate Ratio (TRR). Table 8 describes the mapping between MOS value and login waiting time.

**Table 8: Mapping between MOS value and login waiting time**

MOS value	Login Waiting Time (s)
5	5,3
4	6,5
3	8,5
2	11,5
1	30

The MOS value decreases as the login waiting time increases. The mapping relationship between MOS and LWT is depicted in Figure 9.



**Figure 9: Mapping of the login waiting time and MOS**

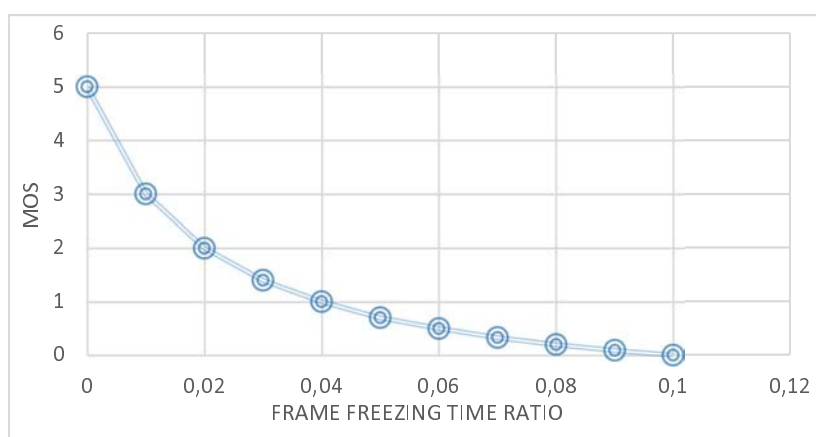
By fitting the mathematical model, formula (10) shows the mapping between MOS and LWT:

$$MOS_{LWT} = 12,64 \times (\exp(-0,277 \times LWT) + 0,094) \quad (10)$$

### 7.6.3 MOS mapping of Frame Freezing Time Ratio (FFTR)

See clause 5.5.4 of the present document for the definition of Freezing Time Ratio (FFTR). The key reference points for the MOS mapping of the frame freeze time ratio are as follows: a MOS value of 5 is assigned to 0 % of FFTR, while value of 3 and 0 are correlated to 1 % and 10 % respectively.

Figure 10 illustrates the MOS mapping for FFTR.



**Figure 10: Mapping between FFTR and MOS**

Formula (11) illustrates the mapping between FFTR and MOS:

$$MOS_{FFTR} = \begin{cases} \frac{12}{100 \times FFTR + 2} - 1, & FFTR \leq 10 \% \\ 0, & FFTR > 10 \% \\ 0, & \text{Test failure} \end{cases} \quad (11)$$

## 7.6.4 Comprehensive service score

The operation response delay, login waiting time and freezing duration ratio are the key factors, for evaluating user experience of cloud desktop. To have a quantitative evaluation through MOS value, a weighted formula (12) is used:

$$MOS_{cloud\ desktop} = (MOS_{ORD}^{w1} \times MOS_{LWT}^{w2} \times MOS_{FFTR}^{w3}) / (5^{(w1 + w2 + w3 - 1)}) \quad (12)$$

The exact weight value ( $w1$ ,  $w2$ ,  $w3$ ) can be determined by the service operator. The recommended values are  $w1 = 40\%$ ,  $w2 = 20\%$ ,  $w3 = 40\%$ . A large weight indicates great impact on user experience. The value of  $MOS_{cloud\ desktop}$  could be used to reflect overall user experience of cloud desktop service.

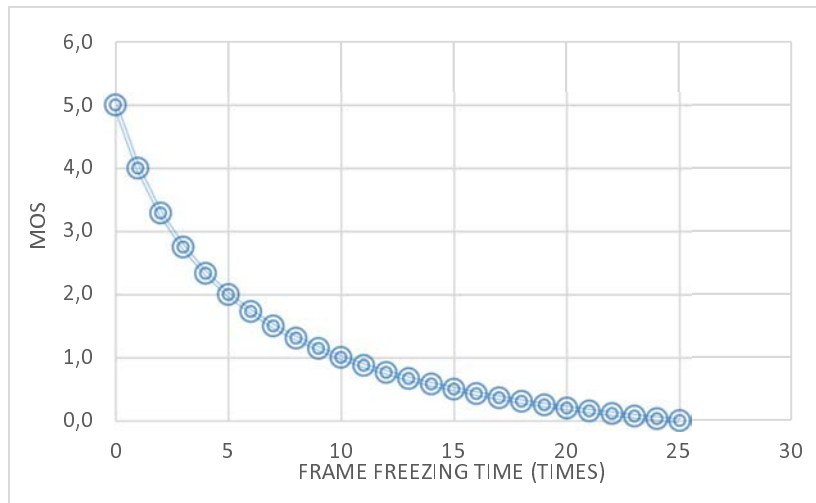
## 7.7 Video conference

### 7.7.1 MOS mapping of Viewing Quality (VQ)

Viewing quality focuses on the impact of frame freezing factors on user experience. Freezing factors include the number of Frame Freezing Times (FFT) and Frame Freezing Time Ratio (FFTR). See clause 5.6.2 for the definition of Viewing quality.

A MOS value of 5 is assigned to 0 number of Frame Freezing Times (FFT), while MOS value of 3 and 0 are assigned to 2,5 and 25 frame freezing times respectively.

