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*Technical Report*

**User Group;**
**End-to-end QoS management at the Network Interfaces;**
**Part 1: User's E2E QoS -**
**Analysis of the NGN interfaces (user case)**

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# Foreword

This Technical Report (TR) has been produced by ETSI User Group (USER).

The present document is part 1 of a multi-part deliverable covering the End-to-end QoS management at the Network Interfaces, as identified below:

**Part 1: "User's E2E QoS - Analysis of the NGN interfaces (user case)";**

Part 2: "Control and management planes solution - QoS continuity";

Part 3: "QoS informational structure".

# Introduction

In all parts of this multi-part deliverable, the Quality of Service (QoS) should be seen from the end-user standpoint. This means that the QoS assessment should be performed with regards to the users' requirements. Telecommunication world evolves and is now **user centric** in opposition to system centric (behaviours are constrained by the system) and network centric (behaviours are constrained by the network).

User-centric requirements are expressed through user-related information, such as QoS parameters and end-user's preferences. The QoS commitments of the related providers should match that of the end-user's requirements and can be defined in his contract as unilateral commitments or with a Service Level Agreement negotiated with the customer (generally corporate end-user).

As networks are evolving towards NGN (Next Generation Network), the network environment is becoming more and more complex. Heterogeneity and mobility are two specific characteristics in NGN that take into account end-user terminals, access networks, core networks and services. Mobility allows end-users to communicate regardless of location, device used, access mode or network across multiple spatial domains.

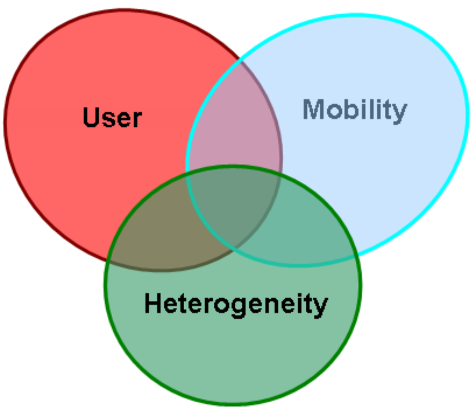


**Figure 1: NGN context**

The end-user wishes to choose any terminal or any access as a mean to use any service in a heterogeneous environment. Meanwhile, the end-user expects to have a continuous comprehensive service throughout the whole session while moving (terminal mobility) or changing terminal (user mobility). During this session, service connectivity is considered as a composition of elements in each layer (User, Terminal, Network and Service).

The solution today is located at the intersection of the three domains defined in [i.9]: User-centric, mobility and heterogeneity as shown in figure 1. As networks become more and more complex and new services emerge continuously, the requirement for an end-to-end (E2E) QoS for the end-user is growing.

Taking all the above into consideration, the goal is now to identify at which point end-users could and should enter their choices and preferences, etc. in the future network. These interactions have been taken into consideration in the user case. That is why in clause 4, all the scenarios representing and concerning the NGN context are identified as well as the QoS aspects from the end-user's viewpoint with a particular attention to the sensitivity to QoS criteria of the services used. In clause 5, the components, which play a key role in the interactions with the end-users, are delineated and identified. The functional procedures of the scenarios are described in order to define the interworking unit such as AF, RACS, PCRF, and GGSN. The transfer of the QoS information between networks, included in signalling or managing messages, is analyzed in clause 6. In clause 7, the conclusion introduces in TR 102 805-2 [i.3].

# 1 Scope

The present document provides an analysis of the NGN interfaces by using a user case designed to show how the QoS could be handled in the NGN context to ensure end-to-end QoS from the end-user's viewpoint.

# 2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific.

- For a specific reference, subsequent revisions do not apply.
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## 2.1 Normative references

The following referenced documents are indispensable for the application of the present document. For dated references, only the edition cited applies. For non-specific references, the latest edition of the referenced document (including any amendments) applies.

Not applicable.

## 2.2 Informative references

The following referenced documents are not essential to the use of the present document but they assist the user with regard to a particular subject area. For non-specific references, the latest version of the referenced document (including any amendments) applies.

[i.1] ITU-T Recommendation G.1010 (11/2001): "End-user multimedia QoS categories".

[i.2] ITU-T Recommendation Y.1541 (02/2006): "Network performance objectives for IP-based services".

[i.3] ETSI TR 102 805-2 (V1.1.1): "User Group; End-to-end QoS management at the Network Interfaces; Part 2: Control and management planes solution - QoS continuity".

[i.4] ETSI EG 202 009-1: "User Group; Quality of Telecom Services; Part 1: Methodology for identification of parameters relevant to the Users".

[i.5] ETSI TS 102 464 (V1.1.1): "Satellite Earth Stations and Systems (SES); Broadband Satellite Multimedia (BSM); Interworking with DiffServ Qos".

[i.6] ETSI TS 123 107 (2009-01): "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; Quality of Service (QoS) concept and architecture (3GPP TS 23.107 version 8.0.0 Release 8)".

[i.7] ETSI TS 129 207 (2005-09): "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS);Policy control over Go interface (3GPP TS 29.207 version 6.5.0 Release 6)".

[i.8] ETSI TS 101 329-2 (V2.1.3): "Telecommunications and Internet Protocol Harmonization Over Networks (TIPHON) Release 3;End-to-end Quality of Service in TIPHON systems; Part 2: Definition of speech Quality of Service (QoS) classes".

[i.9] ETSI STF 360 report (January 2009): "Analysis of current E2E QoS standardization state".

[i.10] IETF RFC 1633: "Integrated Services in the Internet Architecture: an Overview".

[i.11] IETF RFC 2474: "Definition of the Differentiated Services Field (DS Field) in the IPv4 and IPv6 Headers".

[i.12] IETF RFC 2475: "Architecture for Differentiated Services".

[i.13] ITU Study Group 19 - Contribution 25 (2007): "Considerations of horizontal handover and vertical handover".

[i.14] ETSI ES 282 003: "Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); Resource and Admission Control Sub-System (RACS): Functional Architecture".

[i.15] ETSI ES 283 003: "Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); IP Multimedia Call Control Protocol based on Session Initiation Protocol (SIP) and Session Description Protocol (SDP) Stage 3 [3GPP TS 24.229 [Release 7], modified]".

[i.16] IETF RFC 854: "Telnet Protocol Specification".

[i.17] ETSI TR 102 805-3: "User Group; End-to-end QoS management at the Network Interfaces; Part 3: QoS informational structure".

# 3 Definitions and abbreviations

## 3.1 Definitions

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

**AmbientGrid:** information inference (AmbientGrid) based on the profiles' matching, to structure with grid covering the needed end-user centric environment

**class of service:** way of traffic management in the network by grouping similar types of traffic and treating them as its own level of service priority

**DiffServ networks:** classify packets into one of a small number of aggregated flows or 'classes', based on the DiffServ codepoint (DSCP) in the packet's IP header

NOTE: This is known as behaviour aggregate (BA) classification (RFC 2475 [i.12]). At each DiffServ router, packets are subjected to a 'per-hop behaviour' (PHB), which is invoked by the DSCP (RFC 2474 [i.11]).

**equipment:** any material with its related OS, through its CPU and memory, which contributes to the end-to-end QoS

**horizontal handover:** handover within homogeneous access networks

NOTE 1: Generally it is referred to as the Intra-AN handover.

NOTE 2: ITU Study Group 19 - Contribution 25: Considerations of horizontal handover and vertical handover, 2007 [i.13].

**infosphere:** decisional knowledge base managing, in the real time, all the personalization and ambient environment information

**IntServ (integrated services architecture):** set of extensions to the traditional best effort model of the Internet with the goal of allowing end-to-end QOS to be provided to applications

NOTE 1: One of the key components of the architecture is a set of service; the current set of services consists of the controlled load and guaranteed services. The architecture assumes that some explicit setup mechanism is used to convey information to routers so that they can provide requested services to flows that require them. While RSVP is the most widely known example of such a setup mechanism, the IntServ architecture is designed to accommodate other mechanisms.

NOTE 2: See RFC 1633 [i.10].

**multi-homing:** end-user's services can be provided by more than one service or network provider

**network mobility:** network's ability, where a set of fixed or mobile nodes are networked to each other, to change, as a unit, its point of attachment to the corresponding network upon the network's movement itself

**Per-Hop Behaviour (PHB):** externally observable forwarding treatment applied at a differentiated services-compliant node to a behaviour aggregate

NOTE: See TS 102 464 [i.5].

**policy control:** adaptation and configuration of QoS according to particular goals dependent of user, network operator and service provider

**QoS Classification:** definition of class priority for QoS by describing traffic condition or performance parameters

**QoS handover:** ensures QoS state establishes when vertical/horizontal handover occurs

**QoS Interworking:** ensures the transfer of all different types of packet data with different QoS parameters in heterogeneous environment whenever the ANs and CNs are of different releases and types by mapping the QoS attributes

**service mobility:** ability to consistently provide services to the end-user, to maintain the expected QoS, at the system's initiative, regardless of the end-user's location, terminals, or networks.

NOTE: To maintain the service continuity, the session mobility is used.

**session mobility:** ability to keep the continuity of a service regardless the mobility of the terminal, of the access network, of the core network or of any service components as well as the Service Provider

**terminal mobility:** end-user uses his equipment to move across the same or different networks while having access to the same set of subscribed services

**user mobility:** ability for a subscriber to move to different physical locations and be able to use one or more devices connected to one or more access networks to gain access to their services without interruption

**user-centric session:** period of communication between one end-user and another or other end-users or servers characterized by a starting time and a termination time, including setting up the relation of the end-user equipment, access network, core network and services invoked during this period

**userware:** innovative user centric middleware (Userware) enhancing the seamless feasibility along with the location and activity, personalization and end-user's ambient contexts

**vertical handover:** handover across heterogeneous access networks. Generally, it is referred to as the Inter-AN handover

NOTE: ITU Study Group 19 - Contribution 25: Considerations of horizontal handover and vertical handover, 2007 [i.13].

## 3.2 Abbreviations

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

| | |
|---|---|
| 3GPP | The 3rd Generation Partnership Project |
| AA | Authentication & Authorization |

| | |
|---|---|
| AAA | Authentication, Authorization, and Accounting |
| AAR | AA-Request |
| ABG | Access Border Gateway |
| ACK | Acknowledgement |
| AF | Application Function |
| AMF | Access Management Function |
| AN | Access Network |
| A-RACF | Access Resource and Admission Control Function |
| AS | Application Server |
| CAC | Connection Admission Control |
| CCA | Credit Control Answer |
| C-BGF | Core Border Gateway Function |
| CLF | Connectivity session and repository Location Function |
| CNG | Customer Network Gateway |
| CODEC | COder / DECoder |
| CPE | Customer Premises Equipment |
| CSCF | Call Session Control Function |
| DHCP | Dynamic Host Configuration Protocol |
| DSCP | Differentiated Service Code Point |
| DiffServ | Differentiated services (IETF) |
| E2E QoS | End-to-End QoS |
| ETSI | European Telecommunications Standards Institute |
| FIFO | First In First Out (queue) |
| GGSN | Gateway GPRS Service Node |
| GPRS | General Packet Radio Service |
| GTP | GPRS Tunnelling Protocol |
| GW | Gateway |
| HSS | Home Subscriber Server |
| I-BGF | Interconnection Border Gateway Function |
| I/CBG | Interconnection/Core Border Gateway |
| IETF | Internet Engineering Task Force |
| IMEI | International Mobile Equipment Identifier |
| IMEISV | IMEI Software Version |
| IMPI | IP Multimedia Private Identity |
| IMPU | IP Multimedia PUblic identity |
| IMS | IP based Multimedia Subsystem |
| INTRADIFF | INTRANET-DIFFSERV (an INRIA project) |
| IntServ | Integrated Services (IETF) |
| IP-CAN | IP Connectivity Access Network |
| IPDV | IP packet Delay Variation |
| IPER | IP packet Error Ratio |
| IPLR | IP packet Loss Ratio |
| IPRR | IP Packet Reordering Ratio |
| IPTD | IP packet Transfer Delay |
| ITU-T | International Telecommunication Union - Telecommunication standardization sector |
| IWU | InterWorking Unit |
| MS | GSM Mobile Station |
| NACF | Network Access Configuration Function |
| NASS | Network Attachment Subsystem |
| NAT | Network Address Translation |
| NGN | Next Generation Network |
| PC | Personal Computer |
| PCEF | Policy Enforcement Point |
| PCRF | Policy and Charging Rule Function |
| P-CSCF | Proxy CSCF |
| PDA | Personal Digital Assistant |
| PDP | Pack Data Protocol |
| PHB | Per Hop Behaviour |
| PPP | Point of Presence Protocol |
| QoS | Quality of Service |
| RACS | Resource and Admission Control Subsystem |
| RCEF | Resource Control Enforcement Function |

RSVP Resource ReserVation Protocol
SAA Server Assignment Answer
SAR Server Assignment Request
SD Service Data
SDL Session Description Language
SDP Session Description Protocol
SGSN Serving GPRS Support Node
SIP Session Initiation Protocol
SP Service Provider
SPDF Service Policy Decision Function
TCP Transmission Control Protocol
TISPAN Telecommunications and Internet converged Services and Protocols for Advanced Networking
UAAF User Access Authorization Function
UE User Equipment
UMTS Universal Mobile Telecommunications Systems
UPSF User Profile Server Function

# 4 User QoS requirements information

In this clause, based on a user case (clause 4.1) highlighting the specificities of the NGN context, the QoS information (clause 4.2) which are relevant to the end-user will be identified.

