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QoS Standards for Distributed Multimedia Applications

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***Abstract**: Unlike the traditional telecommunication networks which provide 'best effort' services, the future ones have to carry out a wide range of traffic types, from variable rate sources (voice, variable rate coded video) to constant rate sources (constant bit transmission). The integrated transmission of different data types (variable and constant rate) through a network forms the Distributed Multimedia Applications (DMA), which are the hungriest for network resources. Multimedia networks have to provide a guaranteed performance or Quality of Service (QoS) to the users. The considerable amount of research on QoS over the past several years shows the agony of researchers and users about guaranteed quality. The procedure of setting QoS standards in such a rapid innovative technology environment is not an easy task. Furthermore, future needs must be considered. This paper presents a basis for QoS standards for Distributed Multimedia Applications.*

SUMMARY

Quality of Service (QoS) is defined as the set of quantitative and qualitative characteristics of a telecommunication system that are necessary to achieve the required functionality of applications and furthermore to satisfy the user. Therefore the Network (telecommunication system) supports a QoS level to make sure that the Application (user) QoS requirements are met.

Distributed Multimedia Applications (DMA) lie at the intersection of: (i) Entertainment, TV, Games; (ii) Computer hardware and software applications, and (iii) Telecommunications and Networking. Multimedia traffic are very hungry for network resources requiring: (1) large volume transfer, (2) real-time delivery, (3) long connection times, (4) synchronization of different media (voice and video), (5) distribution-oriented applications and (6) long-range dependency (or similarity) [21, 31]. Multimedia Applications can be classified according to the following categories:

Multimedia Application Category	*Example*
Interactive: Multimedia Collaboration	Videotelephony / Videoconference Distance Learning, Remote presentation
Multimedia Information Retrieval	Video, Image, Document, Data retrieval, Videotext
Multimedia Mail	Videomail, Voicemail, Document mail
Distribution	Existing quality TV and High Definition TV distribution, Pay TV, Document-image-Audio-Video Distribution, Full channel broadcast videography

In order to incorporate the QoS requirements into the Network and Application Design and Management, a QoS framework is needed. This will be based on [2]:

QoS Principles: transparency, integration, separation, multiple time scales, and performance.

QoS Specification: flow performance, level of service, management policy, and cost of service, flow synchronization, security.

QoS Mechanisms:

i) QoS provision mechanisms: QoS mapping, admission testing, resource reservation protocols.

ii) QoS control mechanisms: flow scheduling, flow shaping, flow policing, flow control, flow synchronization

iii) QoS management mechanisms: QoS monitoring, availability, degradation, routing, maintenance, renegotiations and scalability.

Different applications demand different service qualities. Some need minimal delay and guaranteed response time, while others may need a good image quality (resolution/color information/frame rate of picture, etc.), or good sound quality (dynamic range/frequency performance/noise ratio/distortion ratio etc.). The following Table classifies the QoS parameters into five categories and provides examples of QoS parameters that are important [31]:

QoS Category	*Example of QoS Parameters*
Performance – oriented	End – to - end delay, bit rate
Format – oriented	Video resolution, frame rate, storage format and compression scheme
Synchronization – oriented	Skew between the beginning of audio and video sequences
Cost – oriented	Connection and data transmission charges and copyright fees
User – oriented	Subjective image and sound quality

Customer satisfaction is usually calculated as the percentage of customers satisfied with the particular aspect of service or overall service under consideration. The following Table provides the mapping of network QoS parameters to the user-perceived quality [15]:

Network QoS parameter	*Equivalent user-perceived QoS feature*
Probability of blocking	Access and availability
Probability of connection dropping during handover	Reliability of communication
Probability of QoS-negotiation during handover	Continuity of same QoS during communication
Delay and/or delay-bound	Timeliness and/or freshness of communication
Delay jitter	Smoothness of communication
Throughput or rate	Resolution of communication
Capacity bounds	Scalability of communication capacity
Error (stream, burst, mean time between error etc.)	Quality/reliability of connection/channel

The video quality can be assessed either subjectively or objectively. Traditionally, video quality has been measured by expert viewers or viewing panels. These measurements are subjective, and a quantitative metric would provide a more objective and repeatable measurement. In subjective assessments, a panel of selected human viewers is shown the video clips, and Subjective Grade Points (SGPs) are given by the viewers.
The subjective video quality would be divided into five scales [29]:

Rating	*Impairment*	*Quality*
5	Imperceptible	Excellent
4	Perceptible, not annoying	Good
3	Slightly annoying	Fair
2	Annoying	Poor
1	Very annoying	Bad

The Peak Signal-to-Noise Ratio (PSNR) has been used as a quantitative metric to measure video quality. Objective measurement techniques based on the human visual system (HVS) are necessary because some perceptible video artifacts may not be apparent when measuring video quality with traditionally used metrics such as the PSNR. Several new metrics have been developed recently, including the Just Noticeable Difference (JND) metric [10]. So, in the objective assessments, a set of parameters are calculated based on the video clips, and an Objective Grade Point (OGP) is derived which should match that of subjective assessment closely. Such OGPs can be based on [18]:

- SNR and Peak SNR measurements.
- Linear combination of n measurements after comparing the original and decoded video sequences.
- Number of frames reconstructed by the decoder.
- Combination of the above three OGPs.