The mapping relationship between MOS and FFT is depicted in Figure 11 and the mapping function is described by formula (13). The number of frame freezing times is the number of frame freezing times within 5 minutes of the conference duration. If the actual test duration is another period, the number of frame freezing times can be converted into the number of frame freezing times within 5 minutes based on the actual test duration.



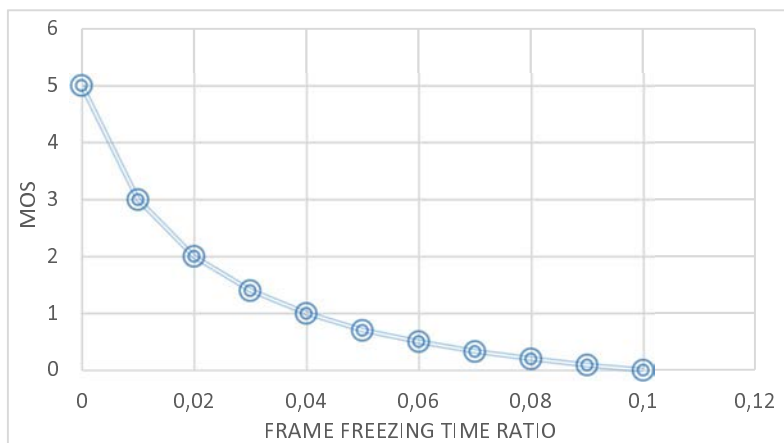
**Figure 11: Mapping between the number of frame freezing times and MOS**

Formula (13) shows the mapping relationship between FFT and MOS:

$$MOS_{FFT} = \begin{cases} \frac{30}{FFT + 5} - 1, & FFT \leq 25 \\ 0, & FFT > 25 \\ 0, & Test\ failure \end{cases} \quad (13)$$

A MOS value of frame freezing time ratio of 5 is assigned to 0 % of FFTR, while values of 3 and 0 are correlated to 1 % and 10 % respectively.

The mapping relationship between MOS and FFTR is depicted in Figure 12 and the mapping function is described by formula (14).



**Figure 12: Mapping between the freezing time ratio and MOS**

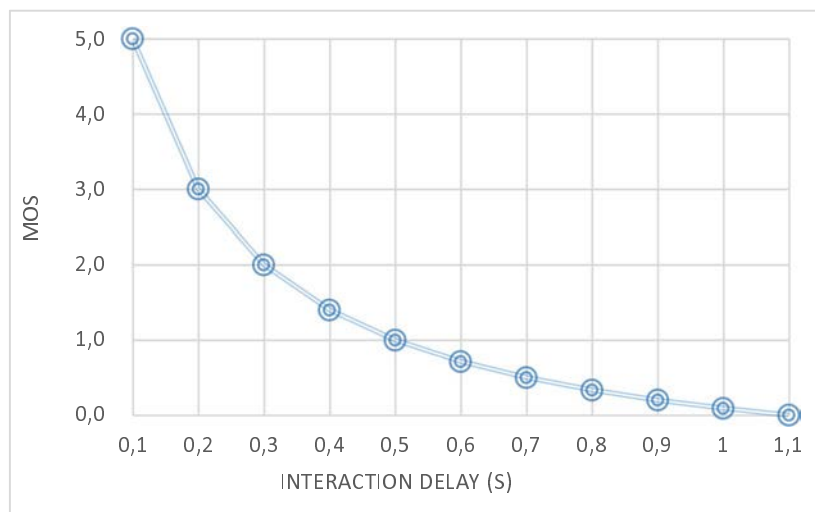
Formula (14) shows the mapping relationship between FFTR and MOS.

$$MOS_{FFTR} = \begin{cases} \frac{12}{100 \times FFTR + 2} - 1, & FFTR \leq 10 \% \\ 0, & FFTR > 10 \% \\ 0, & \text{Test failure} \end{cases} \quad (14)$$

## 7.7.2 MOS mapping of Interaction Delay (ID)

See clause 5.6.3 of the present document for the definition of Interaction Delay (ID). In the video conference service, the voice and image interaction delay between the speaker and the audience is used as the interaction quality KQI. The MOS value of 5 indicates the delay less than or equal to 0,1 s, which is close to a face-to-face communication. The MOS value of 3 and 0 are given by 0,2 s and 1,1 s, respectively.

Figure 13 shows the mapping between the interaction delay and MOS.



**Figure 13: Mapping between interaction delay and MOS**

The mapping between interaction delay KQIs and MOS values is shown in formula (15).

$$MOS_{ID} = \begin{cases} 5, & ID \leq 0,1 \\ \frac{12}{10 \times ID + 1} - 1 & 0,1 < ID < 1,1 \\ 0, & \text{Test failure} \end{cases} \quad (15)$$

### 7.7.3 Comprehensive service score

The freezing times, freezing time ratio, and interaction delay are the key factors, for evaluating user experience of video conference. To have a quantitative evaluation through MOS value, a weighted formula (16) is used:

$$MOS_{video\ conference} = (MOS_{FFT}^{w1} \times MOS_{FFTR}^{w2} \times MOS_{ID}^{w3}) / (5^{(w1 + w2 + w3 - 1)}) \quad (16)$$