## 4.1 User case description

The user case described below is that of an end-user which needs to stay connected both at home and while going and getting at work. This user case clearly highlights the specificities of the NGN context. It shows how the end-user goes from end-user mobility to terminal mobility, changing services on heterogeneous networks. Such scenarios details are described below figure 2.

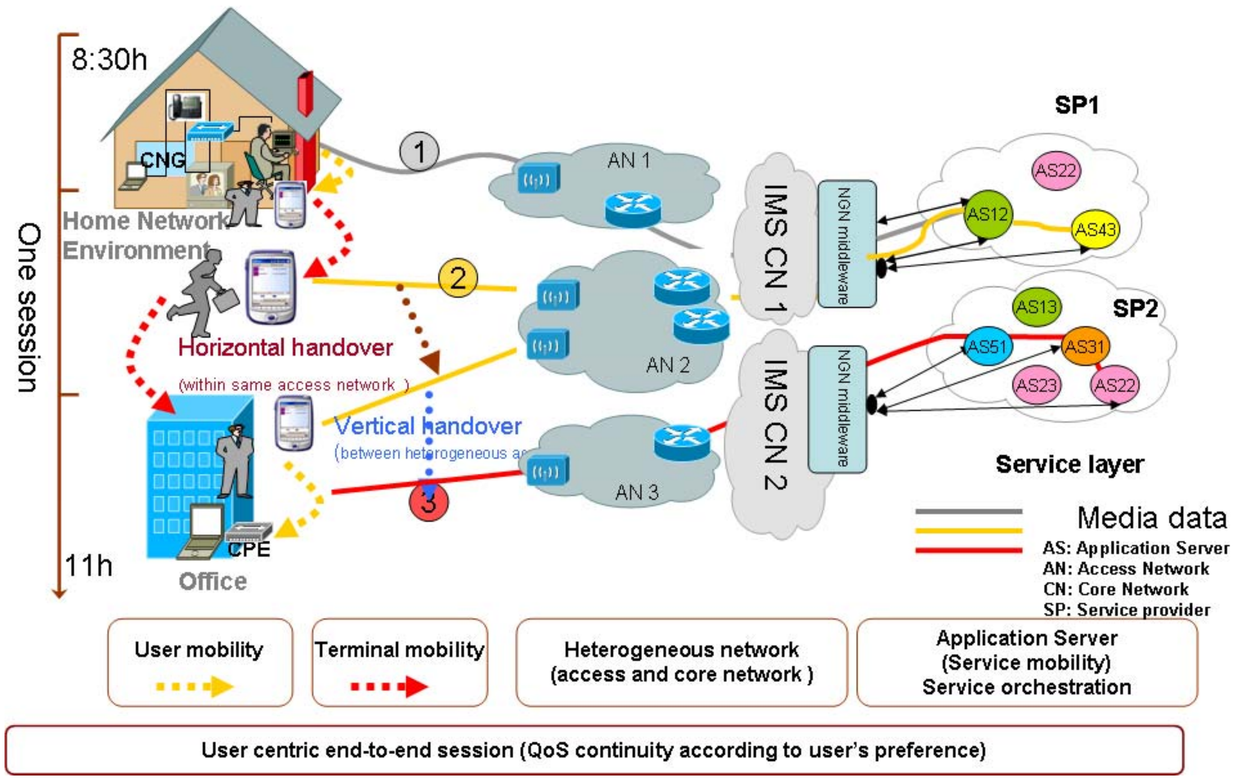


**Figure 2: User case**

The Services used by the end-user in the user case are:

- AS12: Video Conference.
- AS31: Telephony Service.
- AS51: Web Services.
- AS22: Video Broadcast Service.
- AS43: Text to Voice Service.

Description of the user case:

While still at home the end-user Tom starts his PC (QoS1) at 8h30 in the morning and engages in a Video Conference service AS12 (Service 1 for a QoS2) provided by the service provider SP1. Tom uses his home network environment and accesses to the service through an Access Network AN1, which is a mobile GPRS access.

Before leaving his home, Tom switches terminals (User Mobility), leaving his PC for his PDA (QoS2), keeping both the same home network environment and Access Network AN1. Tom can still access his services though the same opened session, while keeping his predefined preferences.

On his way to work (Terminal Mobility), Tom starts another Video Conference service AS12 provided by the same Service Provider SP1 than before, but using another Access Network AN2 (Vertical Handover).

At this point, Tom, as a pedestrian, prefers to receive his message in vocal mode rather than in text mode, by accessing the Text to Voice AS43 (Service 4 for a QoS3) provided by the same Service Provider SP1through the same Access Network AN2.

When arriving at work, Tom's PDA is still attached to the same Access Network AN2 but has changed his Access Point (Horizontal Handover). Tom decides to end both his Video Conference and listening to his messages.

At work, Tom changes his terminal for another one (User Mobility), switching from his PDA to his laptop.

The laptop is connected to another Access Network AN3 than the one previously used for the PDA, through which Tom is now able to access different services provided by another Service Provider SP2 (Service mobility): web service AS51 (Service 5 for a QoS1), Telephony Service AS31 (Service 3 for a QoS1) and Video broadcast Service AS22 (Service 2 for a QoS2).

- At 11AM, Tom closes the session, which he opened at home at 8h30AM.

**Table 1: User case scenario detail**

| Mobility | End-user | Private NW (User/ corporate) | | Access Network | | | Transport (IP Network) | | | Application Server (ASxx) | Service provider (SPx) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Terminal SIP | CPE | Access NW Edge (ANEx) | Access NW: IPCAN | Access IP Edge | (access network) side | Backbone | Server side | | |
| User Mobility (User changes terminal) | At home Scenario 1 | PC (GPRS) (QoS1) | N.A | SGSN (ANE1) | PDP context | GGSN | N.A | x | N.A | Video conf AS12 | SP1 |
| | | PDA (GPRS) (QoS2) | N.A | | PDP context | | | | | | |
| | At work Scenario 2 | PDA | N.A | SGSN (ANE2) | PDP context | GGSN | N.A | x | N.A | Video conf AS12+ Text to voice AS43 | SP1 |
| | | PC | CPE | ABG (Vertical HO) | IPCAN Broadband (Vertical HO) (QoS3) | IP Edge | CBG | x | CBG | Web service AS 51+ Telephony service AS31+ Video broadcast service AS22 | SP2 |
| Terminal Mobility (User moves, terminal the same) Scenario 3 | At home | PDA | N.A | SGSN (ANE1) | PDP context | GGSN | N.A | x | N.A | Video conf AS12 | SP1 |
| | Outside | | N.A | SGSN (ANE2) | | | N.A | x | N.A | Video conf AS12+ Text to voice AS43 | SP1 |
| | At work | | N.A | SGSN (ANE2) (Horizontal HO) | PDP context (Horizontal HO) (QoS4) | GGSN | N.A | x | N.A | Video conf AS12+ Text to voice AS43 | SP1 |
| Service Mobility (Session mobility) Scenario 2 | At work | PDA | N.A | SGSN (ANE2) (Horizontal HO) | PDP context (Horizontal HO) (QoS4) | GGSN | N.A | x | N.A | Video conf AS12+ Text to voice AS 43 (QoS6) | SP1 |
| | | Laptop | CPE | ABG (Vertical HO) | IPCAN Broadband (Vertical HO) (QoS5) | IP Edge | CBG | x | CBG | Web service AS 51+ Telephony service AS31+ Video broadcast service AS22 | SP2 |

CPE: Customer Premise Equipment.

Table 1 describes the different steps, which the end-user goes through technically, while experiencing User Mobility, Terminal Mobility or Service Mobility (Session Mobility), all of which are done during a single session.

## 4.2 User QoS

Having defined the QoS assessment criteria (clause 4.2.1), each will be applied to the user case described previously (clause 4.2.2).

### 4.2.1 QoS assessment

According to the description given in EG 202 009-1 [i.4], the following set of eight QoS criteria is needed for a comprehensive QoS appraisal:

- Availability, Fidelity/Accuracy, Speed, Capability, Reliability, Flexibility, Usability and Security.
- Each of these criteria should be expressed in quantifiable and measurable parameters.

Nevertheless, the aim of the present document is to focus on a method, which will ensure an End-to End QoS. This QoS should depend not only on the network performance but also on the equipment and applicative components, which are co-operating to achieve the End-to-End QoS. A QoS model applicable to these three actors (network, equipment, and applicative components) will enable the aggregation of the End-to-End QoS.

Among the eight criteria listed above, only four are essential to describe the behaviour of the service: availability, fidelity/accuracy, speed and capability, all of which will be taken into consideration in this multi-part deliverable. However, how the information relates to the handling of the whole set of QoS criteria is out the scope of the present document. To achieve a QoS model applicable to all three actors, the speed criterion is evaluated looking at both the delay and delay variation and fidelity via information loss.

In addition, a detailed description of the application (function / service, components, etc.) being crucial to ensure an efficient QoS management, the category of service as defined in [i.1] to which a particular service belongs to will be identified. Since some services may contain several components, each of them often having different QoS requirements, a component by component handling of the QoS would be more efficient as long as technology allows it. However, this is not currently always the case and the following tables should be updated as technology progresses.

A mapping between the services' flows requirements and the network classes of service is provided in annex A.

### 4.2.2 Application to the User case

As explained earlier, table 2 provides a view of the sensitivity to QoS criteria of the services used in the user case scenario to the QoS parameters related to the availability, fidelity/accuracy, speed and capability criteria. This sensitivity is mapped in the classes of services defined in [i.1], [i.2], [i.6], PHB and INTRADIFF (QoS sensitivity dependent classes).

The table listed bellow highlights management and signalling services which are not mentioned in the user case (AAA bearer for instance) but which are important in the end-to-end QoS.

**Table 2: End-to-end QoS service requirements user case services (table of sensitivity to four QoS criteria)**

| Service | Medium | Sensitivity to QoS criteria | | | | | QoS class Y.1541 | CoS UMTS | QoS category G1010 | PHB (DIFFSERV) | QoS sensitive classes (INTRADIFF) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Delay | Delay variation | Fidelity (Information loss) | Capacity | Availability | | | | | |
| **Authentication, Authorisation session** | Data | < 250 ms | U | Zero | VBW | UAI | Class 3 | Interactive | EI Interactive | AF4 | CoS 4.1 |
| **Signalling** | Data | < 250 ms | U | Zero | DBW | UAI | Class 3 | Interactive | EI Interactive | AF4 | CoS 4 |
| **Video Tele-Conferencing service (VTC): AS12** | Video | < 150 ms | U | EI PLR < 1 % | DBW 16 kbit/s to 384 kbit/s | UAT | Class 0 | Interactive | ET Interactive | AF1.2 | CoS 6.2 |
| | Audio | < 150 ms | < 1 ms | ET PLR < 3 % | DBW | | | Convers. | | EF | CoS 6.0 |
| **Signalling** | Data | < 250 ms | U | Zero | DBW | UAI | Class 3 | Interactive | EI Interactive | AF4 | CoS 4 |
| **Text to voice AS 43** | Audio | | < 1 ms | | DBW 4 kbit/s to 32 kbit/s | | | | | | |
| **Signalling** | Data | < 250 ms | U | Zero | DBW | UAI | Class 3 | Interactive | EI Interactive | AF4 | CoS 4 |
| **Web service AS 51** | Data | < 2 s/page (< 4 s/page acceptable) | U | Zero | DBW | UAI | Class 3 | | EI Interactive | AF 3.1 | CoS 5.1 |
| **Video broadcast AS 22** | Video | < 10 s | < 1 ms | ET PLR < 1 % | VBW 16 kbit/s to 384 kbit/s | UAT | | Streaming | ET Timely | AF3.2 | CoS 2 |

| Service | Medium | Sensitivity to QoS criteria: Delay | Delay variation | Fidelity (Information loss) | Capacity | Availability | QoS class Y.1541 | CoS UMTS | QoS category G1010 | PHB (DIFFSERV) | QoS sensitive classes (INTRADIFF) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Telephony service AS31** | Audio | < 150 ms | < 1 ms | ET PLR < 3 % | DBW | UAT | Class 0 | Convers. | ET Interactive | EF | CoS 6.0 |

NOTE 1: DBW: Dedicated Bandwidth
ET: Error Tolerant
EI: Error Intolerant
PHB Per Hop Behaviour
PLR: Packet Loss Rate
U: Unspecified
UAI: UnAvailability Intolerant
UAT: UnAvailability Tolerant
VBW: Variable Bandwidth

NOTE 2: Per Hop Behaviour parameters:
AF: Assured Forwarding
BE: Best Effort
EF: Expedited Forwarding

# 5 Identification of InterWorking unit (IWU)

The study of the user case example highlights the three scenarios, which represent the different situations in the NGN context:

- User mobility in mobile network.
- User mobility between mobile and fixed networks (vertical handover), and session mobility.
- Terminal mobility in mobile network (horizontal handover).

