Information & Communication Technologies Authority

Consultation Ref: ICTA/2010/01

CONSULTATION PAPER ON QUALITY OF SERVICE (QoS) FRAMEWORK FOR INFORMATION AND COMMUNICATION SERVICES IN MAURITIUS

17 May 2010

Explanatory memorandum

Considering that:

1) the ICT Authority has as function under section 18(1)(b)of the ICT Act 2001 "*to provide economic and technical monitoring of the information and communication industry in accordance with recognised international standard practices, protocols and having regard to the convergence of technology*";
2) the ICT Authority has as function under section 18(1) (f) of the ICT Act 2001 *"to establish, for public operators, performance standards and linkage standards in relation to the provision of international and local telephone services, and monitor compliance with both of those standards"* and "*to report, in such manner as may be required, to the Minister or to any other person on any matter that lies within its purview, such as the performance of public operators, the quality of consumer service and consumer satisfaction, measured against the best available international standards of practice".*
3) the ICT Authority has as function under section 18(1) (n) of the ICT Act 2001 "*to ensure the safety and quality of every information and communication services including telecornmunication services, and for that purpose, determine technical standards for telecommunication network, the connection of customer equipment to telecommunication networks*";
4) standards bodies such as the International Telecommunication Union (ITU) and the European Telecommunications Standards Institute (ETSI) have issued pertinent recommendations, directives and guides on Quality of Service (QoS);
5) regulators around the world have set out regulations/directives on QoS with a view to monitoring and improving quality and assisting consumers in making informed choices on service providers;
6) there is need for the ICT Authority, in pursuance of its statutory objectives and in line with international best-practices, to define an appropriate framework for monitoring the quality of the services offered on the market;

The Information and Communication Technologies Authority resolves to:

1) make available for public consultation the Consultation Document Ref ICTA/2010/01;
2) invite views, contributions, and comments on the Consultation Document.

GUIDELINES ON RESPONDING TO THIS CONSULTATION

G.1 All comments that you may have to improve this document are welcomed. Your input is specially required on Section 4. It would make the task of analyzing responses easier if comments were referenced to the relevant question numbers from this document. The questions are listed together at ANNEX B.

G.2 You are invited to send your written views and comments on the issues raised in this document to the **Executive Director, ICT Authority, 12th Floor The Celicourt, Celicourt Antelme Street, Port Louis**, or by email to icta@intnet.mu at latest by 16h00 on 16 July 2010.

G.3 Should you be including confidential information as part of your responses, you are requested to clearly identify the said confidential materials and to place same in a separate annex to your response.

Executive Summary

Pertinent recommendations, directives and guides related to Quality of Service (QoS) have been issued by standard bodies such as the ITU and ETSI, most of which have been developed primarily to assist operators in network planning and operation.

Recently Quality of Service (QoS) has also become an important aspect of regulation as part of industry monitoring and consumer protection objectives. Some regulatory bodies have gone further into enforcing quality of service through appropriate regulatory instruments e.g. regulations/directives. These regulations/directives usually require operators to measure and report the quality of the services they provide, which are then accordingly published by the regulators. The latter may further set performance targets for operators.

In the same endeavour, the ICT Authority sets the obligation on licensees "*to maintain quality of service in accordance with international best-practices"*. Although this requirement is in the form of a licence condition, no framework has been adopted so far by the Authority for monitoring quality of service. Our regulation also falls short of providing any QoS-related directives which would help to improve quality of service and empower consumers to make informed decision about the choice of services and service providers.

This consultation paper proposes such a framework with due regard to international best practices. The first part of this paper broadly reviews, for general information, the QoS monitoring process by quoting pertinent notes for most of the parts from ITU and ETSI documents. It further briefly surveys international practices with regard to QoS regulation.

Although there are several standards describing QoS measurements, the question of which indicators are to be monitored and the values which they should meet are still open.[1] The paper thus makes a review of several QoS-related standards (as annexed). Information from these sources is then used to define QoS parameters and to report target values. In some cases, the QoS parameters and target values reported in this document are those which have been adopted by other regulatory bodies. The services under consideration are mostly legacy services; however it is expected that the framework proposed herein could be evolved to cater for next-generation services.

[1] ETSI EG 202 009-1 V1.1.1 (2002-02), *User Group; Quality of Telecom Services; Part1: Method for identification of parameters relevant to the Users.*

List of Abbreviations

ACF	Accessibility Continuity Fulfilment
ASR	Answer Seizure Ratio
ETNO	European Telecommunications Network Operator's Association
ETSI	European Telecommunications Standards Institute
GOS	Grade of Service
F-M	Fixed to Mobile
IT	Intermediate Term
ITU	International Telecommunication Union
LT	Long Term
M-M	Mobile to Mobile
M-F	Mobile to Fixed
MMS	Multimedia Message Service
MMSC	Multimedia Message Service Centre
MOS	Mean Opinion Score
MTTR	Mean Time To Repair
NP	Network Performance
PDD	Post Dialling Delay
PLMN	Public Land Mobile Network
PSD	Post Selection Delay
PSTN	Public Switched Telephone Network
QoS	Quality of Service
SMS	Short Message Service
SMSC	Short Message Service Centre

1. QoS-RELATED TERMINOLOGIES

Quality of Service (QoS) is defined in ITU-T Recommendation E.800 as *"the collective effect of service performances which determine the degree of satisfaction of a user of the service"*. Therefore QoS provides an indication of what the customers experience when using the network.

The QoS parameters, also known as QoS metrics, QoS indicators, QoS measures or QoS determinants, are used to characterize the quantity level of a certain aspect of a service being offered, and ultimately the customer satisfaction[2].

In the context of Quality of Service, a target is a potential value (or range of values) for a measurement that must be attained if quality is to be regarded as satisfactory. It is often referred to as 'objectives', 'benchmarks', 'thresholds', 'standards' or 'reference values' in different documents[3].

The terms Network Performance (NP) and Quality of Service (QoS) are often used interchangeably in some work; however there is a clear distinction between these two terms. Network Performance is defined by ITU as "the ability of a network or network portion to provide the functions related to communications between users". Network performance is measured in terms of parameters which are meaningful to the network provider and are used for the purposes of system design, configuration, operation and maintenance. On the other hand, QoS parameters are described in network-independent terms which are meaningful to users. QoS is inherently an end-to-end requirement since, for the user, the whole concept of QoS is only attractive if the presentation at the user interface satisfies his/her needs[4]. Although Network performance contributes towards QoS that a user/customer experience when using the network, it may or may not be on an end to end basis. The following table summarises the characteristics distinguishing NP and QoS, as provided by ITU-T Rec. I.350.