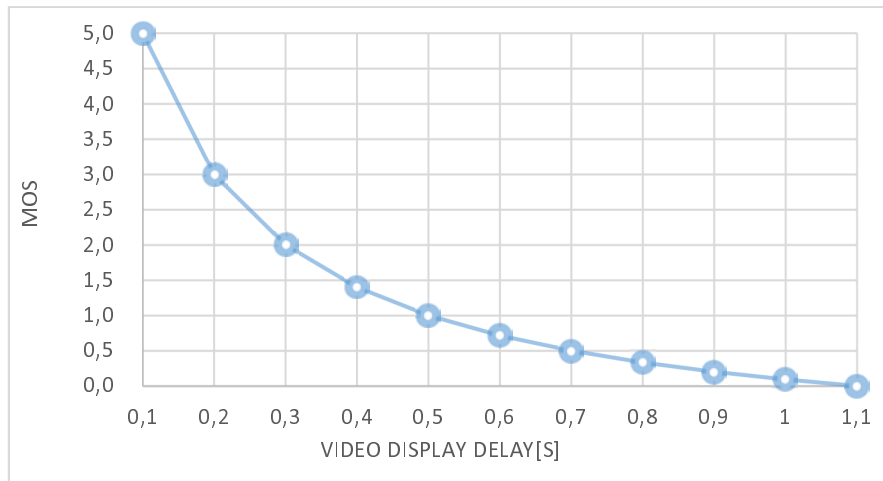
The exact weight value ( $w1$ ,  $w2$ ,  $w3$ ) can be determined by the service operator. The recommended values are  $w1 = 25\%$ ,  $w2 = 25\%$ ,  $w3 = 50\%$ . A large weight indicates great impact on user experience. The value of  $MOS_{video\ conference}$  could be used to reflect overall user experience of video conference.

## 7.8 Interactive Enterprise Live Streaming

### 7.8.1 MOS mapping of Live Video Display Delay (LVDD)

See clause 5.7.2 of the present document for the definition of Live Video Display Delay (LVDD). For Interactive Enterprise live streaming which is defined in CCSA TC615 2024 [i.6], a MOS value of 5 is assigned to less than or equal to 0,1 s of video display delay, while MOS value of 3, 2 and 1 are assigned to 0,2 s, 0,3 s and 0,5 s of video display delay respectively. The MOS value of 0 is assigned to more than 1,1 s of video display delay or test failure.

The mapping relationship between MOS and LVDD is depicted in Figure 14 and the mapping function is described by formula (17).



**Figure 14: Mapping between the live video display and MOS**

By fitting the mathematical model, formula (17) shows the mapping between MOS and LVDD:

$$MOS_{LVDD} = \begin{cases} 5, & KQI_{LVDD} \leq 0,1 \\ \frac{12}{10KQI_{LVDD} + 1} - 1, & 0,1 < KQI_{LVDD} < 1,1 \\ 0, & KQI_{LVDD} \geq 1,1 \\ 0, & Test\ failure \end{cases} \quad (17)$$

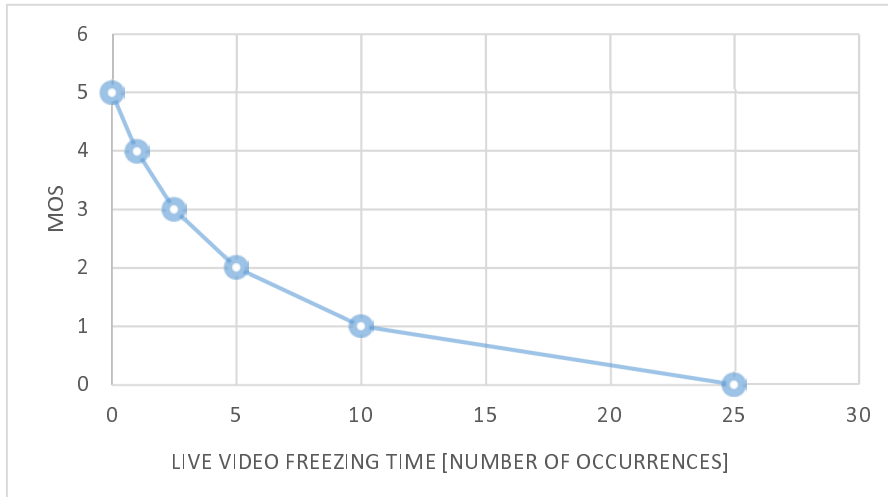
### 7.8.2 MOS mapping of Live Video Freezing Times (LVFT)

The evaluation of Video Freezing Times (LVFT) is quantified in Table 9, which shows the typical relationship between MOS and video freezing times when the observation time is 5 minutes. If the actual test time is another time, the number of freezing times can be converted into the number of freezing times of 5 minutes according to the actual test time. From the statistical analysis, a good experience ( $MOS = 5$ ) needs the Video Freezing Times is 0. And a bad experience ( $MOS = 0$ ) needs the Video Freezing Times is more than 25.

The mapping relationship between MOS and LVFT is depicted in Figure 15.