These scenarios are used to identify the interworking units and their related interfaces in an application session, establishing between the end-user equipment and the IP multimedia subsystem which is setup by an application level session (established using SIP before the use of the service) and which requires one or more QoS related resource reservations to take place in a bearer session ES 282 003 [i.14]. For GPRS, the information about the end-user equipment (e.g. IMEISV), negotiated QoS, SGSN Address, SGSN country and network codes etc. for the bearer session are provided in the PDP context (PDP session). For the fixed access network, the QoS and end-user related information are provided for the connectivity session.

When changes of QoS appear, due to User, Terminal or Service Mobility, requiring to adapt the QoS in a mobility and heterogeneity environment, each actor (network, equipment, and applicative components) has a role to play. The roles, which are of interest are: the initiator, the decider and the executor. Each role is identified for each scenario for the analysis of the end-to-end QoS.

- Initiator is the entity (user, network or Application Server) which notices the change and informs the decider.
- Decider is the entity which makes the decision according to its responsibilities.
- Executor is the entity which performs the related necessary actions.

For the QoS adaptation, the fulfilment of the functional procedures of the QoS control is also described in the 3GPP and ETSI TISPAN architecture.

## 5.1 Scenario 1: User mobility in mobile network

Figure 3 illustrates the scenario of end-user mobility in GPRS based mobile access network. The most important logical interfaces required for the interworking of access networks with the IMS core network are drawn with dotted lines.

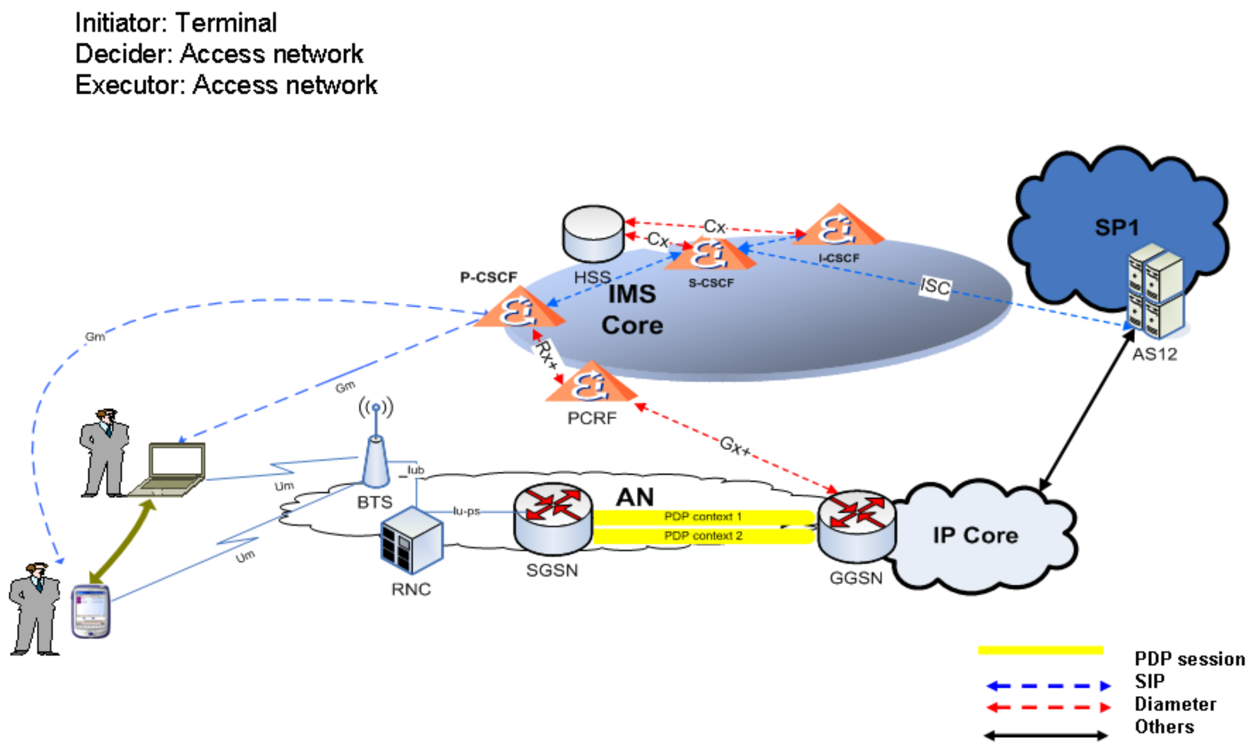


**Figure 3: Scenario 1 User mobility**

In GPRS based mobile network, the end-user switches from his PC to his PDA within the opened session. This change results in altering the QoS parameters. In response to such QoS change, one new PDP context for the new QoS parameters may be active. The SGSN or the GGSN could initiate this procedure for updating the corresponding PDP session (as figure 3 shows, from PDP context 1 to PDP context 2) under the control of IMS. The end-user's terminal is aware of an Access Point Name for which the DNS function provides the address of a GGSN.

In this scenario, the initiator is the user's terminal; the decider and executor for initializing the new PDP context are located in the access network. The related interworking units are:

1) Bearer entities: SGSN and GGSN. They are responsible for establishing the PDP context of the application with a well defined QoS. The GGSN receives a PDP context activation request from the MS containing parameters of the requested QoS .The GGSN creates a GTP tunnel to route IP packet between SGSN and GGSN.

2) IMS core entities P-CSCF, I-CSCF, S-CSCF. These three entities are responsible for controlling the application session. The P-CSCF receive a SIP request for establishing a session with the QoS parameters defined in the message SDP, After the negotiation with the AS through the S-CSCF, the P-CSCF sends the request to the sub layer responsible for access control (CAC) and resources reservation.

3) IMS policy control entity: PCRF. The main function of the PCRF is to control the QoS of the network. It composed of policy control decision function and flow based charging control functionalities, providing network control regarding the QoS requested by the service.

The session control protocol-SIP is used between the end-user's terminal and CSCFs (blue dotted line in the figure 3). It can transmit QoS parameters contained in the SDP field.

Among these SIP-based interface, the Gm interface implements the signalling communication between the IMS user and the IMS core network by performing the end-user registration and Service request.

The Mw interface implements the signalling communication between the CSCFs for handling end-users' data.

The ISC interface is used for transferring information pertinent to the terminal capabilities, end-user registration state and service characteristics between the AS and the S-CSCF.

The red dotted lines in the figure 3 show diameter protocol based interfaces which are related to policy control from the AF to bearer session (Rx+ and Gx+ interfaces) and end-user data solicitation from subscriber's database (S-CSCF communicates with HSSs via Cx interfaces and Application Servers communicate with HSS via the Sh interface).

## 5.2 Scenario 2: User mobility between mobile and fixed network, and service mobility

Figure 4 illustrates two kinds of mobility in one scenario, one is the end-user mobility between mobile and fixed access networks (inter-technology handover or vertical handover) and the other is the service mobility among the application servers belonging to different Service Providers (SP). The most important logical interfaces required for the interworking of access networks with the IMS core network are drawn with dotted lines.

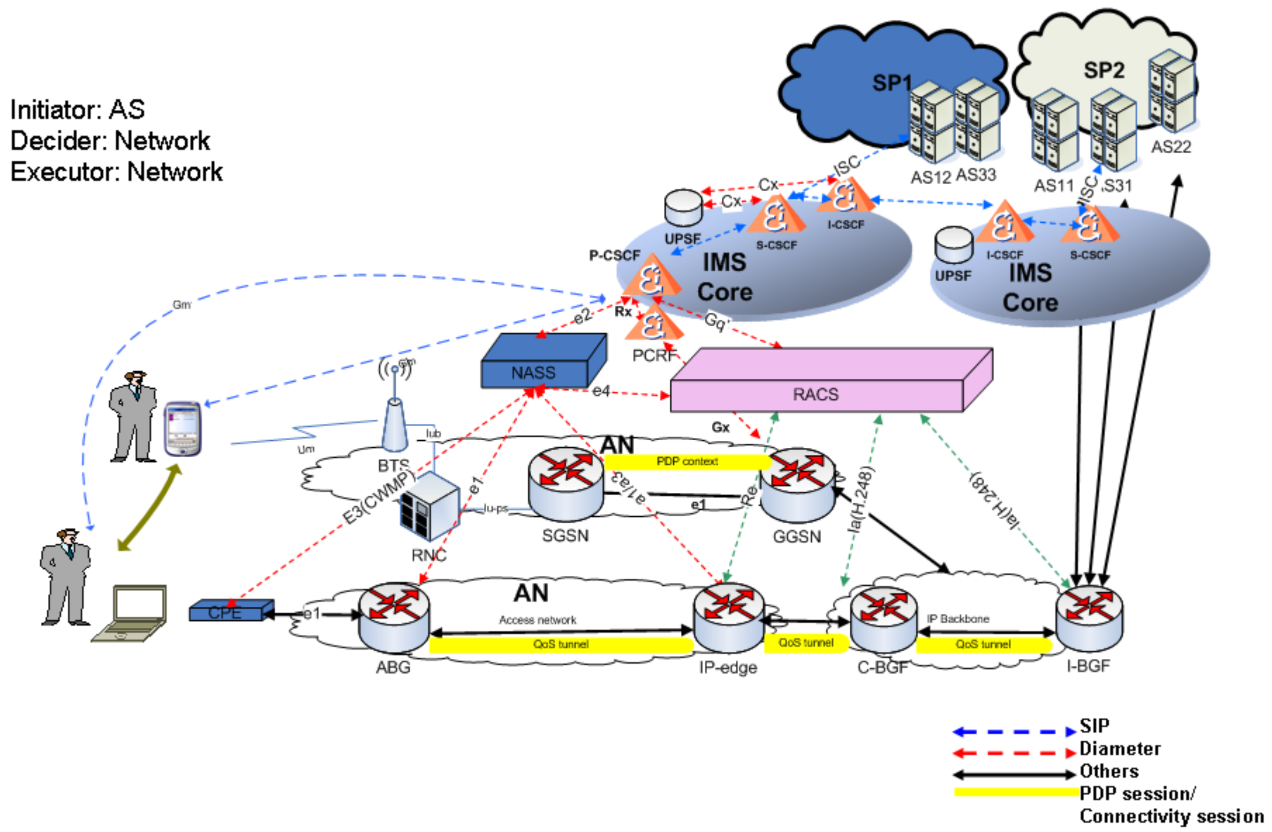


**Figure 4: Scenario 2 User mobility + Vertical handover + Service mobility**

The end-user switches from the original terminal, which accessed a GPRS based mobile network, to another terminal, which accesses a fixed network. As a result, the previous Application Server (AS) cannot fulfil the new demand. Therefore, the AS initials the handover. Both the IMS-IMS interconnection and the service orchestration find the new server applications which can fulfil the demand. Meanwhile, the IP-based fixed network establishes a connectivity session with the QoS required instead of the previous PDP session in the mobile network architecture. In the fixed network architecture of ETSI TISPAN, two new entities are introduced, which are the Network Attachment Subsystem (NASS) and the Resource and Admission Control Subsystem (RACS).

The NASS provides registration at access level and initialization of the User Equipment (UE) for accessing the TISPAN NGN services. The interfaces between NASS and the User, RACS and P-CSCF respectively are diameter-based.

RACS is the NGN subsystem responsible for the interoperation between the IMS control and the bearer enforcement components of the network, such as policy control, resource reservation and admission control. The interface Gq+ between IMS and RACS is diameter-based.

The SIP-based interfaces are the same, as described in clause 5.1.

In this scenario, the initiator of the handover is the AS; the decider and executor for initializing the QoS path are located in the network. The related interworking units are:

1) Bearer entities: SGSN and GGSN. I-BGF (located between two core networks) and C-BGF (located between access and core network) which control the PDP session with controlling access by packet filtering on IP and opening/closing gates into the network; IP-Edge and ABG which are functional entities that control flow for IP-Based access network.