[2] ITU Handbook (2004), *Quality of Service and Network Performance*.
[3] ITU document Background Paper (Sep. 2006), *ICT Quality of Service Regulation: Practices and Proposals*- Global Seminar on Quality of Service and Consumer Protection, Geneva.
[4] ITU-T Recommendations I.350

Table 1: Characteristics distinguishing Quality of Service and Network Performance[5]

Quality of service	Network performance
User oriented	Provider oriented
Service attribute	Connection element attribute
Focus on user-observable effects	Focus on planning, development (design), operations and maintenance
Between (at) service access points	End-to-end or network connection elements capabilities

Other terms that are often used interchangeably with QoS are 'Class of Service' and 'Grade of Service'. In fact, 'Class of service' describes a level of network performance appropriate to particular services in IP and other data networks. Grade of Service (GOS) is the traffic related part of network performance (NP) and are of two general types: delay parameters and probability of mishandling or blocked call parameters[6]. Grade of Service is defined in ITU-T Recommendation E.600 as a number of traffic engineering variables used to provide a measure of adequacy of a group of resources under specified conditions. These grades of service variables may be probability of loss, dial tone delay, etc.

2. THE QOS MONITORING PROCESS

Dealing with telecommunication services QoS assumes that, first of all, the QoS requirements are identified from the user viewpoint then a set of indicators (QoS parameters) is defined, measured and monitored with respect to reference (target) values in order to check whether the requirements are fulfilled[7]. Measurements may also be published.

Defining measurements and carrying out the above process serves the following purposes:-

- To protect the interest of consumers of telecommunication services by ensuring that they become aware of the quality of service level for which they have the right to expect;
- To allow service providers to manage and improve the quality of the service they offer;
- To support commercial contracts such as Service Level Agreement formulation and verification;

[5] Source : ITU-T Recommendation I.350
[6] ITU-T Recommendations E.493
[7] ETSI EG 202 009-1 V1.1.1 (2002-02), *User Group; Quality of Telecom Services; Part1: Method for identification of parameters relevant to the Users.*

- To facilitate the task of the regulator in monitoring the quality of service of the industry and in assessing its level of performance;
- They are also used in call-minute trading, where the price is determined by volume and quality grade.

Although regulators are generally responsible for setting out the framework for monitoring QoS, other players such as operators, consumers as well as independent entities may all be involved in the above process. Operators can be involved in defining measurements, setting targets, making measurements, auditing measurements and publishing measurements. Customers can be involved, too, in defining measurements and making measurements[8]. In other scenario, independent entities may be involved in making measurements or auditing measurements made by operators.

2.1 Identifying and Defining QoS Parameters

ETNO (European Telecommunications Network Operators' Association) and also ETSI, on the basis of the 2002/22/EC Directive, proposes the selection of QoS parameters (indicators) as follows[9]:

- QoS parameters should be easily understood by the public, and be useful and important to them.
- All parameters are applicable at the network termination point. Where measurements are possible, they should be made on the customer's premises, using in-service lines. To be as realistic as possible, real traffic rather than test calls should be used as a basis of the measurements, wherever possible.
- Parameters should be capable of verification by independent organizations. This verification might be made by direct measurements or by audit of the operator's measurements.
- The accuracy of QoS parameter values should be set to a level consistent with cost-effectively available measurement methods.
- The parameters are designed for both statistical and individual application. The statistical values should be derived by the application of a simple statistical function to the individual values. The statistical function should be specified in the standard. The

[8] ITU document Background Paper (Sep. 2006), *ICT Quality of Service Regulation: Practices and Proposals*- Global Seminar on Quality of Service and Consumer Protection, Geneva.
[9] ITU Handbook (2004), *Quality of Service and Network Performance*.

standard should also contain guidelines on how statistically significant samples should be selected.

For any communication service, QoS parameters may be identified by applying the simple rule of the QoS matrix presented in ITU-T Recommendation G.1000. The principle of this matrix is to first identify the different functions experienced or performed by the customers when using the communication service; then the second step is to list the criteria used by the customer to judge the quality with which each of these functions is performed. Having combined the Service Functions (*Sales and Pre-contract, Provision, Alteration, Service Support, Repair, Cessation, Connection Establishment, Information Transfer, Connection Release, Charging/Billing and Network/service Management by the customer*) and the list of service Quality Criteria (*Speed, Accuracy, Availability, Reliability, Security, Simplicity* and *Flexibility*) into a matrix, the next step is then to populate the cells with performance parameters, and performance objectives may then be set.

ETNO on the basis of the 2002/22/EC Directive lists the following activities pertaining to telecommunication services: *Provision, Service Support, Repair, Communication, Billing and Complaint Handling*. The quality criteria defined by ETNO are as follows: *Speed, Accuracy, Availability, Reliability, Security and Simplicity*.

		Service Quality Criteria						
		SPEED 1	ACCURACY 2	AVAILABILITY 3	RELIABILITY 4	SECURITY 5	SIMPLICITY 6	FLEXIBILITY 7
Service Function								
SERVICE MANAGEMENT	Sales & Pre-Contract Activities 1							
	Provision 2							
	Alteration 3							
	Service Support 4							
	Repair 5							
	Cessation 6							
CONNECTION QUALITY	Connection Establish. 7							
	Information Transfer 8							
	Connection Release 9							
Billing 10								
Network/Service management by customer 11								

Fig. 2: Matrix for determining quality criteria[10]

[10] Source: ITU-T Recommendation G.1000

It is to be noted that the QoS matrix was developed in an era of circuit-switched telephony. Whilst still appropriate for Internet-derived services, the technical service functions have been expanded by the use of the ACF (Accessibility, Continuity and Fulfilment) model developed by the IETF to present the computing industry view of QoS[11].

- Accessibility is the ability of a user to access the application and initiate a transaction
- Continuity is the ability to deliver the service with no interruption, given that the accessibility has been successful and a transaction has been initiated.
- Fulfilment is the ability to deliver the service meeting the user's quality expectations.

What is important for users of Internet-based services is to access the desired application, initiate a transaction, continue using the application with no interruption for a desired duration of time and fulfil the initiated transaction at a desired quality.

For any framework of QoS to be truly useful and practical enough to be used across the industry, it must be meaningful from four viewpoints, as presented below. The description of these four viewpoints can be found in ITU-T Recommendation G.1000.

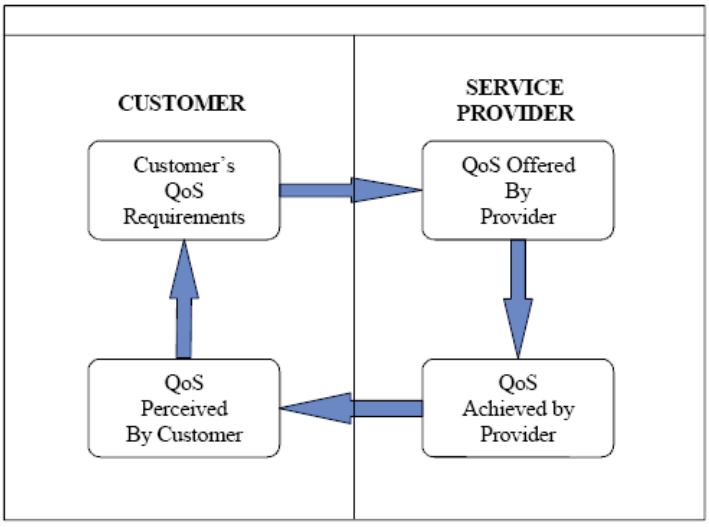


Fig. 3: Four Viewpoints of QoS[12]

Once QoS parameters are identified, they should be defined in measurable terms. Each regulator could have its own definition for a particular QoS parameter. For instance, the QoS parameter "Time to Repair" could be defined as "Maximum time to repair" or "Average time to repair" or expressed as "Number of faults cleared within next working day".