**Table 9: Relationship between MOS and live video freezing times**

MOS value	Live Video Freezing Times
5	0
4	1
3	2,5
2	5
1	10
0	25

**Figure 15: Mapping between the live video freezing time and MOS**

By fitting the mathematical model, formula (18) shows the mapping between MOS and LVFT:

$$MOS_{LVFT} = \begin{cases} \frac{30}{KQI_{LVFT}+5} - 1, & KQI_{LVFT} \leq 25 \\ 0, & KQI_{LVFT} > 25 \\ 0, & Test\ failure \end{cases} \quad (18)$$

### 7.8.3 Comprehensive service score

The live video display delay, and video freezing times are the key factors, for evaluating user experience of interactive enterprise live streaming. To have a quantitative evaluation through MOS value, a weighted formula (19) is used:

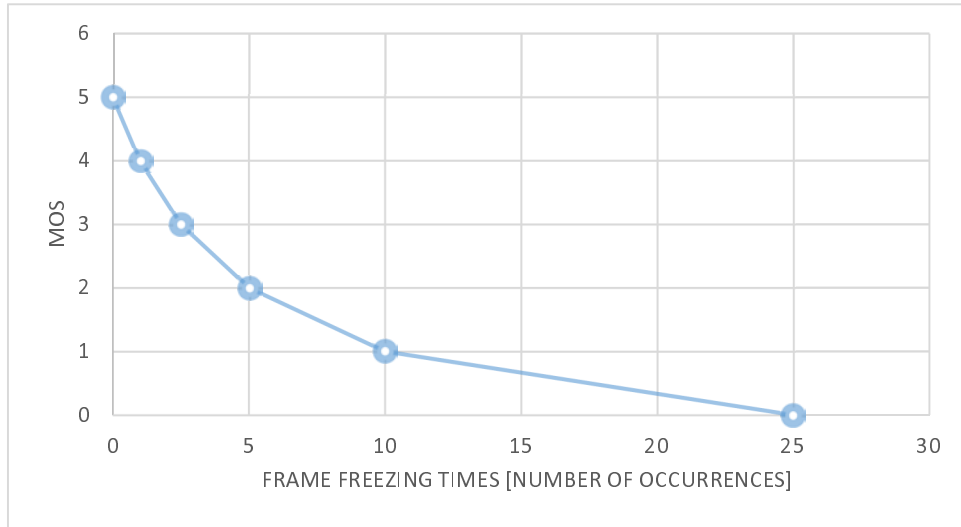
$$MOS_{interactive\ enterprise\ live\ streaming} = (MOS_{LVDD}^{w1} \times MOS_{LVFT}^{w2}) / (5^{(w1 + w2 - 1)}) \quad (19)$$

The exact weight value ( $w1$ ,  $w2$ ) can be determined by the service operator. The recommended values are  $w1 = 50\%$ ,  $w2 = 50\%$ . A large weight indicates great impact on user experience. The value of  $MOS_{interactive\ enterprise\ live\ streaming}$  could be used to reflect overall user experience of interactive enterprise live streaming service.

## 7.9 Cloud enabled Design and Rendering

### 7.9.1 MOS mapping of Frame Freezing Times (FFT)

See clause 5.8.2 of the present document for the definition of Frame Freezing Times (FFT). The mapping relationship between MOS and FFT is depicted in Figure 16 and the mapping function is described by formula (20). Observation time is 5 minutes. If the actual test time is another time, the number of frame freezing times can be converted into the number of freezing times of 5 minutes according to the actual test time.



**Figure 16: Mapping between the frame freezing times and MOS**

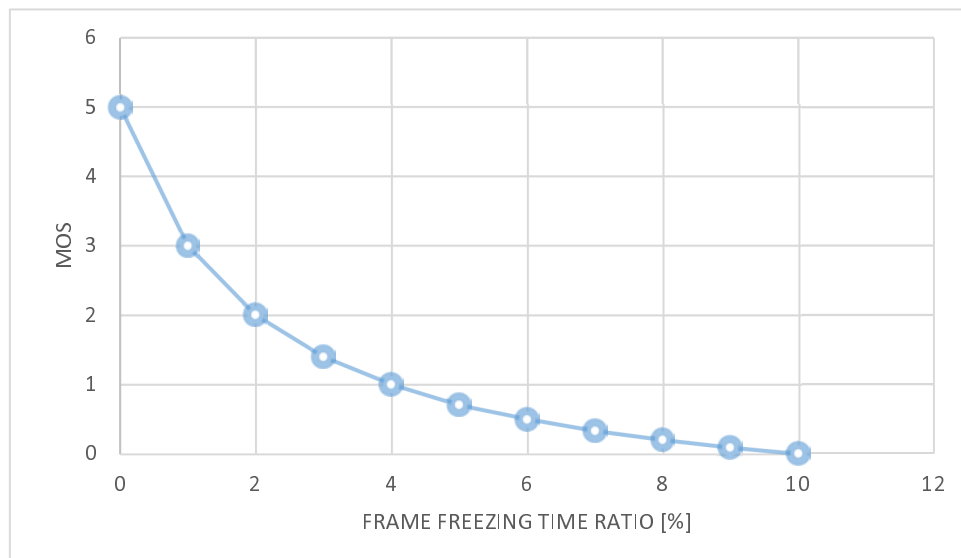
By fitting the mathematical model, formula (20) shows the mapping between MOS and FFT:

$$MOS_{FFT} = \begin{cases} \frac{30}{KQI_{FFT}+5} - 1, & KQI_{FFT} \leq 25 \\ 0, & KQI_{FFT} > 25 \\ 0, & \text{Test failure} \end{cases} \quad (20)$$

### 7.9.2 MOS mapping of Frame Freezing Time Ratio (FFTR)

The Frame Freezing Time Ratio (FFTR) reflects the percentage of frame freezing phenomenon during the measurement period. A MOS value of 5 indicates no frame freezing has occurred during the entire measurement period, while 1 % and 10 % are correlated to 3 and 0, respectively.