2) IMS core entities, such as P-CSCF, I-CSCF, S-CSCF.

3) ETSI TISPAN admission control, policy and resource control entity: NASS and RACS. The main function RACS is to control the QoS of the network. It receives the request of resources from the AF, and then it associates resource requirements of the service layer, with resource allocation of the bearer layer, and performs such functions as policy control, resource reservation, admission control and Network Address Translation (NAT). In the Process of the resource allocation, the RACS consults the NASS for the access and transport layer QoS profile. NASS is responsible for the network attachment of the MS by providing address allocation, authentication and authorisation, access network configuration and location management to the session controller and the RACS.

## 5.3 Scenario 3: Terminal mobility in mobile network

Figure 5 illustrates the scenario of terminal mobility in a GPRS based mobile access network (horizontal handover). The most important logical interfaces required for the interworking of the access networks with the IMS core network are drawn with dotted lines.

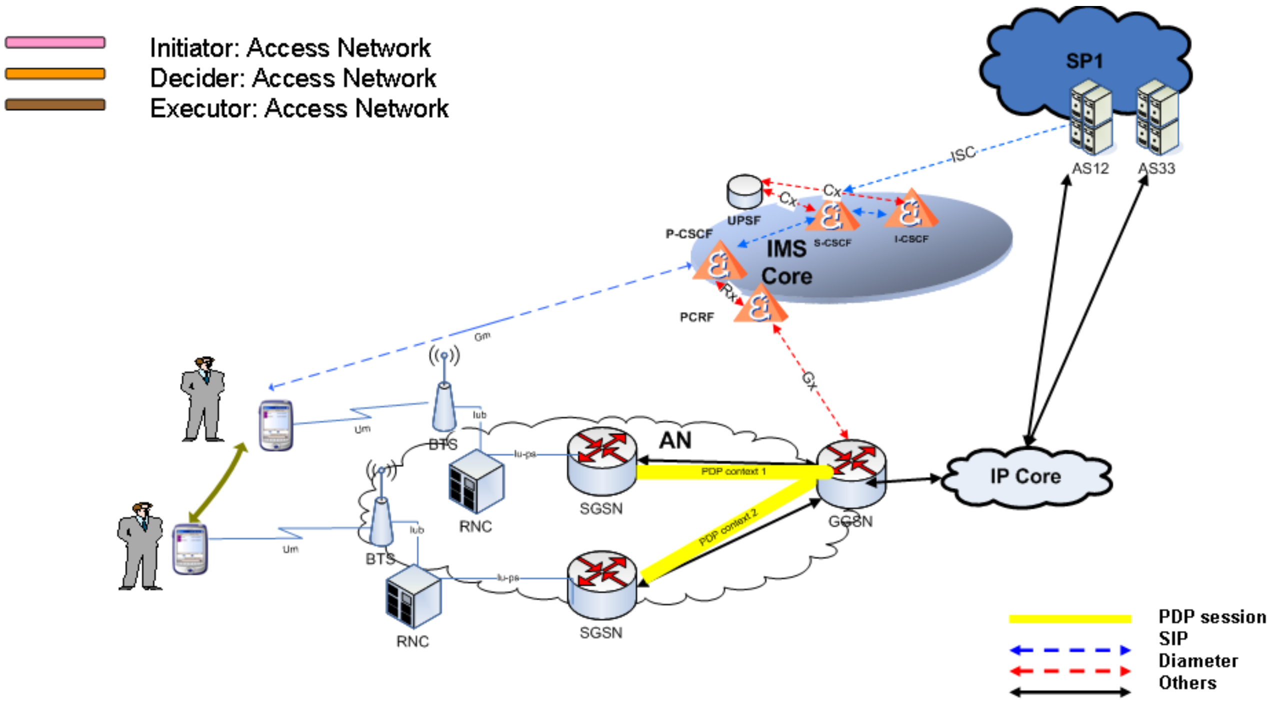


**Figure 5: Scenario 3 Terminal mobility**

In the GPRS based mobile network, the end-user with his/her terminal moves to another location, and gets access to another access point. In response to such QoS change, the SGSN initiates the procedure for updating the corresponding PDP session (as figure 5 shows, from PDP context 1 to PDP context 2) under the control of the IMS. The end-user's terminal is aware of an Access Point Name (the address of a GGSN), which gives access to the service-providing entity by the IMS.

The related interfaces are the same than described in clause 5.1.

In this scenario, the initiator of mobility is the access network; the decider and executor for initializing new PDP context are located in the access network as well. The related interworking units are:

1) Bearer entities: SGSN and GGSN.

2) IMS core entities: such as P-CSCF, I-CSCF, S-CSCF.

3) IMS policy control entity: PCRF.

## 5.4 QoS framework in 3GPP and ETSI TISPAN

The QoS control mechanism should be defined in the same framework although QoS control can be implemented in many different ways. ETSI TISPAN and 3GPP are currently developing the QoS control architecture and procedures. In this clause, the QoS architectures and procedures proposed by ETSI TISPAN (figure 6) and 3GPP (figure 7) will be explained further and compared to one another. Procedures of QoS control and management can be divided into five steps:

1) Authentication, Authorisation and Configuration for the service demanded (management plane).

2) Service request from UE to application function (e.g. P-CSCF, S-CSCF, I-CSCF, AS) based on SIP protocol (Control plane).

3) Policy request from application function to policy-cased resource control entity (Management plane).

4) Resource request and reservation (Control plane).

5) Policy enforcement in the bearer entities (User plane).

### 5.4.1 QoS framework in ETSI TISPAN

Figure 6 shows the general procedure of QoS control and related entities in the ETSI TISPAN framework.

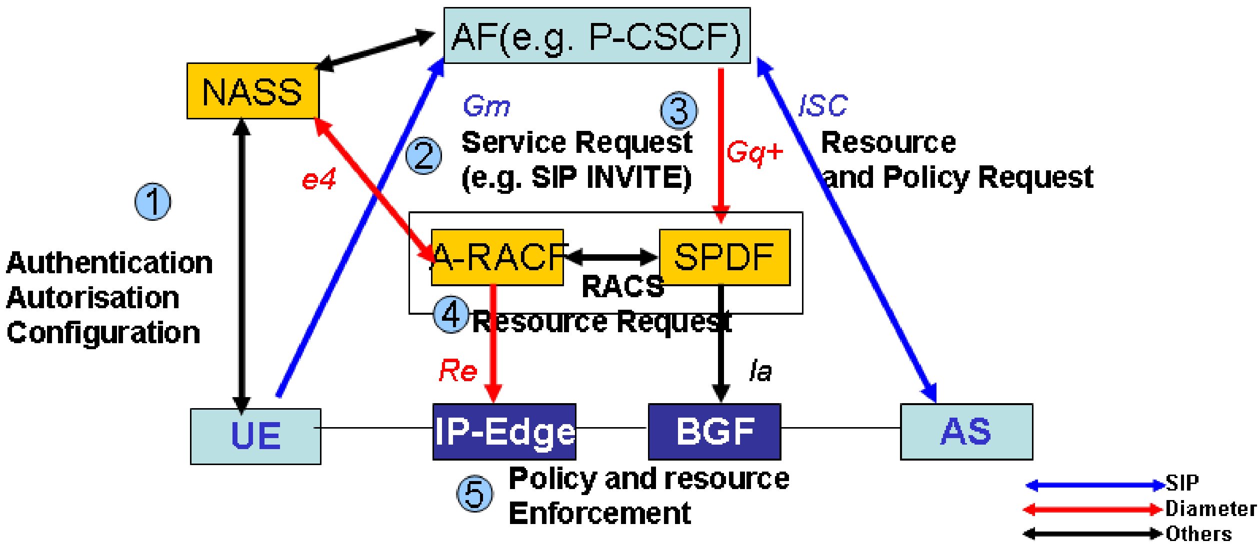


**Figure 6: ETSI TISPAN QoS control**

The QoS control consists of the five following steps:

**Step1:** The authentication, authorisation and configuration to the required service and end-user device with the NASS.

**Step2:** User sends a SIP message to the Application Function (AF), requesting that the QoS parameters necessary to support that session be admitted into the network.

**Step3:** The AF issues a request for QoS to the Policy Control Function (SPDF, a function contained in RACS). By linking the applications' needs with the connectivity network, the policy control interprets the needs of various services into the language, which the connectivity infrastructure will understand (such as loss rates, bandwidth, error rates etc). The SPDF determines whether the session can be admitted based on a number of factors, such as network topology, available bandwidth, and static user-related policy parameters.

**Step4:** Resource request to the A-RACF. Access resource and admission control functions (A-RACF) make the admission decision based on the resource state of the access network, and the service-based policy decision function (SPDF) performs the policy-based decision and the control of the edge of the core network.

**Step5:** Once the RACS makes a decision to admit the service and reserves the resources, it pushes the policies to the Policy enforcement in the IP edge router or border gateway router.

Then, the session via the reserved path goes through the core network to the application server or its destination.

## 5.4.2 QoS framework in 3GPP

Figure 7 shows the general procedure of QoS control and related entities in the 3GPP framework.

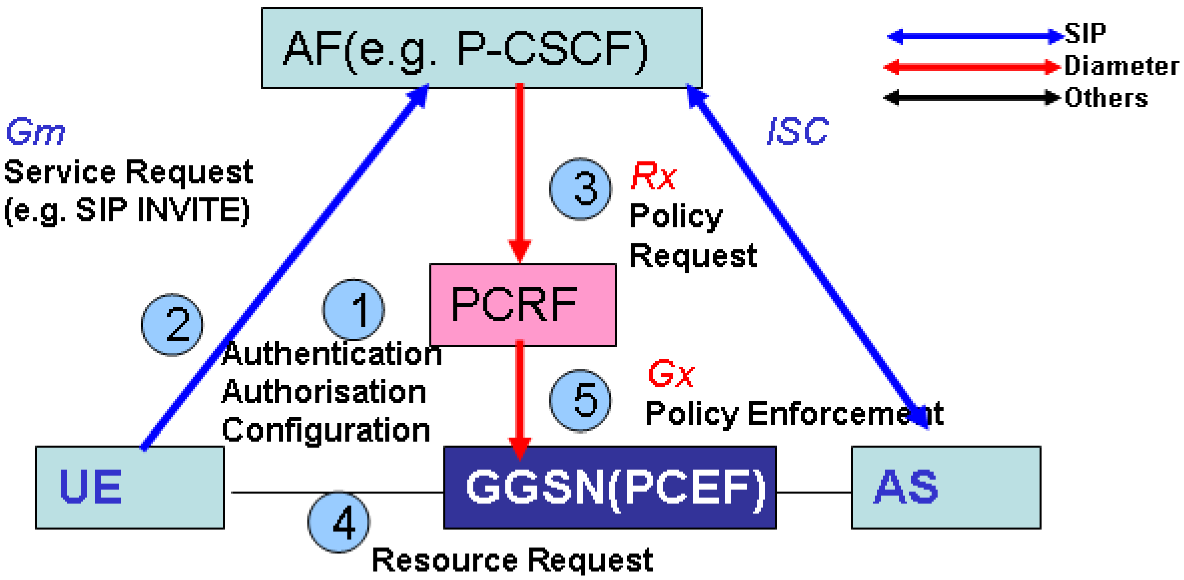


**Figure 7: 3GPP QoS control**

The QoS control consists of the five following steps:

**Step1:** The authentication, authorisation and configuration to the required service and end-user device.

**Step2:** End-user sends a SIP message to the Application Function (AF), requesting the QoS parameters necessary to support that session be admitted into the network.

**Step3:** The AF issues a request for QoS to the Policy and Charging Rules Function (PCRF). By linking the applications' needs with the connectivity network, policy control interprets the needs of various services into the language the connectivity infrastructure will understand (such as loss rates, bandwidth, error rates, etc.). The PCRF determines whether the session can be admitted based on a number of factors, such as network topology, available bandwidth, and static user-related policy parameters, etc.

**Step4:** Resource request in the bearer path.

**Step5:** Once the PCRF makes a decision to admit the service, it pushes the policies to the Policy Enforcement Points (PCEF) in the access node or IP edge router.

Then, the session via the reserved path go through the core network to the application server or its destination.

# 6 QoS and E2E user-centric session

During an on-going session, it is preferable that the end-user experiences service continuity without, for example, the need to be authenticated for each new service as he evolves during his user-centric session.

In the end-to-end-user-centric session, different QoS parameters are transmitted to the UE, Resource/policy control entities (PCRF/PCEF, RACS/NASS/BGF/RCEF) and AF (P-CSCF, I-CSCF, S-CSCF and AS).

Such QoS information are:

- Parts of a Session Description Language (SDL), e.g. SDP.
- IP QoS parameters.
- Access specific QoS parameters.