[11] Oodan A., Ward K., Savolaine C., Daneshmand M. and Hoath P.: 'Telecommunications Quality of Service Management, from legacy to emerging services', IEE Telecommunications Series 48, 2003.
[12] Source: ITU-T Recommendation G.1000

Therefore while proposing a definition of measurement for a QoS parameter, the following factors, among others, should generally be taken into consideration:

- The practicability for operators to make the required measurements;
- The practicability for regulators or any independent entity to audit the results;
- The measurement being made should retain the customer experience aspect.

2.2 Setting Target Values

Once Quality of Service parameters have been defined in measurable terms, targets may be set. Target setting is generally the responsibility of the regulator, although in some countries a group of operators may be responsible for same. While setting target values, regulators generally take into consideration references that have already been worked out by standards bodies.

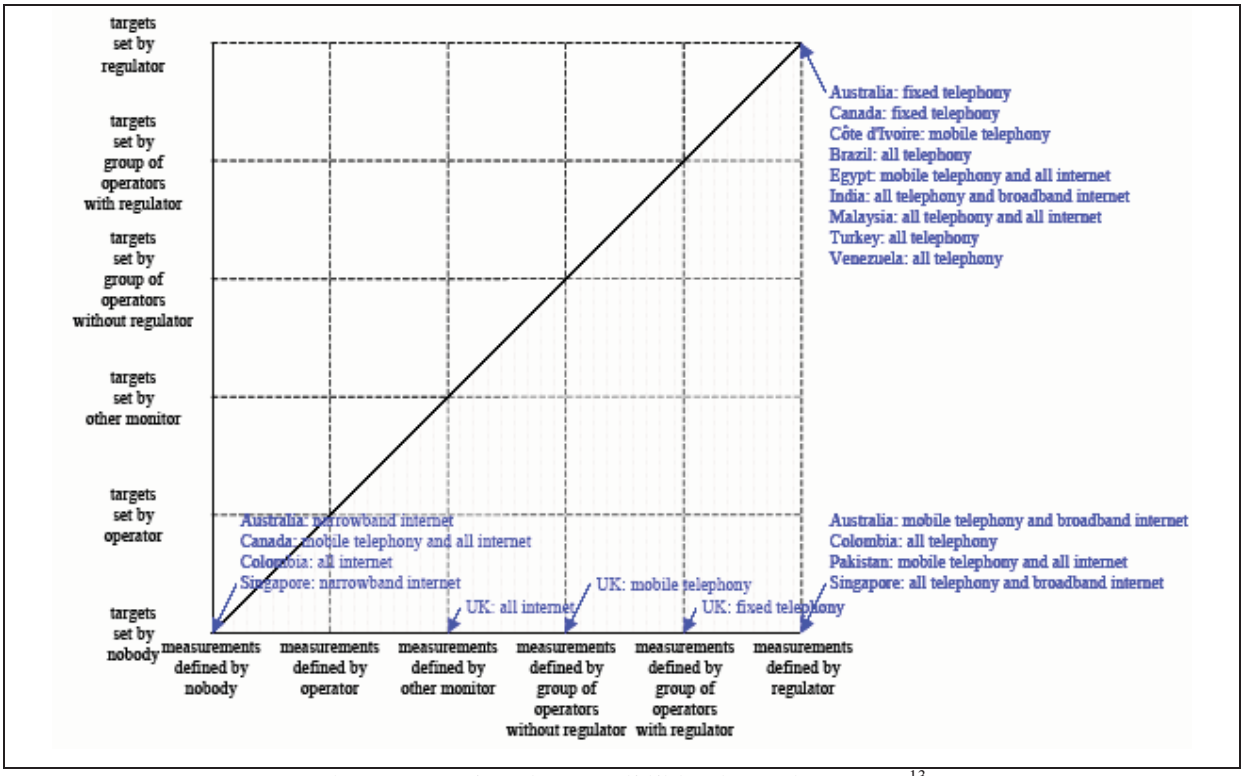


Fig. 4: Examples of responsibilities for setting targets[13]

2.3 Measurements of QoS parameters

QoS parameters are not always directly measurable. The relative weight of their influence in the user's evaluation depends on the nature of the service. Preponderating criteria will obviously be

[13] Source: ITU document Background Paper (Sep. 2006), *ICT Quality of Service Regulation: Practices and Proposals*- Global Seminar on Quality of Service and Consumer Protection, Geneva. (Source: Robert Milne-Antelope Consulting)

different for users of interactive applications conversational, messaging or retrieval services and users of distribution services.

Some measurements (such as fault repair times) are best made by operators. Others are best made by external measurement agencies, because doing so makes them more comparable between different operators and, sometimes, less costly[14].

Quality of Service parameters may be measured either objectively via technical means or subjectively via surveys amongst the users. Subjective measurement is a time-consuming and expensive procedure. Therefore, objective measurements are often used where specific network related QoS parameters measured can be correlated to the user's perception of QoS[15]. However doing both objective and subjective measurements allows getting the whole QoS picture.

Objective Measurements

Objective measurements are made by measuring physical attributes of circuits, networks and signals. These measurements can be made either on real traffic or on artificially generated traffic;-

- *Intrusive measurement* is performed on artificially generated traffic (established test calls) and the traffic can be tailored to check almost everything.
- *Non-intrusive measurement* is performed on real traffic conditions and therefore is expected to give a more realistic vision of the QoS, however not all possibilities are checked.

Subjective Measurements

Subjective measurements are used to assess aspects of QoS that cannot be measured easily by technical means or that may be missed out due to a limited number of measurement points. They are used to assess the quality of a service with respect to audio i.e. speech and video quality. This includes the performance of specific transmission elements. They are also used as reference for objective measurement methods. Some subjective tests which are described in ITU-T Recommendation P.800 include: Listening opinion tests, conversation-opinion tests and double-talk tests, interview and survey tests.

Subjective assessments use surveys of customer opinions to calculate a Mean Opinion Score (MOS). For instance, Recommendation P.82 recommends the use of telephone user's surveys in the manner of Recommendation E.125 (now deleted) as a means of measuring speech transmission

[14] ITU document Background Paper (Sep. 2006), *ICT Quality of Service Regulation: Practices and Proposals*- Global Seminar on Quality of Service and Consumer Protection, Geneva.