The mapping relationship between MOS and FFTR is depicted in Figure 17 and the mapping function is described by formula (21).



**Figure 17: Mapping between the frame freezing time ratio and MOS**

$$MOS_{FFTR} = \begin{cases} \frac{12}{100 \times KQI_{FFTR} + 2} - 1, & KQI_{FFTR} \leq 10 \% \\ 0, & KQI_{FFTR} > 10 \% \\ 0, & \text{Test failure} \end{cases} \quad (21)$$

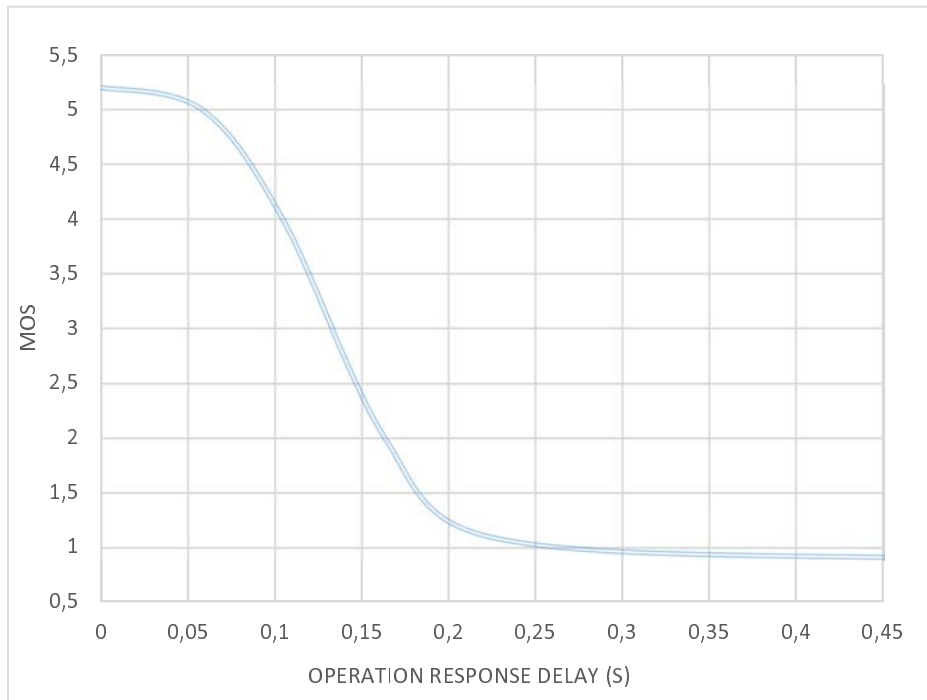
### 7.9.3 MOS mapping of Interaction Quality (IQ)

The Interaction Quality (IQ) is measured by the operational response delay which is described in BBF TR126 [i.2]. The mapping relationship between MOS and operational response delay is shown in Table 10.

**Table 10: Relationship between MOS and operation response delay**

MOS value	Operation response delay (s)
5	0,055
4	0,11
3	0,135
2	0,16
1	0,22

The mapping relationship is depicted in Figure 18 and the mapping function is described by formula (22).



**Figure 18: Mapping between the operation response delay and  $MOS_{IQ}$**

$$MOS_{IQ} = 4,293 / (1 + 0,007035 \times \exp^{37,4 \times KQI_{\text{operation response delay}}}) + 0,9256 \quad (22)$$

### 7.9.4 Comprehensive service score

The frame freezing times, frame freezing time ratio, and interaction quality are the key factors, for evaluating user experience of cloud enable design and rendering. To have a quantitative evaluation through MOS value, a weighted formula (23) is used:

$$MOS_{\text{cloud enabled design and rendering}} = (MOS_{FFT}^{w1} \times MOS_{FFTR}^{w2} \times MOS_{IQ}^{w3}) / (5^{(w1 + w2 + w3 - 1)}) \quad (23)$$

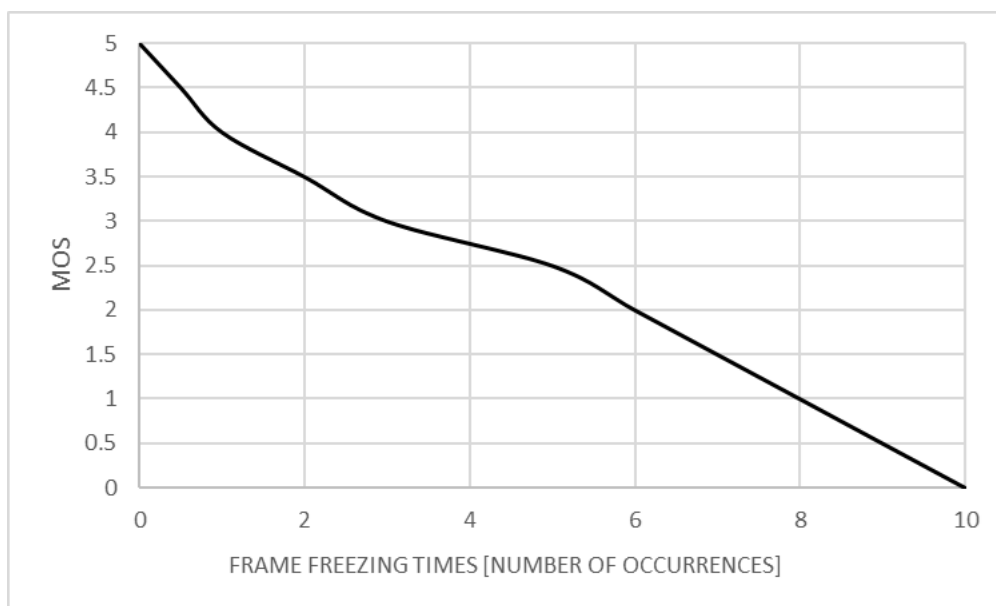
The exact weight value ( $w1$ ,  $w2$ ,  $w3$ ) can be determined by the service operator. The recommended values are  $w1 = 25\%$ ,  $w2 = 25\%$ ,  $w3 = 50\%$ . A large weight indicates great impact on user experience. The value of  $MOS_{\text{cloud enabled design and rendering}}$  could be used to reflect overall user experience of cloud enabled design and rendering.