Several QoS parameters mapping functions are needed for the purpose of converting QoS parameters from one format to another. The following sequence diagrams describe the QoS information carried in the SIP and Diameter messages as well as the achievement of the functional procedures respectively in ETSI TISPAN (figures 8 and 9) and 3GPP architecture (figure 10).

## 6.1 Sequence diagram in ETSI TISPAN based architecture

In the following sequence figures, the blue arrows correspond to the SIP messages (control plane) and the red arrows correspond to the Diameter messages (Management plane). Figure 8 represents the procedure of authentication, authorisation and configuration. Afterwards the UE sends a SIP invite to initial a session (shown in figure 9).

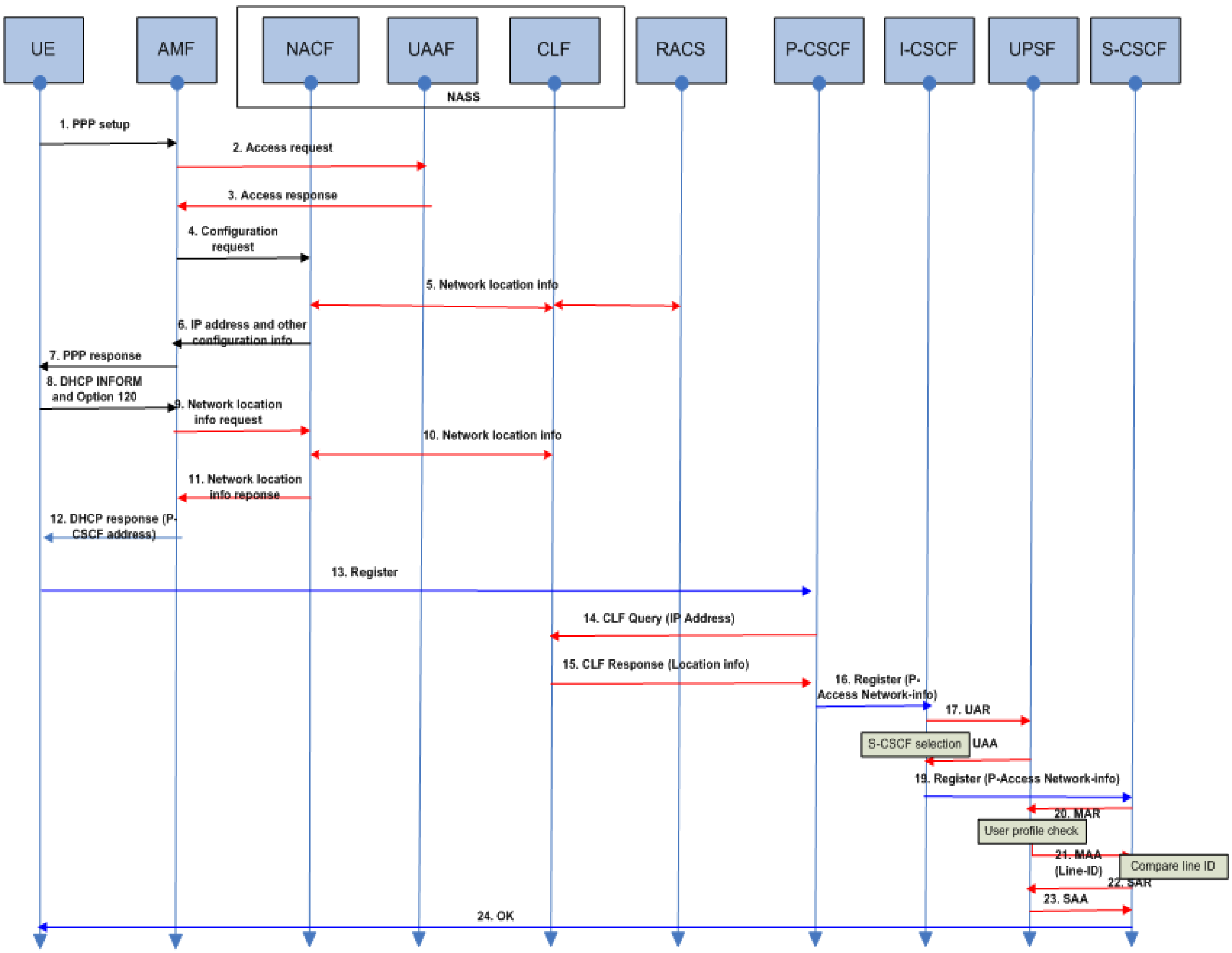


**Figure 8: Authentication, authorisation with NASS and user registration**

The UE may acquire an IP address via other means than the PPP. In such a case, upon acquiring an IP address, the UE requests the configuration information (that includes the DNS and P-CSCF addresses) from the DHCP server through a single request and reply exchanged with the DHCP server.

1. UE/CNG initiates a PPP request to apply for an IP address. PPP is used for Access and Line authentication.

2. to 3. AMF relays translates PPP request to an Access request to the UAAF.

4. AMF sends the configuration request to NACF to obtain IP address and other parameters optionally including the IP address of a TISPAN NGN Service/Applications Subsystems (e.g. P-CSCF).

5. NACF sends to the CLF the binding information of allocated IP address, Line ID and IP edge ID. The CLF pushes the *binding information* to the RACS via the e4 interface.

8. to 12. The UE/CNG uses DHCP INFORM message to request other network parameters including the IP address of a TISPAN NGN Service/Applications Subsystems (e.g. P-CSCF). NACF requests to CLF network location information.

13. The UE sends a new SIP REGISTER message to the P-CSCF. The P-CSCF identifies whether or not a security association is required at this point, based on the presence of security client header and the access network location from where the SIP REGISTER is received. During the SIP registration, the P-CSCF locates the CLF based on the UE's IP address or/and based on the information of the access network from which the P CSCF receives the IP packet (P -CSCF may have several logical/physical interfaces toward different Access Networks).

14. P-CSCF performs a "Location Information Query" towards the CLF over the e2 interface. The key for the query is the IP address indicated by the UE.

15. The CLF sends the response to the P-CSCF including the location information of the UE using the given IP address.

16. to 19. The P-CSCF appends the NASS location information to the SIP REGISTER message and forwards the REGISTER message to I-CSCF and eventually to S-CSCF.

20. S-CSCF queries the UPSF over the Cx interface using MAR request, indicating that the NASS-IMS bundled authentication method should be used.

21. The UPSF returns a message with the location information of the end-user identified by the IMPI and IMPU (if NASS Bundling is the preferred authentication scheme). S-CSCF authenticates the end-user by comparing the location info embedded in the REGISTER message with the location information received from the UPSF. If they match, the end-user is successfully authenticated and the processing continues.

22. to 23. The S-CSCF sends a SAR message to the UPSF and the UPSF responds with a SAA message back to the S-CSCF.

24. The S-CSCF sends a 200 OK message to the UE.

After the NASS authentication and network attachment, the end-user begins to request the service. The next procedure is shown in figure 9.

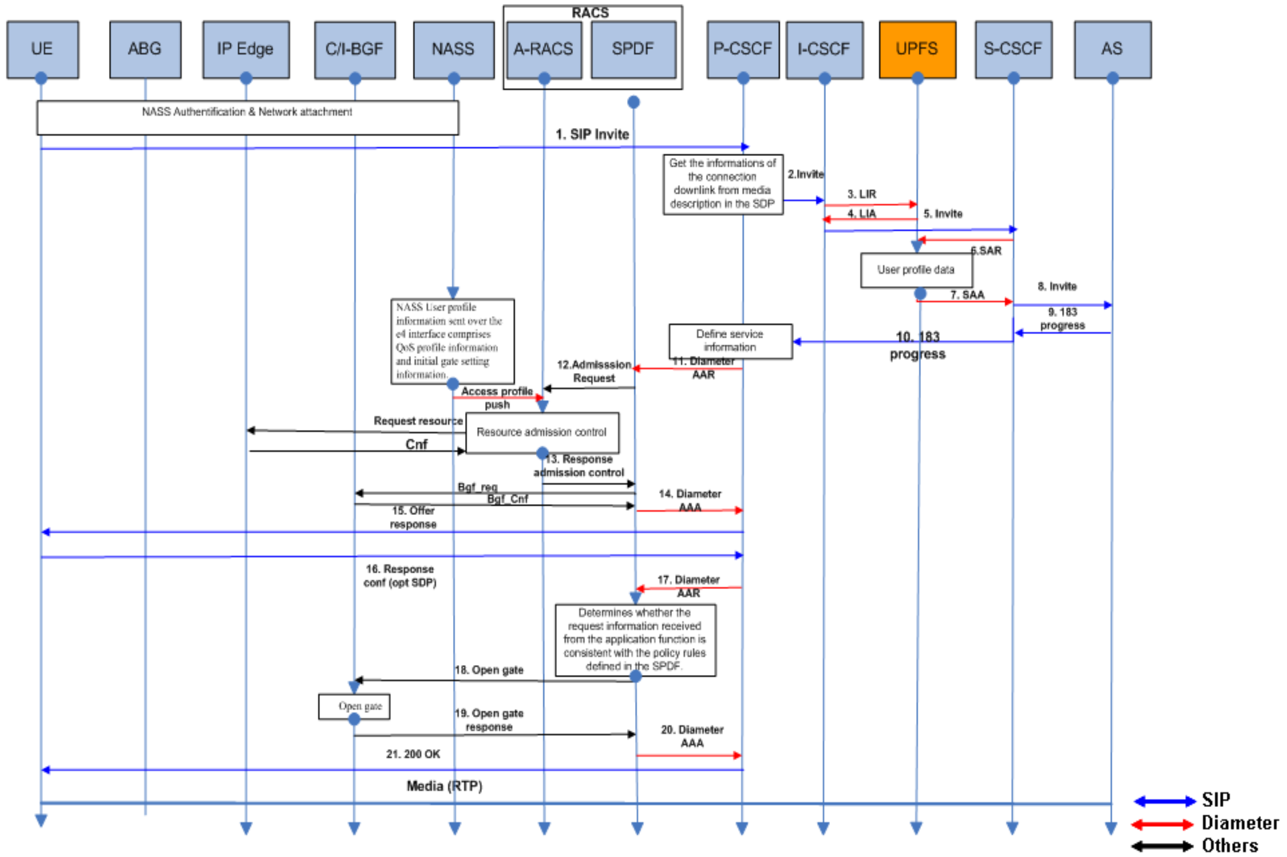


**Figure 9: Service request, resource reservation and policy control (ES 283 003 [i.15])**

1. An INVITE request generated by a UE contains a SDP offer and at least one *media description* (Media type, DL bandwidth, delay, etc.). The SDP offer reflects the original end-user's terminal capabilities, and end-user preferences for the session. The UE orders the SDP offer with the most preferred codec listed first. Upon receiving an SDP answer, which includes more than one codec for one or more media streams, the UE sends an SDP offer at the first possible time, selecting only one codec per media stream.

2. When the P-CSCF receives any SIP request containing an SDP offer, the P-CSCF examines the media parameters in the received SDP. If the P-CSCF finds any media parameters, which are not allowed on the network by local policy or if available by bandwidth authorisation limitation information coming from the IP-CAN (e.g. via PCRF), the P-CSCF returns a 488 (Not Acceptable Here) response containing SDP payload. This *SDP payload* contains all the media types, codecs and other SDP parameters, which are allowed according to the local policy, or, based on configuration by the operator of the P-CSCF, a subset of these allowed parameters. This subset may depend on the content of the received SIP request. The P-CSCF orders the SDP payload with the most preferred codec listed first. If the P-CSCF finds all the media parameters can be allowed on the network, it sends an INVITE message to I-CSCF.

3. to 5. I-CSCF finds the address of S-CSCF with the help of the subscriber profile, relays the INVITE message to S-CSCF.

6. to 8. When the S-CSCF receives the SIP request containing an SDP offer; the S-CSCF examines the media parameters in the received SDP by soliciting the User data profile (UPSF) in the diameter message. If the S-CSCF finds any media parameters which are not allowed based on subscription rules (i.e. the information in the instances of the Core Network Service Authorization class in the service profile) the S-CSCF returns a 488 (Not Acceptable Here) response containing the SDP payload. This *SDP payload* contains all the media types, codecs and other SDP parameters, which are allowed according to the end-user's subscription or, based on configuration by the operator of the S-CSCF, a subset of these allowed parameters. This subset may depend on the content of the received SIP request.

9. to 10. When the AS sends a 183 (Session Progress) response as a provisional response with the SDP payload including one or maybe more media types, it has the capacity of requesting confirmation for the resource reservation in the network. In addition, the AS has the capability of reflecting the originating *AS's capabilities, desired QoS and precondition requirements* for the session in *SDP payload* in an INVITE request generated by AS.

11. The P-CSCF defines the up-link connection information needed and the P-CSCF sends a *Diameter AAR* message containing the *service request information* to SPDF in RACS.