[15] ITU Handbook (2004), *Quality of Service and Network Performance*

quality on international calls. The questions to be asked when interviewing customers are provided in the said recommendation. To provide quantitative information suitable for comparisons, the subjective assessments of excellent, good, fair or poor are accorded score of 4, 3, 2 and 1 respectively and a Mean Opinion Score calculated for all associated responses[16].

ITU-T Rec. P.10 defines MOS as the values on a predefined scale that subjects assign to their opinion of the performance of the telephone transmission system used either for conversation or for listening to spoken material. Apart from subjective opinion, the abbreviation "MOS" is also used for scores that originate from objective models or network planning models which may lead to confusion and misinterpretations. Therefore, ITU-T Rec. P.800.1 recommends to use the abbreviation "MOS" with specific identifiers in order to distinguish the area of application, where LQ refers to Listening Quality, CQ refers to Conversational Quality, S refers to Subjective, O refers to Objective, and E refers to Estimated.[17]

Table 2: Use of "MOS" with specific identifiers in order to distinguish the area of application

	Listening-only	**Conversational**
Subjective	MOS-LQS	MOS-CQS
Objective	MOS-LQO	MOS-CQO
Estimated	MOS-LQE	MOS-CQE

ITU-T Rec. P.800.1 provides a terminology which shall be used in conjunction with speech quality expressions in terms of Mean Opinion Score (MOS). The new terminology is motivated by the intention to avoid misunderstanding as to whether specific values of MOS are related to listening quality or conversational quality, and whether they originate from subjective tests, from objective models or from network planning models.

2.4 Auditing and Publishing Measurements

The measurements submitted by operators may be independently audited for accuracy by the regulator. However, it may be inconvenient and costly to carry out auditing of all measurements. The regulator may therefore audit only part of the measurements either at random or upon complaints or suspects of falsification.

[16] ITU-T Recommendations P.82
[17] ITU Handbook (2004), *Quality of Service and Network Performance.*

The definitions of measurements themselves, as well as the subsequent measurements, require auditing both before the definitions are implemented and thereafter: though the definitions may be intended to be precise enough to achieve comparability, they may remain open to slightly different interpretations. If the auditors for different operators and regulators meet together, they can find and resolve minor problems of comparability, agree the main parts of each measurement procedure needing investigations in audits, and validate the auditing techniques of each other[18].

In some countries measurements from operators are published at regular intervals by the regulators. Many of the published measurements are often unlikely to interest many potential customers, but they may help to demonstrate that the regulator is fair and open. Collecting measurements from multiple operators introduces delays and administrative overheads. Slightly less co-ordination is needed if measurements are published by individual operators separately, as is done in Belgium and Spain for telephony services and in Chile for internet services. However if the responsibility of publishing remains with the operator, the task can be simplified by reducing the measurements to be published, the operators to be monitored (excluding those with few revenues or very few customers) and the frequency of publication.

3. INTERNATIONAL PRACTICES ON QOS REGULATION

- ***Australia***

Australia has a Customer Service Guarantee (GSC) made by law and incorporated in the Act[19]. The CSG sets minimum performance standards for basic services in order to protect residential and small business customers from poor telephone service. Under the CSG Standard, service providers are required to meet performance standards and provide users with financial compensation if same are not met. CSG Standard specifies the timeframes for connection of specified services, report of faults and attendance of appointments by service providers[20]. In 2005, the dominant operator exceeded 4% of service supply times, 9% of fault repair times and 6% of appointment times, with average compensation payments of AUD58 (USD46), AUD25 (USD20) and AUD14 (USD11) respectively[21].

[18] ITU document Background Paper (Sep. 2006), *ICT Quality of Service Regulation: Practices and Proposals*- Global Seminar on Quality of Service and Consumer Protection, Geneva.
[19] ITU (doc. 10) Global Symposium for Regulators, Hong Kong, China, 7-8 December 2002, *New Performance Indicators Issues for Converged Services-A Report from the Asia-Pacific Telecommunity (APT) Forum on Telecommunication Policy and Regulation held in Kuala Lumpur, Malaysia from 17-18 May 2002.*
[20] http://www.acma.gov.au
[21] ITU (doc. 2 -Final Paper) Global Seminar on Quality of Service and Consumer Protection, Geneva (31 Aug-1Sep. 2006), *ICT Quality of Service Regulation: Practices and Proposals.*

ACMA publishes the Quarterly Telecommunications Performance Data every quarter which reports on telephone companies' compliance, in percentage terms, against the Customer Service Guarantee (CSG) requirements. The reports also cover call centre performance, complaints, payphone availability and mobile network call congestion levels and drop-out rates. Special reports on current topics of interest are also included. ACMA have other quality of service monitoring schemes; among them are ones assessing the performance of operators offering mobile telephony, the reliability of the universal service provider, and the responsiveness of operators giving priority to customers with life-threatening medical conditions. Some of these give force to work by an industry group of operators, the Australian Communications Industry Forum (ACIF), which has drawn up several codes of practice for telephony service customer protection and network operation. ACIF is now part of a larger group, the Communications Alliance.) Another industry group, the Internet Industry Association (IIA), has drawn up codes of practice for internet service customer protection[22].

- ***India***

On 05th July 2000, TRAI issued the "*Regulation on Quality of Service of Basic and Cellular Mobile Telephone Services, 2000*" wherein quality parameters and benchmarks for basic and cellular mobile telephone service were defined to be achieved in the short, medium and long term. Given that performance was not fully met after the long-term period has expired, TRAI, after extensive debates, decided to review the existing parameters and introduce others. The Authority accordingly issued a Consultation Paper on various issues relating to QoS on 22nd February 2005 and held an Open House Session on 06th February 2005. The new "*Regulation on Quality of Service of Basic and Cellular Mobile Telephone Services, 2005*" was thus issued by TRAI on 1st July 2005. TRAI published for every 3 months since July 2005 14 measurements with targets for 71 fixed telephony operators and 128 mobile telephony operators in 27 and 23 geographic areas respectively. Participation in the scheme is compulsory. The targets have been generally the same for successive years. In 2009 TRAI issued the new *"Standards of Quality of Service of Basic Telephone Service (Wireline) and Cellular Mobile Telephone Service Regulations,2009"* following a consultation process launched on 18th December 2008. In the new regulation, some of the previous parameters have been deleted as they are considered no longer relevant in the present competitive scenario. Moreover the regulation provides a more extensive definition of each parameter and their measurement methodology.