## 7.10 Surveillance

### 7.10.1 MOS mapping of Frame Freezing Times (FFT)

See clause 5.9.2 of the present document for the definition of Frame Freezing Times (FFT) [number of occurrences].

The mapping relationship between MOS and FFT is depicted in Figure 19 and the mapping function is described by formula (24). A MOS value of 5 indicates no frame freezing has occurred during the entire measurement period, while 3 times and 10 times are correlated to 3 and 0, respectively. The recommended measurement period is 5 minutes, if the actual test time is another time, the number of frame freezing times can be converted into the number of freezing times of 5 minutes according to the actual test time.



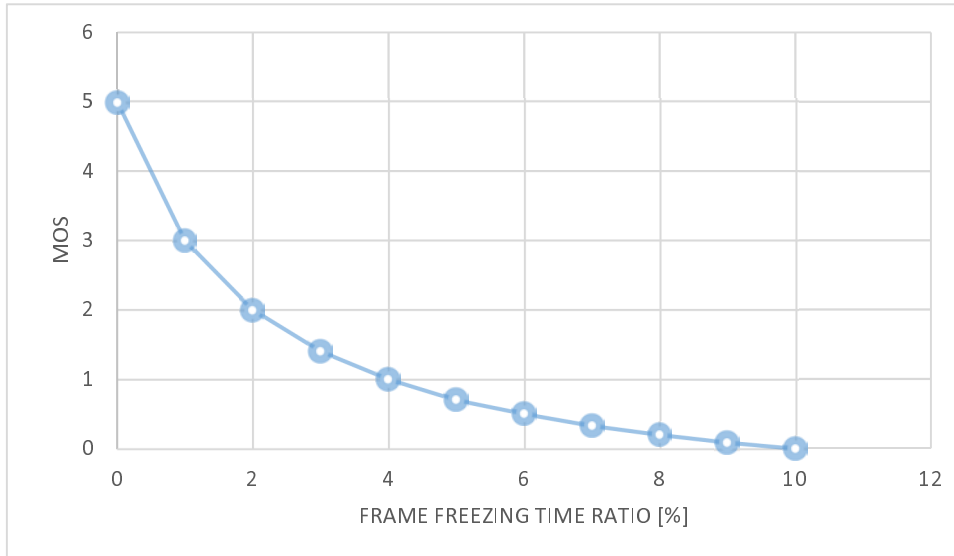
**Figure 19: Mapping between the frame freezing times and MOS**

By fitting the mathematical model, formula (24) shows the mapping between MOS and FFT.

$$\text{MOS}_{\text{FFT}} = \begin{cases} 0,0016\text{KQI}_{\text{FFT}}^4 - 0,0374\text{KQI}_{\text{FFT}}^3 + 0,2869\text{KQI}_{\text{FFT}}^2 - 1,2155\text{KQI}_{\text{FFT}} + 5,0076, & \text{KQI}_{\text{FFT}} \leq 10 \\ 0, & \text{KQI}_{\text{FFT}} \geq 10 \\ 0, & \text{Test failure} \end{cases} \quad (24)$$

### 7.10.2 MOS mapping of Frame Freezing Time Ratio (FFTR)

See clause 5.9.2 of the present document for the definition of Frame Freezing Times Ratio (FFTR). The Frame Freezing Time Ratio (FFTR) [%] reflects the percentage of frame freezing time ratio. The recommended measurement period is 5 minutes. The mapping relationship between MOS and FFTR is depicted in Figure 20 and the mapping function is described by formula (25). A MOS value of 5 indicates no frame freezing has occurred during the entire measurement period, while 1 % and 10 % are correlated to 3 and 0, respectively.



**Figure 20: Mapping between the frame freezing time ratio[%] and MOS**

The mapping relationship between MOS and KQI of FFTR [%] is described by formula (25):

$$MOS_{FFTR} = \begin{cases} \frac{12}{100 \times KQI_{FFTR} + 2} - 1, & KQI_{FFTR} \leq 10 \% \\ 0, & KQI_{FFTR} > 10 \% \\ 0, & \text{Test failure} \end{cases} \quad (25)$$

### 7.10.3 Comprehensive service score

The frame freezing times, frame freezing time ratio are the key factors, discussed for evaluating user experience of the surveillance service. To have a quantitative evaluation through MOS value, a weighted formula (26) is used:

$$MOS_{surveillance} = (MOS_{FFT}^{w1} \times MOS_{FFTR}^{w2}) / (5^{(w1 + w2 - 1)}) \quad (26)$$

The exact weight value ( $w1$ ,  $w2$ ) can be determined by the service operator. The recommended values are  $w1 = 60\%$ ,  $w2 = 40\%$ . A large weight indicates great impact on user experience. The value of  $MOS_{surveillance}$  could be used to reflect overall user experience of surveillance service.