12. The SPDF authorizes the request. This process consists of verifying if the required resources for the AF session, present in the service request, are consistent with the operator policy rules defined in the SPDF for that particular AF. In case the service is authorized, the SPDF determines how to serve the request. It may be required to send *Resources-Req* to allocated resources of the A-RACF and/or *bgf-Req* request to BGF. The A-RACF maps the request from SPDF into the internal network topology. The A-RACF performs the *authorization and admission control based on the access network policies* (access user profile from NASS) and evaluates the availability and, if successful, reserves resources and requests the RCEF to install the traffic policies to be applied to the associated flows.

13. The A-RACF sends Resource-Cnf to inform the SPDF if the resources are reserved. The SPDF has determined that serving this request requires sending a request to the appropriate BGF and therefore the SPDF sends a bgf_Req to the BGF. The BGF performs the requested service (e.g. allocates the necessary resources to insert a RTP relay function) and confirms the operation to the SPDF.

14. The SPDF forwards the result to the AF by diameter message AAA.

15. Upon reception of the acknowledgement from the RACS, the SDP parameters are passed to the UE in the SIP signalling.

16. The end-user sends an Ack to the P-CSCF for informing of reception of response.

17. P-CSCF sends an AAR message to SPDF. SPDF determines whether the request information received from the application function is consistent with the policy rules defined in the SPDF.

18. to 19. Request to open gate in GW entities.

20. SPDF sends a response AAA message to P-CSCF.

21. P-CSCF sends a 200 OK SIP message to UE.

After that, the media can be transported in a resource-reserved path with the QoS, which was requested. The media QoS information is circulated in the SDP payload in SIP. RACS interprets the service request information to request resource information in network and is in charge of controlling the policy control, admission control and resource reservation in bearer. The IP QoS tunnel is then created between the bearer entities (ABG, IP-CAN, I/CBG).

## 6.2 Sequence diagram in 3GPP based architecture

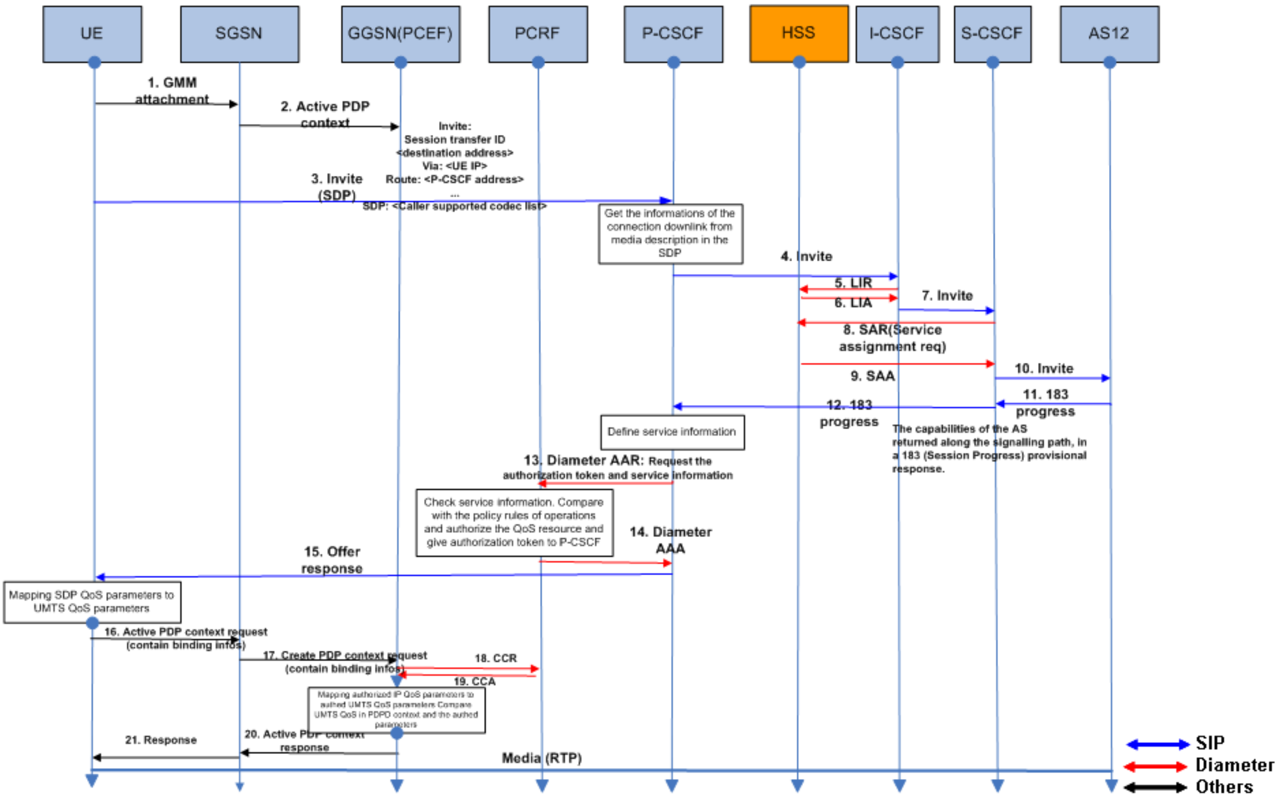


**Figure 10: 3GPP QoS Control Sequence Diagram**

In the 3GPP QoS control, on the aspect of service request (messages 1 to 12), the procedure and related message are the same than those in ETSI TISPAN proposed architecture.

13. The P-CSCF defines the up-link connection information needed. The procedure of the update flow and the implementation of this decision in the PCEF are launched by a DIAMETER AAR message sent by the P-CSCF to the PCRF over an Rx interface.

14. PCRF checks the service information and compares it with the policy rules of operations. It authorizes the QoS resource and gives an authorization token to P-CSCF, after which the PCRF replies to the P-CSCF with a Diameter AAA.

15. Upon reception of the acknowledgement from the PCRF, the *SDP parameters* are passed to the UE in SIP signalling.

16. to 17. The end-user's terminal maps the *SDP QoS parameters* to the *connectivity QoS parameters* and then the end-user sends to the PCEF (GGSN) an Establish IP-CAN Session Request (active PDP context).

18. The PCEF informs the PCRF of the establishment of the IP-CAN Session, and therefore sends a CCR message. The PCRF stores the information such as equipment information and UMTS QoS information, generates the rules to be installed and makes a decision by deriving an *authorized QoS*.

19. The PCRF sends to the PCEF (GGSN) the rules using Diameter CCA, indicating to the IP-CAN Bearer where it is going to be installed and which authorized QoS it refers to. The PCEF installs and enforces the received Rules.

20. to 21. The PCEF (GGSN) maps the *authorized IP QoS parameters* to the *authorized UMTS QoS* parameters, and compares the UMTS QoS in PDP context and the authorized parameters. Then PCEF sends a response for informing to active a PDP context.

After that, the media can be transported in a resource reserved-path with the QoS, which was requested. The media QoS information is circulated in the SDP payload in SIP. PCRF controls and maps the authorized IP QoS to authorized UMTS QoS. Then the GTP tunnel with PDP context is created between the SGSN and GGSN.

# 7 Conclusion

The objective of the present document was to find the actors of QoS, which would allow the end-user to choose the service provider meeting his needs. In such a user-centric approach, it is important for the end-to-end QoS to take into consideration the behaviour of the service components as well as the end-user terminal, profile and preferences.

The present document identifies the end-to-end QoS information to identify all the actors involved in the end-to-end chain, located according to the visibility's level. The QoS model applicable to each level takes into account four criteria (availability, fidelity/accuracy, delay and capability), which are essential to describe the behaviour of each actor: equipment, network and applicative components. The End-to-End QoS is the result of the behaviour of all actors at each level.

The methodology used in this first part of the report, was to describe, through a user case, the different scenarios representing and concerning the NGN context (heterogeneity and mobility). The QoS aspects were looked upon, in an end-to-end-user-centric session from the end-user's viewpoint. The components, which played an important role for interworking between services and the end-user were isolated and identified. The goal was to study the relevant interaction between such components and the end-user expectations (real-time profile and preferences), in order to achieve an end-to-end QoS continuity.

During the work, some points were highlighted such as the fact that usages are evolving due to new possibilities. In this analysis of user centric the focus was set on the end-user profile and preferences to match expectations through the right composition of services (equipment service, access service, network service, application service) during a user session.

In TR 102 805-2 [i.3], the limits of the current solutions will be looked upon before exploring different alternatives till reaching a final converged solution.

# Annex A: Mapping of services and QoS requirements

Table A.1 provides a list of the main services with the description of their essential functions and their use conditions in order to be able to define the key criteria to ensure a proper management of the end-to-end QoS.

The services listed are drawn from ITU-T Recommendation G.1010 [i.1] with some changes to take into account the current market situation. Some of these services contain several components. In fact, since many services are built on a composition of several components that could be provided by differing providers, tables A.1 and A.2 should highlight the specific requirements of each component. Some attempts have been done in table A.2 to bring in such components (e.g. signalling, authentication or DNS) but further study is needed to embrace all the service components. In today's technology the QoS is most of the time managed as a whole and therefore should be handle according to the most straining component of the service. As technology evolves, this should be revisited accordingly.

**Table A.1: Service functional definitions**

| Services or service components | Basic functions |
|---|---|
| Audiobroadcast | A mechanism whereby audio content can be rendered at the same time that it is being transmitted to the client over the data network. |
| Audio-conference | Connection between two or more terminals, exchanging audio information only. (See note 1). |
| Authentication | Benefit consisting in proving that a user is authorised (by means of an identifier and password or other more robust process) to use a service. This applies to a network service or to an application (web, email, etc.) |
| Directory enquiry services | Operator or machine based service intended to provide information on phone number, addresses or e-mail addresses of people or organizations on user request. (See note 2). |
| DNS | Allowing a user to ask a server to convert a domain name into address IP. This service is pre-requisite to most Internet usages. It is generally provided with the access to Internet. |
| e-Commerce | The commercial activities carried out through computer networks such as the Internet, including online promotion and sale of products, services and information, as well as the exchange of electronic correspondence. (See note 3). |
| Electronic mail | Exchange of text files with possible attached files between two PCs via networks and through distant servers where the message can be stored until the recipient downloads it. The minimal protocols aiming at issuing the service are POP3 and SMTP. A file containing multimedia data (text, picture or digitized sound) can be linked with electronic mail. Reception and sending may have different requirements:<br>1) E-mail (reception): transfer of the distant server to the local machine.<br>2) E-mail (sending): transfer of the local machine to the distant server. |
| Fax | Telecommunications service of transport of facsimile via the PTN such that any user can use equipment connected to a network termination point to exchange facsimiles with another user of equipment connected to another termination point. |
| Files downloading | Service allowing to search and to transfer files from the user computer to a distant server in ftp or http mode or conversely. |
| Instant messaging | Internet oriented system, notifying the presence of a user for instantaneous exchange of messages. Differs from email primarily in that its primary focus is substantially immediate end-user delivery. |
| Interactive games | Internet-based electronic games involving several individuals interacting with each other or with a machine in ongoing, open-ended play. |
| Internet access | Making facilities and/or services available for the purpose of providing an access to the public Internet in order to provide a user with access to services or resources of the Internet. (See notes 4, 5, 6 and 7). |
| Multimedia Message Service (MMS) | Transfer of multimedia messages between users without the requirement for the multimedia messages to be transferred in real-time. |

| Services or service components | Basic functions |
|---|---|
| Newsgroup (Usenet) | A newsgroup is a repository within the Usenet system for messages posted from many users at different locations.<br>Real-time dispatch of messages between local machines and server on which all the messages are available for consultation by the general public or by a restrained group of users. |
| Short Message Service (SMS) | Gives the ability to send character messages to phones. SMS messages can be Mobile Originate (MO) or Mobile Terminate (MT). |
| Telecontrol | Real-time interaction between local and remote machines to control and monitor equipment and Inputs/Outputs signals from various facilities in remote locations. |
| Telephone-conference: | Three or more terminals exchanging audio information. (See note 8). |
| Telephony Service | Provides users with the ability for real time two way speech conversation via the network. (See note 9). |
| Telnet | The Internet standard protocol for remote login. Runs on top of TCP/IP. Defined in STD 8, RFC 854 [i.16] and extended with options by many other RFCs. |
| Video broadcast | A mechanism whereby video content can be rendered at the same time that it is being transmitted to the client over the data network. (See note 10). |
| Video TeleConferencing service (VTC) | Service providing an interactive, bi-directional, real time audio-visual communication, normally intended for multiple users at either end. (See notes 11, 12 and 13). |
| Voice messaging | Any system for sending, storing and retrieving audio messages, like a telephone answering machine. A voice mailbox is typically associated with a telephone number or extension. This service is a multi-components service generally including:<br>a) recording, storage and transmission of a welcome message by the voicemail owner;<br>b) recording and storage of a message by a caller on no reply or busy line under the guidance of a voice server;<br>c) information of the voicemail owner that a message is available;<br>d) listening of a recorded message by the voicemail owner. |
| NOTE 1: This service includes necessarily a signalling component with its specific QoS requirements.<br>NOTE 2: This service includes necessarily a signalling component having specific QoS requirements.<br>NOTE 3: Includes On line shopping.<br>NOTE 4: The Internet access can be separated into two parts, the physical and the logical access. The physical access provides a connection form the user's premises to, but not including, the POP (normally a dial-up circuit or broadband link or leased line) whereas the logical access consist of the setting up of an account that later on enables the user by a login process with the ability to access to the services and resources of the Internet (normally by assigning an IP address).<br>NOTE 5: The physical and logical access may be provided by different service providers.<br>NOTE 6: The function of the physical access may be provided by several interconnected networks.<br>NOTE 7: Internet access is an example of multicomponents services: it cannot work without authentication and domain name services but it usually also includes other components such as Web browsing (consultation, data transfer), web page hosting, etc. Specific QoS requirements are needed for such components.<br>NOTE 8: This service includes necessarily a signalling component and sometimes additional facilities with their specific QoS requirements.<br>NOTE 9: This service includes necessarily a signalling component with its specific QoS requirements.<br>NOTE 10: This service usually includes an audio component with its specific QoS requirements.<br>NOTE 11: The terminals are normally exchanging audio/video/graphic information.<br>NOTE 12: This service includes necessarily signalling and audio components with their specific QoS requirements.<br>NOTE 13: Two options are possible:<br>a) Audio and Video using the same channel.<br>b) Audio and Video using differing channels. | |