[22] ITU (doc. 2 -Final Paper) Global Seminar on Quality of Service and Consumer Protection, Geneva (31 Aug-1Sep. 2006), *ICT Quality of Service Regulation: Practices and Proposals.*

- ***Singapore***

IDA has established a set of minimum QoS standards for key services (PLMN, Wired Telecommunication Services, Internet Access Services, Public Radio Paging Services, Public Trunked Radio Services and Postal Services). Service providers are required to submit quarterly reports of their service quality and IDA monitors their performance to ensure compliance. IDA publishes the QoS performance of service providers with a view to helping customers make informed decisions while choosing service providers[23]. Surveys are also conducted to monitor customer satisfaction and to get customer feedback on how operators' service can be further improved. Results of these surveys are used by IDA to instruct operators to correct their weaknesses and also to fine-tune their own standards of requirement for operators. IDA has ceased the publication of QoS reports of paging and trunked radio services with effect from 1 January 2005; and Internet access services with effect from 1 September 2005. To ensure operators' compliance, IDA has also established a penalty framework which imposes a fine of $5000 per primary indicators (standards having wider public impact) and $1000 per secondary indicators per month[24].

- ***UK***

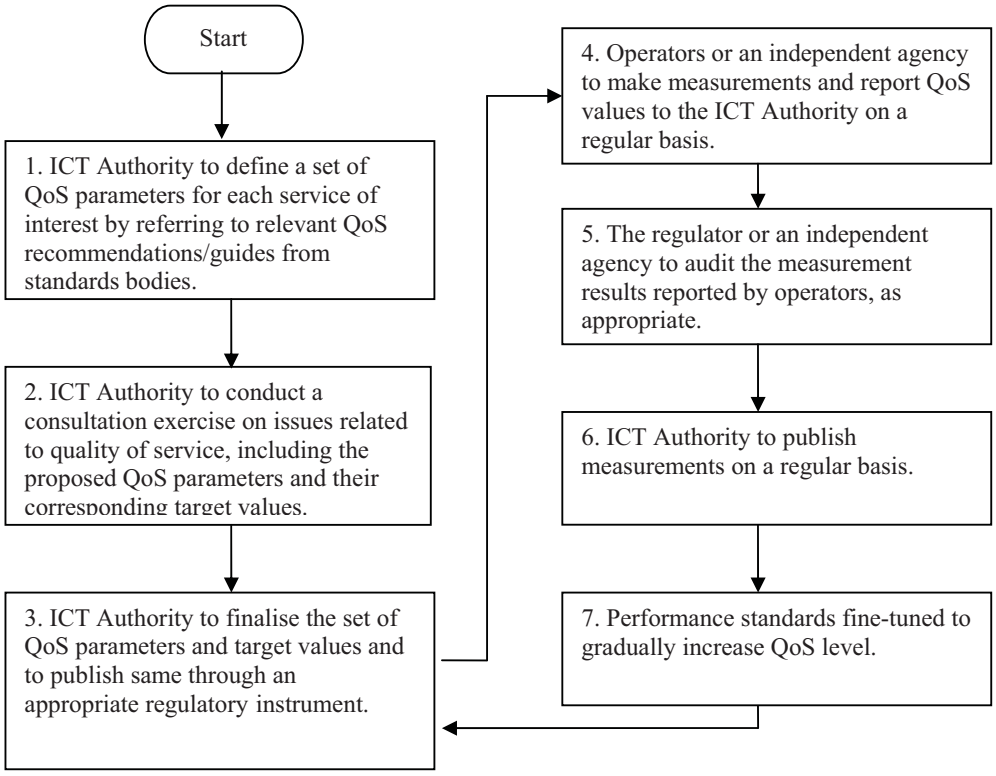
OFCOM is of the view that a successful co-regulatory initiative that provides adequate, timely and comparable QoS information will help to promote investment and innovation in the provision of services and will also promote competition. All consumers should be able to take advantage of the benefits of transparent and comparable information and the competitive benefits that this should bring; this includes consumers in different parts of the UK, from different income groups, and for those with a disability. In this line of thought, OFCOM published in September 2004, a "*Statement on providing Quality of Service information to consumers*" and a "*Consultation on quality parameters*" including a "*Notification and Draft Direction*". The test parameters specified in the Consultation were based on ETSI EG 201 769 (2000-10). Following the responses received, OFCOM made a direction on 27 February 2005 that places a requirement on fixed line Communication Service Providers to report QoS information, derived from test parameters specified in the Consultation of 2004, to consumers.

[23] ITU (doc. 10) Global Symposium for Regulators, Hong Kong, China, 7-8 December 2002, *New Performance Indicators Issues for Converged Services-A Report from the Asia-Pacific Telecommunity (APT) Forum on Telecommunication Policy and Regulation held in Kuala Lumpur, Malaysia from 17-18 May 2002.*

[24] http://www.ida.gov.sg

4. PROPOSED QOS MONITORING FRAMEWORK

In this section of the consultation paper, a QoS monitoring framework is proposed by the ICT Authority.



Steps 1 and 2 of the above flowchart have been undertaken by way of the present consultation paper.

Q.1 Do you agree that the Authority should set performance targets and require operators to meet those values?

Q.2 Do you agree with the proposal of the Authority to publish measurements?

4.1 Proposed Quality of Service Parameters and Target Values

In this sub-section the ICT Authority proposes a set of QoS parameters and target values for the following services, namely:-fixed telephony; mobile telephony; international telephony; and internet services respectively. In making the said proposal, the methodology used by the Authority has been to apply the rule of the QoS matrix of ITU-T Rec. G.1000 in order to identify the Service Functions or Performance Criteria for each service, from which the main QoS parameters have then been derived. Reference has also been made to QoS standards from ETSI and ITU (as detailed in Annex A) in order to define the QoS parameters. The measurements and target values

recommended by standards bodies as well as those implemented by regulators in other countries (e.g. India, Malaysia and Singapore) are reported, where available, and may be used as benchmarks. This information is then used to propose a list of QoS parameters and their corresponding target values for each service.

4.1.1 Parameters for the Fixed Telephony Service

For the fixed telephony service, the main service functions considered are "Connection Quality", "Service Management" and "Billing". The parameters reported under the service function "Connection Quality" are:- call set-up time; unsuccessful call ratio; and transmission delay. Under the service function "Service Management" the parameters reported are: - supply time for initial connection; fault rate; and fault repair time. Under the service function "Billing" the main parameters reported are:- billing complaints and complaint resolution time. Other parameters included are directory enquiry and payphone services respectively.