## 7.11 User experience classification and evaluation framework for service bundles

### 7.11.1 Service bundle evaluation framework

Figure 21 shows the service evaluation framework, using detailed KQIs and stepwise aggregates those into an integrated MOS value for a service bundle. The integrated MOS value is estimating the SME user experience of a service bundle. The MOS values of each SME service defined in the previous clauses are used to calculate the integrated MOS value.

In general, the framework is divided into four steps:

- 1) KQIs are defined to characterize the user experience for dedicated service (see clause 5). A few KQI parameters are specified according to the service characteristics.
- 2) The MOS value of each KQI is calculated using the formula defined in the previous clauses.
- 3) The comprehensive MOS value of each service is then calculated based on each service KQI.
- 4) The integrated MOS value is calculated from the comprehensive MOS values of each service.

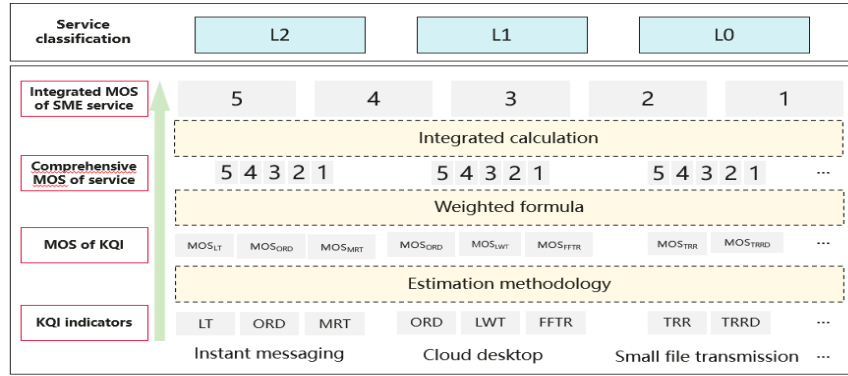


Figure 21: Illustration of the service evaluation framework for SME network services (not all services are shown)

### 7.11.2 Calculation of integrated MOS for SME network service bundles

Based on the integrated MOS value, the SME service bundle user experience is evaluated. The integration step is based on the weighted values per service. The weighted values are derived from the user utilization rate of the dedicated network service. The relative weighted values are a normalization of the weighted values to be a maximum of 10. Table 11 shows the relative weighed value of each SME service.

Table 11: Default relative weighted value of each SME service

Service	Weighted value	Relative Weighted Value (RWV)
Telephony		4
Web browsing		9
Instant messaging		9
Small file transmission		7
Cloud Desktop		4
Video Conference		6
Surveillance		6
Interactive Enterprise Live Streaming(HD)		7
Interactive Enterprise Live Streaming(UHD)		6
Cloud enabled design and rendering		3
NOTE: The relative weighted values are based on overall usage of service and are therefore the recommendation default value. Individual users might have a different set of relative weighted values.		

The integrated MOS value is calculated using formula (27):

$$MOS_{integration} = MOS_{telephony} \times \frac{RWV_{telephony}}{\sum(RWV_{telephony} + RWV_{web} + RWV_{instant} + \dots)} + MOS_{web} \times \frac{RWV_{web}}{\sum(RWV_{telephony} + RWV_{web} + RWV_{instant} + \dots)} + \dots \quad (27)$$

The  $MOS_{integration}$  value can be used to classify the user QoE for a service bundle into categories bad to excellent, see ETSI GS F5G 015 [1], table 8.

NOTE: The  $MOS_{integration}$  value can be on a per-user bases or an average over a set of users. In the latter case the individual service MOS values need to be averaged over that set of users.

## 8 SME Service classification

### 8.1 Overview

This clause discusses the service classification according to the network requirements which are defined in ETSI GR F5G 001 [i.7]. The SME services are classified into different network characteristics levels. The network characteristics level indicates the network performance and functionality required to satisfy the set of SME services. The higher network characteristics level indicates the greater demand on network performance and functionality. By quantifying the network characteristics into different levels, operators and SME subscribers may choose a suitable subscription and develop the appropriate SME network.

### 8.2 SME Service classification into network characteristics levels

Table 12 shows the classification of typical SME services into network characteristics levels based on their network required performance and functionality. Different network characteristics levels (labelled L0, L1, and L2) require specific network performance and functionality. Higher network characteristics levels in the future (such as L3, L4, etc.) may be defined according to new services and network capabilities.

NOTE: Since the number of SME users play a role for the performance needs for enterprises, the classification largely applies for micro and mini enterprises.

**Table 12: Classification of SME service for micro and mini enterprises**

Level Dimension	L0	L1	L2
Service	<ul style="list-style-type: none"> <li>• Telephony</li> <li>• Web browsing</li> <li>• Small file transmission</li> <li>• Instant messaging</li> </ul>	<ul style="list-style-type: none"> <li>• Video conference</li> <li>• Interactive enterprise live streaming (HD)</li> <li>• Cloud desktop</li> </ul>	<ul style="list-style-type: none"> <li>• Interactive enterprise live streaming (UHD)</li> <li>• Cloud enabled design and rendering</li> </ul>

### 8.3 Network evaluation

#### 8.3.1 Introduction

Network capability evaluation can be basic or detailed, depending on the measurement resources used. The basic evaluation contains only a subset of network parameters, which may be easily measured by the SME end user and SME subscriber through mobile device. This helps the SME user/SME subscriber to quickly understand the dynamic status of their network. Such data could be supplied to the service operator for improvement of network performance.