Details on the requirements for each of these services can be found in ITU-T Recommendation G.1010 [i.1]. Additional information on IP-TV should be soon available from ETSI and ITU-T. Table A.2 gives example of QoS requirements for the above services. As stated earlier, some services contain several components, each of them having often differing QoS requirements. This should results in detailing the QoS requirements for each component but this would need technologies not available at the moment. This is why the table provides for each service the QoS requirements of the most constraining component.

These requirements may also vary depending on how a particular provider intends to deliver such a service.

**Table A.2 : Mapping of the various standard QoS classes for some services**

| Service components | Medium | Sensitivity to QoS parameters: Delay | Delay variation | Fidelity (Information loss) | Capacity | Availability | QoS class Y.1541 | CoS UMTS | QoS class G1010 | PHB | QoS criteria depending classes (INTRADIFF) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Interactive games** | Data | < 200 ms | U | Zero | DBW | UAT | Class 2 | Interactive | EI Interactive | AF1.1 | CoS 6.4 |
| **Telecontrol** | Data | < 250 ms | U | Zero | DBW | UAI | Class 2 | Interactive | EI Interactive | AF1.1 | CoS 6.4 |
| **Telnet** | Data | < 200 ms | U | Zero | DBW | UAI | Class 2 | Interactive | EI Interactive | AF2 | CoS 6.4 |
| **Video TeleConferencing service (VTC)** | Video | <150 ms | U | Error tolerant PLR < 1 % | DBW | UAT | Class 0 | Interactive | ET Interactive | AF1.2 | CoS 6.2 |
| | | 400 ms with echo control | U | Error tolerant PLR < 1 % | DBW 16 kbit/s to 384 kbit/s | UAT | Class 1 | Interactive | ET Interactive | AF2 | CoS 6.3 |
| **Audio-conference** | Audio | < 150 ms | < 1 ms | Error tolerant PLR < 3 % | DBW 4 kbit/s to 64kbit/s | UAT | Class 0 | Convers. | ET Interactive | EF | CoS 6.0 |
| | | 400 ms with echo control | < 1 ms | Error tolerant PLR < 3 % | DBW 4 kbit/s to 64 kbit/s | UAT | Class 1 | Convers. | ET Interactive | EF | CoS 6.1 |
| **Telephone service** | Audio | < 150 ms | < 1 ms | Error tolerant PLR < 3 % | DBW | UAT | Class 0 | Convers. | ET Interactive | EF | CoS 6.0 |
| | | 400 ms with echo control | < 1 ms | Error tolerant PLR < 3 % | DBW | UAT | Class 1 | Convers. | ET Interactive | EF | CoS 6.1 |
| **Voice messaging record** | Audio | < 2 s for record | < 1 ms | Error tolerant PLR < 3 % | DBW 4 kbit/s to 32 kbit/s | UAT | Class 1 | Interactive | ET Responsive | AF3.2 | CoS 5.2 |
| **and playback** | | < 1 s for playback | | | | | | | | AF3.2 | CoS 5.0 |
| **Electronic mail SMTP/POP server access** | Data | < 2 s (< 4 s acceptable) | U | Zero | VBW | UAT | Class 4 | | EI Responsive | AF3.1 | CoS 5.2 |
| **Web Browsing** | Data | <2 s/page (< 4 s/page acceptable) | U | Zero | VBW | UAT | Class 3 | | EI Responsive | AF3.1 | CoS 5.2 |
| **MMS (Multimedia Message Service)** | Data | < 2 s (< 4 s acceptable) | U | Zero | VBW | UAT | Class 3 | | EI Responsive | AF3.1 | CoS 5.2 |
| **Instant messaging (chat)** | Data | < 2 s (< 4 s acceptable) | U | Zero | VBW | UAI | Class 3 | | EI Responsive | AF3.1 | CoS 5.1 |
| **High priority transaction services e.g. e-Commerce, ATM** | Data | < 2 s (< 4 s acceptable) | U | Zero | VBW | UAI | Class 4 | Interactive | EI Responsive | AF3.1 | CoS 5.1 |

| Service components | Medium | Sensitivity to QoS parameters | | | | | QoS class Y.1541 | CoS UMTS | QoS class G1010 | PHB | QoS criteria depending classes (INTRADIFF) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Delay** | **Delay variation** | **Fidelity (Information loss)** | **Capacity** | **Availability** | | | | | |
| **Authentication** | Data | < 250 ms | U | Zero | VBW | UAI | Class 2 | Interactive | EI Interactive | AF4 | CoS 4.1 |
| **DNS** | Data | < 250 ms | U | Zero | VBW | UAI | Class 2 | Interactive | EI Interactive | AF4 | CoS 4.1 |
| **Signalling** | Data | < 250 ms | U | Zero | DBW | UAI | Class 3 | Interactive | EI Interactive | AF4 | CoS 4 |
| **SMS (Short Message Service)** | Data | < 30 s | U | Zero | VBW | UAT | Class U | Background | ET DNC | AF3.2 | CoS 3.1 |
| **Files downloading (FTP)** | Data | < 15 s (< 60 s acceptable) | U | Zero | VBW | UAT | Class U | Background | EI Timely | AF3.1 | CoS 3.0 |
| **Audiobroadcast** | Audio | < 10 s | < 1 ms | ET PLR < 1 % | VBW 16 kbit/s to 128 kbit/s | UAT | Class 5 | Streaming | ET Timely | AF | CoS 2.1 |
| **Video broadcast** | Video | < 10 s | < 1 ms | ET PLR < 1 % | VBW 16 kbit/s to 384 kbit/s | UAT | Class U | Streaming | ET Timely | AF | CoS 2.0 |
| **Electronic mail SMTP to POP server transfer** | Data | Can be several minutes | U | Zero | VBW | UAT | Class 5 | Background | EI DNC | BE | CoS 1.1 |
| **Newsgroup (Usenet)** | Data | Can be several minutes | U | Zero | VBW | UAT | Class 5 | Background | EI DNC | BE | CoS 1.1 |

| Service components | Medium | Sensitivity to QoS parameters | | | | | QoS class Y.1541 | CoS UMTS | QoS class G1010 | PHB | QoS criteria depending classes (INTRADIFF) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Delay** | **Delay variation** | **Fidelity (Information loss)** | **Capacity** | **Availability** | | | | | |
| **Fax ("real-time")** | Data | Non-critical < 30 s/page | U | <$10^{-6}$ BER | VBW | UAT | Class 5 | Background | ET DNC | BE | CoS 1.0 |
| **Fax (store & forward)** | Data | Non-critical: Can be several minutes | U | <$10^{-6}$ BER | VBW | UAT | Class 5 | Background | ET DNC | BE | CoS 1.0 |

NOTE 1: BER: Bit Error Rate
DNC: Delay Non Critical
DBW: Dedicated Bandwidth
ET: Error Tolerant
EI: Error Intolerant
PHB: Per Hop Behaviour
PLR: Packet Loss Rate
U: Unspecified
UAI: UnAvailability Intolerant
UAT: UnAvailability Tolerant
VBW: Variable Bandwidth

NOTE 2: Per Hop Behaviour parameters:
AF: Assured Forwarding
BE: Best Effort
EF: Expedited Forwarding

# A.1 ITU-T Recommendation Y.1541 QoS class

The characteristics of each Y.1541 QoS class are summarized here:

**Class 0:** Real-time, highly interactive applications, sensitive to jitter. Mean delay upper bound is 100 ms, delay variation is less than 50 ms, and loss ratio is less than $10^{-3}$. Application examples include VoIP, Video Teleconference.

**Class 1:** Real-time, interactive applications, sensitive to jitter. Mean delay upper bound is 400 ms, delay variation is less than 50 ms, and loss ratio is less than $10^{-3}$. Application examples include VoIP, Video Teleconference.

**Class 2:** Highly interactive transaction data. Mean delay upper bound is 100 ms, delay variation is unspecified, and loss ratio is less than $10^{-3}$. Application examples include signalling.

**Class 3:** Interactive transaction data. Mean delay upper bound is 400 ms, delay variation is unspecified, and loss ratio is less than $10^{-3}$. Application examples include signalling.

**Class 4:** Low Loss Only applications. Mean delay upper bound is 1s, delay variation is unspecified, and loss ratio is less than $10^{-3}$. Application examples include short transactions, bulk data, video streaming.

**Class 5:** Unspecified applications with unspecified mean delay, delay variation, and loss ratio. Application examples include traditional applications of Default IP Networks.

**Class 6:** Mean delay ≤ 100 ms, delay variation ≤ 50 ms, loss ratio ≤ $10^{-5}$. Applications that are highly sensitive to loss, such as television transport, high-capacity TCP transfers, and TDM circuit emulation.

**Class 7:** Mean delay ≤ 400 ms, delay variation ≤ 50 ms, loss ratio ≤ $10^{-5}$. Applications that are highly sensitive to loss, such as television transport, high-capacity TCP transfers, and TDM circuit emulation.

Table A.3 gives some examples of services for each of these classes.

**Table A.3: Y.1541 IP QoS Class Definitions and Network Performance Objectives**

| QoS class | IPTD | IPDV | IPLR | IPER | IPRR | Applications (examples) |
|---|---|---|---|---|---|---|
| 0 | 100 ms | 50 ms | $1 \times 10^{-3}$ | $1 \times 10^{-4}$ | - | Real-time, jitter sensitive, high interaction (VoIP, VTC) |
| 1 | 400 ms | 50 ms | $1 \times 10^{-3}$ | $1 \times 10^{-4}$ | - | Real-time, jitter sensitive, Interactive |
| 2 | 100 ms | U | $1 \times 10^{-3}$ | $1 \times 10^{-4}$ | - | Transaction data, highly interactive (Signalling) |
| 3 | 400 ms | U | $1 \times 10^{-3}$ | $1 \times 10^{-4}$ | - | Transaction data, interactive |
| 4 | 1 s | U | $1 \times 10^{-3}$ | $1 \times 10^{-4}$ | - | Low loss only (short transaction, bulk data, video streaming) |
| 5 | U | U | U | U | - | Traditional applications of default IP network |
| 6 | 100 ms | 50 ms | $1 \times 10^{-6}$ | $1 \times 10^{-5}$ | $1 \times 10^{-6}$ | High bit rate, strictly low loss/error (TV broadcast on IP) |
| 7 | 400 ms | 50 ms | $1 \times 10^{-6}$ | $1 \times 10^{-5}$ | $1 \times 10^{-6}$ | High bit rate, strictly low loss/error |

# A.2 UMTS Classes of Service (CoS)

UMTS QoS Classes of Service are defined in [i.6].

When defining the UMTS QoS classes, also referred to as traffic classes, the restrictions and limitations of the air interface have to be taken into account. It is not reasonable to define complex mechanisms as have been in fixed networks due to different error characteristics of the air interface. The QoS mechanisms provided in the cellular network have to be robust and capable of providing reasonable QoS resolution. Table A.4 illustrates the QoS classes for UMTS.

There are four different QoS classes:

- conversational class;
- streaming class;
- interactive class; and
- background class.