The following parameters and target values are thus proposed for the fixed telephony service:

Definition	Measurement	International Benchmarks	Proposed Target
Supply time for initial connection			
The duration from the instant a valid service order being received by a direct service provider to the instant a working service is made available for use. This includes cases where a new access line is installed; an existing access line is taken over by another customer; an upgrade on the existing line.	-Time by which the fastest 95 % and 99 % of orders are completed (in elapsed days); - % of orders completed by the date agreed with the customer; Measurement to be made according to **ETSI EG 201 769-1**	*India* Provision of telephone after registration of demand **:** 100 % in 7 days *Malaysia* Installation Orders : - 80% within 24 hrs; - 90% within 48hrs; 100%within 7 business days. *Singapore* Installation time: 95% within 5 working days or date specified by customer	100% of orders to be completed within 7 working days
Local call set-up time (s)			
The period starting when the address information required for setting up a call is received by the network (e.g. recognised on the calling user's access line) and finishing when the called party busy tone or ringing tone or answer signal is received by the	Post Selection Delay (in seconds) **ITU-T Rec. E.721** Mean value (in seconds) Measurements to be made according to **ETSI EG 201 769-1**	The mean value of the Post Selection Delay (en bloc) at normal load should be 3.0sec **ITU-T Rec. E.721**	Mean value of local call set-up time: less than 5sec

calling party.			
Unsuccessful call ratio			
Ratio of unsuccessful calls to the total number of call attempts in a specified time period. An unsuccessful call is call attempt to a valid number, properly dialled following dial tone, where neither called party busy tone, nor ringing tone, nor answer signal is recognised on the access line of the calling user within 30 seconds from the instant when the address information required for setting up a call is received by the network.	Probability of end-to-end blocking **ITU-T Rec. E.721** Percentage of unsuccessful calls. Measurements to be made according to **ETSI EG 201 769-1**	*India* Call completion rate: In Short Term >55% ; In Intermediate Term >60%; In Long Term >65% The mean value for probability of end-to-end blocking at normal load should be 2% **ITU-T Rec. E.721**	
Transmission Delay (ms)			
Includes delay due to equipment processing as well as propagation delay.	End-to- End Transmission Time **ITU-T Rec. G.114**	One way transmission time should be less than 150 ms **ITU-T Rec. G.114**	One way transmission time: less than 150 ms
Fault Rate			
A fault report is a report of disrupted service or degraded service that is made by a customer and is attributable to the network of the service provider or any interconnected public network, and that is not found to be invalid. Faults in any equipment on the customer side of the network termination point are excluded.	Fault reported per access line per year Measurements to be made as per **ETSI EG 201 769-1**	*India* Fault incidence/100 subscribers per month shall be less than 3 *Malaysia* No of complaints for every 1000 lines shall not exceed 500 complaints over one year *Singapore* no. of faults reported per 100DELs should be less than 0.5	no. of faults reported per 100DELs should be less than 0.5 during the reporting period.
Fault repair time			
The duration of the instant a fault has been notified by the customer to the service provider to the instant when the service has been restored to the normal working order.	Time by which the fastest 80 % and 95 % of valid faults on access lines are repaired (in hours) Measurements to be made as per **ETSI EG 201 769-1**	*India* Faults repaired by next working day In Short term:>85% ; In Intermediate term:>87%; In Long term:>90% Mean Time To Repair (MTTR) In Short term:<24hrs ; In Intermediate term:<12hrs;	90% of repairs within 24hrs; 95% of repairs within 48hrs

		In Long term:<8hrs *Malaysia* Time to repair:- 80% within 24 hrs; 90% within 48hrs MTTR; 3hrs Singapore Time to repair:- 90% within 24hrs; 95%within 48hrs	
Billing Complaints			
The proportion of bills resulting in a customer complaining about the correctness of a given bill.	Percentage of bills resulting in a customer complaint. Measurements to be made as per **ETSI EG 201 769-1**	*India* Billing complaints Short term:<0.2% ; Intermediate term:<0.15%; Long term:<0.1% *Malaysia* Billing complaints: <2%	Percentage of bills resulting in customer complaint should be less than 2%
Complaint Resolution Time			
Time taken for a service provider to resolve a complaint.	The time by which the fastest 80 % and 95 % of complaints have been resolved or % of complaints resolved any time stated as an objective by the service provider Measurements to be made as per **ETSI EG 202 057-1**	*Malaysia* 90% resolved within15 working days; 95%within30 working days *Singapore* 100% resolved within 5 working days	100% resolved within 5 working days
Response time for directory enquiry service			
Duration from the instant when the address information required for setting up a call is received by the network (e.g. recognised on the calling user's access line) to the instant the human operator or an equivalent voice-activated response system answers the calling user to provide the number information requested.	- Mean time to answer -% answered within 20 seconds Measurements to be made as per **ETSI EG 201 769-1**	*India* 85%-95% of enquiry calls answered in less than 10sec; 80% of enquiry calls answered within 20s. *ITU Rec* 90% of inquiry to be answered within 10s. An initial acknowledgement to a request of a subscriber should however be given within 5 seconds.	90% of inquiry to be answered within 10s.
Public payphones in working order			
The proportion of public pay-telephone in full	% of public payphones in working order		

working order i.e. the user is able to make use of the services advertised as normally available.	Measurements to be made as per **ETSI EG 201 769-1**		

Q.3 Do you agree with the proposed set of QoS parameters for fixed telephony services?

Q4. Do you agree with the target values proposed for fixed telephony services? If not, please suggest other benchmarks.

4.1.2 Parameters for Mobile Telephony Services

For mobile telephony service, the main performance criteria as detailed under **ETSI EG 202 057-3** are "Network Coverage", "Network Availability"," Service Accessibility" and "Service Retainability". The definition of these terms can be found at Annex A.2.

Under the criteria "Network Coverage" the parameter service coverage is reported in terms of signal strength. Under the performance criteria "Service Accessibility and Retainability", the main parameters reported hereunder are: - call set-up time; blocked call ratio; and dropped call ratio.

The following parameters and target values are thus proposed for the mobile telephony service:

Definition	Measurement	International Benchmarks	Proposed Target
Service Coverage			
Percentage of test route over which a minimum signal strength of -100 dBm is achieved	Measurement to be made as per **ETSI EG 202 057-3**	*India* In door >= -75 dBm In-vehicle>= -85 Bm Out door- in city >= -95 dBm *Singapore* Percentage of test route over which a minimum signal strength of -100 dBm is achieved Street: >95% In -building: >85%	On Street: >95% In -building: >85%
Network Availability			
Network availability gives an indication about the downtime of the MSC/BS but excludes all planned service downtime for any maintenance or software upgrade work.	Measurement to be made as per **ETSI EG 202 057-3**		
Blocked Call Rate			
Percentage of unsuccessful calls. An unsuccessful	Percentage of unsuccessful calls.	*India* SDCCH Congestion should be	