For detailed network evaluation, the use of complex testing equipment is necessary to obtain the full set of parameters. This is mainly done by the service operator or third-party testing laboratories.

It is expected that the user with network KQIs in a certain level receives good experience (MOS value  $\geq 3,5$ ) also for the services of the lower levels.

#### 8.3.2 Detailed network evaluation

The recommended SME network performance classification is shown in Table 13.

Table 13: SME network performance classification

Graded	Carrying services	Throughput requirements	Round trip latency requirement	Connectivity requirements	Cloud and network integration	Security requirements	Smart O&M Indicator Requirements
L0	<ul style="list-style-type: none"> <li>• Telephony</li> <li>• Web browsing</li> <li>• Small File Transmission</li> <li>• Instant messaging</li> </ul>	≥ 100 Mbps	≤ 100 ms	<p>Number of connected users: 64</p> <p>Number of concurrent users: 16</p>	No requirement.	The basic security requirements of SME devices shall be met. There are no security immunity requirements. More secure security mechanisms and encryption methods shall be supported. Intruders shall be prevented from creating their own encryption keys to match the encryption keys used by secure networks. Message integrity check shall be supported. Any changed data packets sent by hackers shall be scanned.	The system needs to provide auxiliary monitoring capabilities for autonomous networking. All network planning, design, deployment, and O&M tasks need to be manually executed.
L1	<ul style="list-style-type: none"> <li>• Video Conference</li> <li>• Interactive enterprise live streaming (HD)</li> <li>• Cloud desktop</li> </ul>	≥ 1 000 Mbps	≤ 50 ms	<p>Number of connected users: 128</p> <p>Number of concurrent users: 32</p>	<p>Automatic service handling, automatic service orchestration, and cloud resources.</p> <p>Automatic service handling, automatic provisioning of PON private lines, and automatic provisioning of cloud private lines.</p>	Firewalls shall be supported to defend against DDoS attacks with at least 3 000 attack packets per second. Supports access control, channel security, device security, and intranet security for SMEs.	For known repetitive tasks, execute pre-configuration to improve network operation efficiency.

Graded	Carrying services	Throughput requirements	Round trip latency requirement	Connectivity requirements	Cloud and network integration	Security requirements	Smart O&M Indicator Requirements
L2	<ul style="list-style-type: none"> <li>Interactive enterprise live streaming(UHD)</li> <li>Cloud enabled Design and Rendering</li> </ul>	$\geq 2\ 000$ Mbps	$\leq 15$ ms	Number of connected users: 256 Number of concurrent users: 32	Supports multi-cloud deployment, high-performance cloud-edge collaboration, and integrated provisioning.	In terms of access security, anti-intrusion detection shall be supported. In terms of application security, anti-virus detection shall be added. In terms of device security O&M, security situational awareness shall be supported. Security reports shall be generated based on security views. In terms of channel security encryption, the encryption capability shall support regional cryptographic standards. In identity authentication scenarios, the next-generation NAC function shall be supported, security applications (such as firewalls and antivirus software) shall be implemented, and the availability of SME intranet resources shall be restricted to endpoint devices based on defined security policies, especially for mobile devices.	Based on the data model of the SME, the system shall implement closed-loop O&M on some units in the SME network based on the determined external environment.

NOTE: The network performance classification can be applied to micro or small enterprise (up to 50 SME users). For middle size enterprises, which may contain hundreds of employees, the deployment of multiple smaller local networks might be needed to fulfil the coverage and other performance requirements, including multiple local networks working as a whole network (e.g. Passive Optical LANs (POL)). Details for middle size enterprises is for further study.

To build up an SME network, it is important to understand the network requirements for improving the quality of service, and with that improving the user experience for dedicated services. Better quality of service has more stringent requirements on network KQIs, i.e. throughput, latency, connectivity, cloud-and-network integration, security and smart O&M. In order to provide good user experience (MOS value  $\geq 3,5$ ) in a given network characteristics level (L0, L1, and L2) the network shall comply with the corresponding network KQI values. A given network characteristics level supports a certain set of services with good user experience.

### 8.3.3 Basic network evaluation

The basic network evaluation provides relatively simplified network indicators in order to help users be capable to evaluate the network. Table 14 lists the recommended network KQI for the basic network evaluation.

**Table 14: Basic network evaluation of SME services**

Grade	Downstream Throughput	Upstream Throughput	Number of Wi-Fi connected users	Latency of E2E network	E2E packet loss rate requirements
L0	≥ 100 Mbps	≥ 30 Mbps	≥ 64	≤ 100 ms	≤ 10 <sup>-3</sup>
L1	≥ 1 000 Mbps	≥ 200 Mbps	≥ 128	≤ 50 ms	≤ 5 × 10 <sup>-6</sup>
L2	≥ 2 000 Mbps	≥ 500 Mbps	≥ 256	≤ 15 ms	≤ 10 <sup>-6</sup>

NOTE: L3 for F5G-A (such as 50G PON, 10G FTTR) are for further study.

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## History

<b>Document history</b>		
V1.1.1	April 2025	Publication