Two telecommunication services have been defined:

- *Multimedia teleservices*: telecommunication service that provides the complete capability, including terminal equipment functions, for multimedia communication between users or a user and a provider.
- *Bearer service*: telecommunication service that provides the capability for transmission of signals between user-network interfaces. These services are classified into one of the following categories: circuit-, cell-, and packet-based services.

Teleservice QoS standards:

QoS Parameter	*QoS Class 1*	*QoS Class 2*	*QoS Class 3*
Audio transfer delay with echo control	<400ms	<400ms	<150ms
Audio frequency range	>0,3-3,4 kHz	>0,3-3,4 kHz	>0,05-6,8 kHz
Audio level (typical)	-20dBm0	-20dBm0	-20dBm0
Audio level free interval	>5min	>15min	>30min
Video transfer delay	<10s (still image only)	<600ms	<250ms
Video/audio differential delay	N/A	>-400 and <200ms	>-150 and <100ms
Video frame rate	N/A	>5 frames/s	>25frame/s
Video resolution	N/A	>176x144	>352x288
Video error free interval	N/A	>15min	30min
DSD/audio differential delay	<1s	<200ms	<100ms
DSD error free interval	>5min	15min	>30min
Date rate	>5Kbit/s	50kbit/s	>500kbit/s

Bearer Service QoS Standards:

QoS Parameter	*QoS Class 1*	*QoS Class 2*	*QoS Class 3*
Equivalent transfer delay w. echo control	<200ms	<200ms	<100ms
User information transfer rate	>10 kbit/s	>100kbit/s	>1000kbit/s
Error free seconds ratio	>94%	>97%	>99%
Severely impaired seconds ratio	<0.3%	<0,1%	<0,05%

Multimedia networks contain multiple components that may be provided and maintained by different organizations. Three types of components can be distinguished:

- *Terminal equipment (TE)*
- *Private network*
- *Public network*

TE QoS Standards:

QoS Parameter	*QoS Class 1*	*QoS Class 2*	*QoS Class 3*
Audio transfer delay with echo control	<200ms	<200ms	<50ms
Audio frequency range	>0,3-3,4 kHz	>0,3-3,4 kHz	>0,05-6,8 kHz
Audio level (typical)	-20dBm0	-20dBm0	-20dBm0
Audio level free interval	>60min	>150min	>300min
Video transfer delay	9,8s	<400ms	<150ms
Video/audio differential delay	N/A	<200ms	<100ms
Video frame rate	N/A	>5 frames/s	>25 frames/s
Video resolution	N/A	>176x144	>352x288
Video error free interval	>60min	>150min	>300min
DSD/audio differential delay	<1s	<200ms	<100ms
DSD error free interval	>60min	>150min	>300min
Date rate	>5Kbit/s	>50kbit/s	>500kbit/s

Private Network QoS Standards:

QoS Parameter	*QoS Class 1*	*QoS Class 2*	*QoS Class 3*
Equivalent transfer delay w. echo control	<20ms	<20ms	<10ms
User information transfer rate	>10 kbit/s	>100kbit/s	>1000kbit/s
Error free seconds ratio	>99,5%	>99,75%	>99.9%
Severely impaired seconds ratio	<0.03%	<0,01%	<0,005%

Public Network QoS Standards:

QoS Parameter	*QoS Class 1*	*QoS Class 2*	*QoS Class 3*
Equivalent transfer delay w. echo control	<160ms	<160ms	<80ms
User information transfer rate	>10 kbit/s	>100kbit/s	>1000kbit/s
Error free seconds ratio	>95%	>98%	>99.2%
Severely impaired seconds ratio	<0.24%	<0,08%	<0,04%

In this paper, we have presented some basic principles for a QoS model that describes the demands of the Distributed Multimedia Applications and the requirements of the network to support the application demands.

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Audio level free interval	> 30min
Video transfer delay	< 250ms
Video/audio differential delay	> -150 and < 100ms
Video frame rate	> 25frame/s
Video resolution	> 352x288
Video error free interval	30min
DSD/audio differential delay	< 100ms
DSD error free interval	> 30min
Date rate	> 500kbit/s

Components of Multimedia Networks:

- *Terminal equipment (TE)*
- *Private network*
- *Public network*

Example of Public Network QoS Standards:

QoS Parameter	*QoS Class 3*
Equivalent transfer delay w. echo control	< 80ms
User information transfer rate	> 1000kbit/s
Error free seconds ratio	> 99.2%
Severely impaired seconds ratio	< 0,04%