call is call attempt to a valid number, while in a coverage area, where neither the call is answered nor the called party busy tone nor ringing tone is recognised at the access of the calling user within 40 seconds from the instant when the last digit of the destination subscriber number is received by the network.	Measurements to be made as per **ETSI EG 202 057-3** Probability of end-to-end blocking **ITU-T Rec. E.771**	less than 0.5% TCH Congestion should be less than 2% *ITU-T Rec. E.771* The average target value for the probability of blocking on radio links: 10^{-2} The average target value for the probability of blocking on PLMN-to-fixed network: $(5)(10^{-3})$	
Call set-up time			
The call set up time can be defined as the time interval from the instant the user initiates a connection request until the complete message indicating call disposition is received by the calling terminal. The call set up time comprises the post-selection delay (authentication, transfer of routing number, paging) and the synchronisation delays of the interworking elements of the network.	Post Selection Delay (in seconds) **ITU-T Rec. E.771** Mean value (in seconds) Measurement to be made as per **ETSI EG 202 057-3**	*India* Service Access Delay: 9-20 sec depending upon paging attempts. (Ave of 100 calls = <15sec) *Singapore* Average call set-up time should be below than 5s *ITU-T Rec. E.771* The mean value of the Post Selection Delay at normal load: Fixed to Mobile: 9 sec ; Mobile to Mobile: 8.5 sec ; Mobile to Fixed: 5.5sec PSD for GSM: less than 5sec	
Dropped Call Ratio			
Proportion of calls, which once they have been correctly established and therefore have an assigned traffic channel, are dropped or interrupted prior to their normal completion by the user, the cause of the early termination being with the operator's network.	Percentage of successfully established calls that are dropped. Measurement to be made as per **ETSI EG 202 057-3**	*India* Dropped calls should be less than 3% *Malaysia* Dropped calls should be less than 5% for intra network calls *Singapore* Dropped calls should be less than 5% *ITU-T Rec. E.771* The average target value for Probability of unsuccessful land cellular handing over:$(5)(10^{-3})$	Percentage of dropped calls should be less than 5%

Q.5 Do you agree with the proposed set of QoS parameters for mobile telephony services?

Q.6 Do you agree with the target values proposed for mobile telephony services? If not, please suggest other benchmarks.

4.1.3 Parameters for International Telephony Services

The main performance criteria considered under International Telephony services are "Call Connectivity and "Speech Quality". The QoS parameters reported under "Call Connectivity" are ASR; NER; and Call set-up time. The QoS parameters reported under "Speech Quality" are the R-value and MOS. The following parameters and target values are thus proposed for the international telephony service:

Definition	Measurement	International Benchmarks	Proposed Target
ASR			
The relationship between the number of seizures that result in an answer signal and the total number of seizures.	Percentage of seizures resulting in answer signal **ITU-T Rec. E.425**	As an indication of "worst-case" limit, reference can be made to the effective call attempt specified by **ITU-T Rec. E.426** as follows: Effective call attempts should be more than 60%. For active test calls placed by some test systems, some typical value specified are: ASR: ≥ 80%. NER: ≥ 90%.	ASR: ≥ 80%.
NER			
The relationship between the number of seizures and the sum of the number of seizures resulting in either an answer message, or a user busy, or a ring no answer, or in the case of ISDN a terminal rejection/unavailability	Percentage of seizures resulting in answer signal or user failure **ITU-T Rec. E.425**	As an indication of "worst-case" limit, reference can be made to the effective call attempt specified by **ITU-T Rec. E.426** as follows: Effective call attempts should be more than 60%. For active test calls placed by some test systems, some typical value specified are: NER: ≥ 90%.	
Call set-up time			
The call set up time can be defined as the time interval from the instant the user initiates a connection request until the complete message indicating call disposition is received	Mean values (in seconds) **ITU-T Rec. E.721** **ITU-T Rec. E.771**		

by the calling terminal.			
R-value			
Transmission Rating Factor R is the primary output of the E-model defined in ITU-T Rec. G.107/ G.108		For best quality: 90≤ R < 100 For high quality: 80 ≤ R < 90 For medium quality:70 ≤ R < 80 **ITU-T Rec. G.109**	R-value should be greater or equal to 80.
MOS			
Values on a predefined scale that subjects assign to their opinion of the performance of the telephone transmission system used either for conversation or for listening to spoken material. Apart from subjective opinion, the abbreviation "MOS" is also used for scores that originate from objective models or network planning models.	Objective assessment based on conversion of R-value. **ITU-T Rec. G.107** Subjective assessment based on use of telephone user surveys. **ITU-T Rec. P.82**	MOS should be greater than 4 **ITU-T Rec. P.82** **ITU-T Rec. G.107**	MOS should be greater than 4

Q.7 Do you agree with the proposed set of QoS parameters for international telephony services?

Q.8 Do you agree with the target values proposed for international telephony services? Could you please suggest benchmarks where unspecified.

4.1.4 Parameters for Internet Services

As explained earlier, for the Internet-based applications user's perspective of quality and reliability may be characterised by the Accessibility (A), Continuity (C) and Fulfilment (F) framework. It is to be noted that users' expectations of service quality of the Internet vary from application to application. Therefore the approach for identifying and defining performance parameters would be to define the ACF parameters impacting the quality of the specified transaction for each of the corresponding applications.

The QoS parameters proposed in the following table are those meant for assessing the quality of Internet Access as perceived by the user. Internet Access should primarily be understood as physical access to the core of the Internet, i.e. the access includes all functionalities that are needed to enable the user to establish connections to other entities within the Internet and engage advanced services (ETSI EG 202 057-4).

Definition	Measurement	Benchmarks	Proposed Target
Successful log-in ratio			
The ratio of successful log-ins to access the Internet when both the access network and the ISP network are available in full working order	% Successful log-ins **ETSI EG 202 057-4** **ETSI TS 102 250-2**		Dial-up users must be able to connect at least 90% of the time Leased line users must be able to connect at least 99% of the time
Delay (one way transmission time)			
The delay is half the time in milliseconds that is needed for an ICMP Echo Request/Reply (Ping) to a valid IP address	Half the time in milliseconds that is needed for an ICMP Echo Request/Reply (Ping) to a valid IP address. Measurement provided as the Mean value of the delay (in ms) **ETSI EG 202 057-4**	*Singapore* National network latency (two-way) ≤85 ms International network latency (two-way) ≤300 ms For international network latency, the measurement is carried by sending a PING packet from the test point to the first international point of presence. *ITU-T Rec. Y.1541.* Mean upper bound for each class of service is specified in For example the mean upper bound specified for Real-time, highly interactive applications sensitive to jitter is 100ms.	One way transmission time (international) should be less than or equal to 150 ms
Loss Ratio			
Ratio of packets lost to the total packets transmitted between two designated points.	**ITU-T Rec. Y.1541.**	Loss ratio for each class of service is generally $<10^{-3}$ **ITU-T Rec. Y.1541.**	Loss ratio for any class of service should be less than 10^{-3}
Unsuccessful data transmission ratio			
The ratio of unsuccessful data transmissions to the total number of data transmission attempts in a specified time period. A data transmission is successful if a test file is transmitted completely and with no errors.	% Unsuccessful data transmission **ETSI EG 202 057-4**		

Data transmission speed achieved			
The data transmission rate that is achieved separately for downloading and uploading specified test files between a remote web site and a user's computer.	-Maximum data transmission rate in kbit/s achieved; -Minimum data transmission rate in kbit/s achieved; -mean value and standard deviation of the transmission rate in kbit/s achieved; **ETSI EG 202 057-4**		Data transmission achieved should be at least 80% of that advertised by the service provider.

Note: **ETSI EG 202 009-2 (2007-01)** may be consulted for user related parameters on a service-specific basis. The guide includes parameters with respect to web browsing, web page hosting, email, etc.