The main distinguishing factor between these QoS classes is how delay sensitive the traffic is: Conversational class is meant for traffic which is very delay sensitive while Background class is the most delay insensitive traffic class.

# A.2.1 Conversational class

The most well known use of this scheme is telephony speech (e.g. GSM). But with Internet and multimedia a number of new applications will require this scheme, for example voice over IP and video conferencing tools.

Real time conversation - fundamental characteristics for QoS:

- preserve time relation (variation) between information entities of the stream;
- conversational pattern (stringent and low delay).

# A.2.2 Streaming class

When the user is looking at (listening to) real time video (audio) the scheme of real time streams applies. The real time data flow is always aiming at a live (human) destination. It is a one-way transport.

The delay variation of the end-to-end flow should be limited, to preserve the time relation (variation) between information entities of the stream. But as the stream normally is time aligned at the receiving end (in the user equipment), the highest acceptable delay variation over the transmission media is given by the capability of the time alignment function of the application. Acceptable delay variation is thus much greater than the delay variation given by the limits of human perception.

Real time streams - fundamental characteristics for QoS:

- preserve time relation (variation) between information entities of the stream.

# A.2.3 Interactive class

When the end-user, that is either a machine or a human, is on line requesting data from remote equipment (e.g. a server), this scheme applies. Examples of human interaction with the remote equipment are: web browsing, data base retrieval, server access. Examples of machines interaction with remote equipment are: polling for measurement records and automatic data base enquiries (tele-machines).

Interactive traffic is the other classical data communication scheme that on an overall level is characterised by the request response pattern of the end-user. At the message destination there is an entity expecting the message (response) within a certain time. Round trip delay time is therefore one of the key attributes. Another characteristic is that the content of the packets should be transparently transferred (with low bit error rate).

Interactive traffic - fundamental characteristics for QoS:

- request response pattern;
- preserve payload content.

### A.2.4 Background class

When the end-user, that typically is a computer, sends and receives data-files in the background, this scheme applies. Examples are background delivery of E-mails, SMS, download of databases and reception of measurement records.

Background traffic is one of the classical data communication schemes that on an overall level is characterised by that the destination is not expecting the data within a certain time. The scheme is thus more or less delivery time insensitive. Another characteristic is that the content of the packets should be transparently transferred (with low bit error rate).

Background traffic - fundamental characteristics for QoS:

- the destination is not expecting the data within a certain time;
- preserve payload content.

### A.2.5 Summary and QoS Information processing

**Table A.4: Main features of traffic classes**

| Traffic class | Conversational class conversational RT | Streaming class streaming RT | Interactive class Interactive best effort | Background Background best effort |
|---|---|---|---|---|
| Fundamental characteristics | - Preserve time relation (variation) between information entities of the stream<br><br>Conversational pattern (stringent and low delay ) | - Preserve time relation (variation) between information entities of the stream | - Request response pattern<br><br>- Preserve payload content | - Destination is not expecting the data within a certain time<br><br>- Preserve payload content |
| Example of the application | - voice | - streaming video | - Web browsing | - background download of emails |

Explanation on possible way for the QoS Information processing is given in [i.7].

**Table A.5: UMTS QoS Information processing**

| QoS class | UMTS Traffic Class | Traffic Handling Priority |
|---|---|---|
| A | Conversational | N/A |
| B | Streaming | N/A |
| C | Interactive | 1 |
| D | | 2 |
| E | | 3 |
| F | Background | N/A |
| NOTE: QoS class represents the highest class that can be used for the bearer. | | |

## A.3 ITU-T Recommendation G.1010 QoS categories

ITU-T Recommendation G.1010 [i.1] defines a model for multimedia Quality of Service (QoS) categories from an end-user viewpoint. By considering user expectations for a range of multimedia applications, eight distinct categories are identified, based on tolerance to information loss and delay. It is intended that these categories form the basis for defining realistic QoS classes for underlying transport networks, and associated QoS control mechanisms. The impact on QoS of the key parameters impacting the user is detailed hereafter.

# A.3.1 Key parameters impacting the user

## A.3.1.1 Delay

Delay manifests itself in a number of ways, including the time taken to establish a particular service from the initial user request and the time to receive specific information once the service is established. Delay has a very direct impact on user satisfaction depending on the application, and includes delays in the terminal, network, and any servers. Note that from a user point of view, delay also takes into account the effect of other network parameters such as throughput.

## A.3.1.2 Delay variation

Delay variation is generally included as a performance parameter since it is very important at the transport layer in packetized data systems due to the inherent variability in arrival times of individual packets. However, services that are highly intolerant of delay variation will usually take steps to remove (or at least significantly reduce) the delay variation by means of buffering, effectively eliminating delay variation as perceived at the user level (although at the expense of adding additional fixed delay).

## A.3.1.3 Information loss

Information loss has a very direct effect on the quality of the information finally presented to the user, whether it is voice, image, video or data. In this context, information loss is not limited to the effects of bit errors or packet loss during transmission, but also includes the effects of any degradation introduced by media coding for more efficient transmission (e.g. the use of low bit-rate speech codecs for voice).

# A.3.2 Application

Figure A.1 shows the main features and applications for these eight categories with an indication of the QoS requirement ranges for some services.

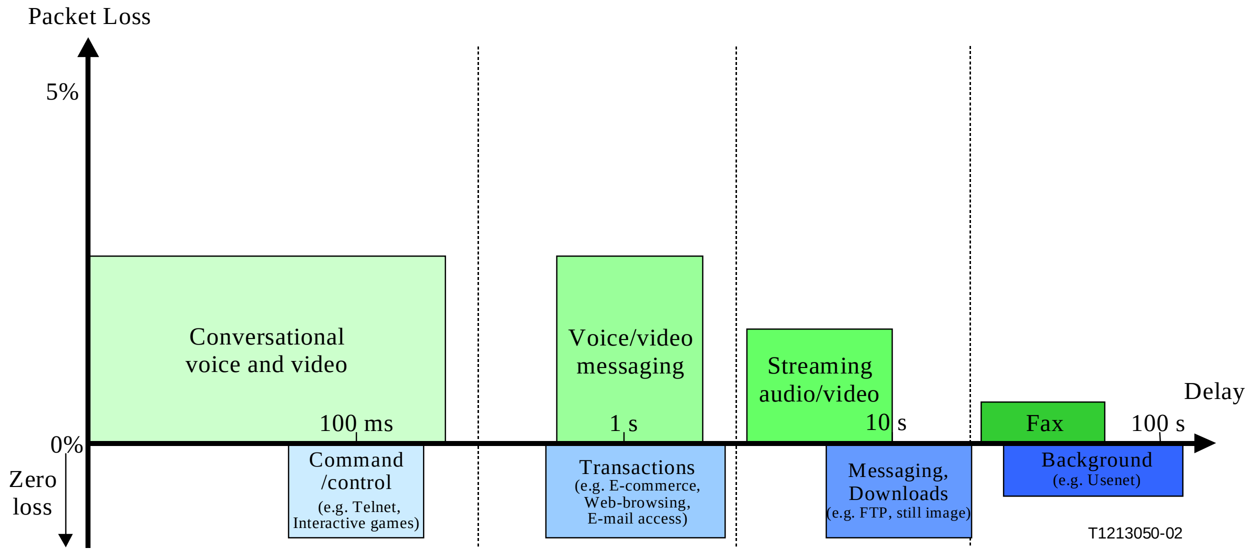


**Figure A.1: G.1010 - Mapping of user-centric QoS requirements**

Figure A.2 provides a recommended model for end-user QoS categories, where the four areas of delay are given names chosen to illustrate the type of user interaction involved. Of course, it is possible that each category could be subdivided into further categories to provide a range of quality levels for a specific service, as has been done for conversational voice in [i.8].

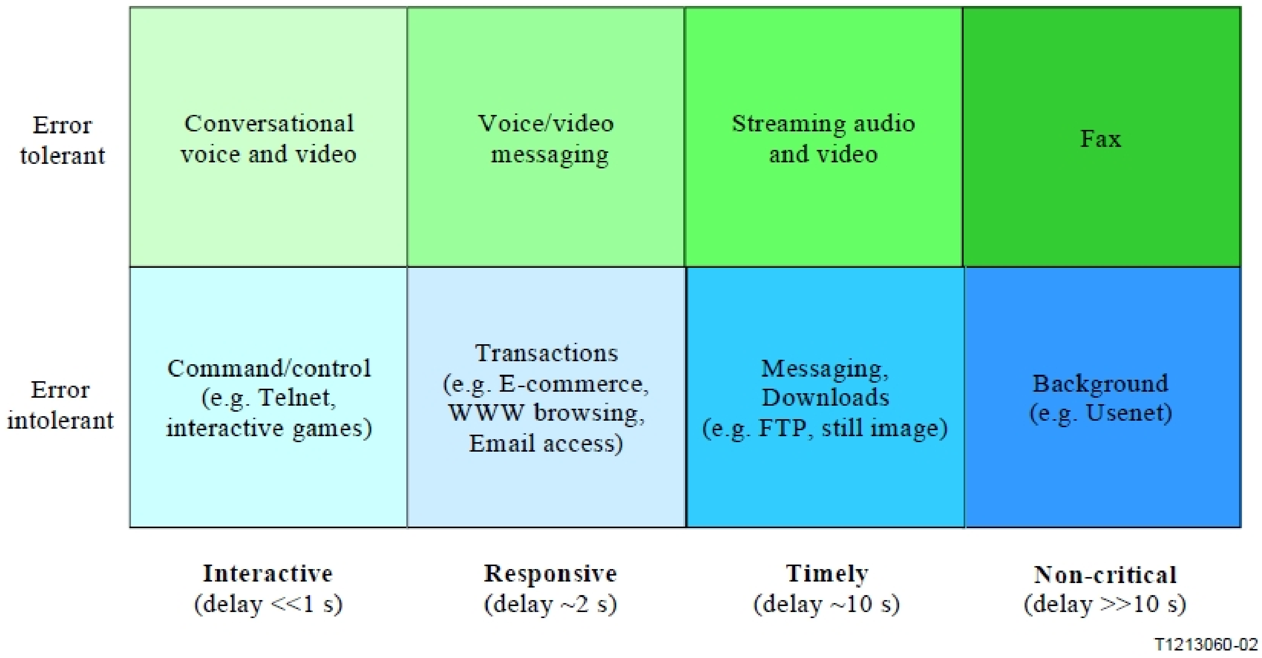


**Figure A.2: G.1010 - Model for user-centric QoS categories**

# A.4 Per Hop Behaviour parameters (DIFFSERV)

The Per Hop Behaviour parameters comprise three classes:

- AF: Assured Forwarding.
- BE: Best Effort.
- EF: Expedited Forwarding.

## A.4.1 Assured Forwarding

IETF defines four independently forwarded AF classes, within each class one of three different levels of drop precedence can be specified. AF*ij*, with $1 \leq i \leq 4$ and $1 \leq j \leq 3$, represents the DSCP for AF class *i* with drop precedence *j*. It is recommended to support at least one AF class with two drop precedence levels.

## A.4.2 Best Effort

The IP flows which are mapped to this PHB have no expectations on the level of service received by the SD layers. So for BE traffic packets are directed to a BE FIFO queue, but without any conditioning. They remain in the queue until layer 2 resources are made available, as a result of layer 2 on capacity control and scheduling.

## A.4.3 Expedited Forwarding

The EF PHB is designed to provide low-loss, low-latency, low-jitter, assured bandwidth services, where packets normally encounter short or empty queues. Intuitively the service rate for EF traffic on the output satellite interface should be at least the configured rate R, independent of the offered load of non-EF traffic.

# A.5 QoS criteria depending classes (INTRADIFF)

While 3GPP proposed a macroscopic classification based on the "Delay" (4 sensibility Level) criterion, IUT-T Recommendation G.1010 [i.1] adds the tolerance to the losses (2 sensibility levels) as an additional criterion (8 class).

DiffServ refines the tolerance to the losses (3 levels) criterion (14 class possibilities).

INTRADIFF was developed in an INRIA project aiming to implement the DIFFSERV concept in an Intranet.

INTRADIFF allows for more refinements with 4 (C) x 4 (D) x 3 (F) x 2 (A) sensibility levels (96 class possibilities) to take into account all the QoS requirement criteria.

# Annex B: Bibliography


- ITU-T Recommendation P.10/G.100 (01/2007): "Vocabulary for performance and quality of service".
- ETSI TR 102 805-3: "User Group; QoS Management at the Network Interfaces; Part 3: Converging solution: QoS continuity".
- ETSI TR 102 806: "User Group; Analysis of current End-to-End QoS standardization state".
- ETSI TS 181 016 (V2.0.0): "Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); Service Layer Requirements to Integrate NGN Services and IPTV".

# History

| Document history | | |
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