Q.9 Do you agree with the proposed set of QoS parameters for Internet services?

Q.10 Do you agree with the target values proposed for Internet services? If not, please suggest other benchmarks.

4.2 Proposal for Measurement and Auditing of Results

Once the list of QoS parameters and their target values have been agreed upon, it is proposed that same be formalised in an appropriate regulatory instrument, e.g. some directives on QoS. The next important step of the monitoring process is then the measurement of the QoS parameters and subsequent reporting and auditing of results as may be appropriate.

The following options are proposed for QoS measurements and auditing:

(i) Measurements made by operators and audited by the regulator;

(ii) Measurements made by operators and audited by an independent agency;

(iii) Measurements made by an independent agency- in which case no further auditing would be required.

4.2.1 Measurements made by Operators

Where it is agreed that operators make the measurements, the way these measurements are to be made and the format in which they should be reported to the Authority should be clear and agreeable to all; since even with uniform parameters the way of collecting and collating data may vary for different operators. Some reference measurements methods recommended by ETSI have been reported in the previous section.

Only part of the measurements may be audited either at random or upon complaints or suspects of falsification. Prior to auditing, the following issues need to be addressed:

- Determine the main QoS parameters to be audited for the services of interest.
- Define in details the methodology for auditing.
- Determine the sampling methodology for auditing.

(i) *Auditing Activities*

It is proposed that the main activities under this audit to include:-

- Auditing the raw data/records maintained by service providers to check the veracity of data reported by the latter.
- Conducting drive-around tests (either operator-assisted or independent drive tests) to verify quality of service especially for mobile services. Parameters such as dropped call ratio, unsuccessful call ratio, blocked call rate, voice quality may be determined by this method. It is proposed that the drive-around be done at similar times, between similar places and in similar circumstances for all mobile telephony operators.
- Performing live tests on a sample basis to check parameters related to efficiency of customer care e.g. service provision, complaint resolution time, directory enquiry, etc.
- Making live measurements to assess the network performance of service providers through live figures recorded from servers over, for instance, a three-day period.

(ii) *whether auditing is to be done by the regulator or an independent external agency*;

In case it is agreed to appoint an external independent agency for the auditing job, a tender process should be initiated by the Authority. It is proposed that requirement of this tender be worked out by the Authority in consultation with other stakeholders.

In the event that the Authority itself carries out the auditing job, then the necessary monitoring equipment should be purchased by the Authority. The technical requirements of the monitoring equipment should be worked out and a tender process initiated accordingly.

4.2.2 Measurements outsourced to independent agency

The measurement exercise may otherwise be outsourced to an independent agency. One approach may entail the Authority contracting an industry expert in QoS measurement to design, build and operate a test platform in Mauritius, with the objective of continuously monitoring and reporting on the service quality of different operators.

Q.11 Should measurements be made by operators or outsourced to an independent agency?

Q.12 If auditing is to be done, should it be done by the regulator or an independent entity?

Q.13 In the event an independent auditor is to be appointed, what are the main criteria to consider for the said appointment?

Q.14 To what extent should the Authority specify how audits should be carried out?

Q.15 What are the main measurements that need auditing?

Q.16 How frequently should an audit be carried out?

Q.17 Any other suggestions or comments?

ANNEX A- QUALITY OF SERVICE STANDARDS/RECOMMENDATIONS

A.1 Fixed Telephony Services

A.1.1 Definition of QoS Parameters for the Fixed Telephony Service

In accordance with EU directives, European Member States are required to ensure publication of up-to-date information on QoS for the universal service, on the parameters listed hereunder, which are defined in **ETSI EG 201 769-1** as follows:-

- ***Supply time for initial connection***

The duration from the instant a valid service order being received by a direct service provider to the instant a working service is made available for use. This includes cases where a new access is installed; an existing access line is taken over by another customer; an upgrade on the existing line. This however excludes cancelled orders and cases where a customer changes operator and the new operator, who is responsible for reporting supply time uses an unbundled local loop as the access line.

- ***Fault rate per access line***

A fault report is a report of disrupted service or degraded service that is made by a customer and is attributable to the network of the service provider or any interconnected public network, and that is not found to be invalid. Faults in any equipment on the customer side of the network termination point are excluded.

- ***Fault Repair Time***

The duration of the instant a fault has been notified by the customer to the published point of contact of the service provider to the instant when the service element or service has been restored to the normal working order. This applies only to services that offer the "standard repair" times to customers and exclude cases where higher maintenance fees or lower fees are applicable for either higher or lower repair levels respectively.

- ***Unsuccessful call ratio***

Unsuccessful call ratio is defined as the ratio of unsuccessful calls to the total number of call attempts in a specified time period. An unsuccessful call is call attempt to a valid number, properly dialled following dial tone, where neither called party busy tone, nor ringing tone, nor answer signal is recognised on the access line of the calling user within 30 seconds from the instant when the address information required for setting up a call is received by the network.

- ***Call set-up time***

The call set-up time is the period starting when the address information required for setting up a call is received by the network (e.g. recognised on the calling user's access line) and finishing when the called party busy tone or ringing tone or answer signal is received by the calling party. Where overlap signalling is used the measurement may start when sufficient address information has been received to allow the network to begin routing. Unsuccessful calls are excluded.

- ***Response times for operator services***

The duration from the instant when the address information required for setting up a call is received by the network (e.g. recognised on the calling user's access line) to the instant the human operator answers the calling user to provide the service requested. The period in this definition includes waiting times and times for going through voice response systems to reach the operator. Services provided wholly automatically, e.g. by voice response systems as well as emergency services are excluded.

- ***Proportion of coin and card operated public pay-telephones in working order***

The proportion of public pay-telephone in full working order i.e. the user is able to make use of the services advertised as normally available. A public pay-telephone that is capable of accepting both coin and card payment should be regarded as not being in working order when it is unable to accept further coins because, for example, the coin box is full.

- ***Bill correctness complaint***

The proportion of bills resulting in a customer complaining about the correctness of a given bill.
A bill correctness complaint is an expression of dissatisfaction with a bill received from a customer.

The ***Response Time for Directory Enquiry*** is also defined under **ETSI EG202 057-1** as the duration from the instant when the address information required for setting up a call is received by the network (e.g. recognised on the calling user's access line) to the instant the human operator or an equivalent voice-activated response system answers the calling user to provide the number information requested.

The measures for each of the QoS parameters are also specified in **ETSI EG 201 769-1**, as reported the following table.

Table A1: Parameters and Measures for fixed telephony services

Parameter	Measure
Supply time for intial connection	-Time by which the fastest 95 % and 99 % of orders are completed (in elapsed days); - Percentage of orders completed by the date agreed with the customer; -Hours for taking orders and stated accuracy for appointments.
Faults rate	Faults/access line/year
Fault repair time	- Time by which the fastest 80 % and 95 % of valid faults on access lines are repaired (in hours) - Percentage repaired on target date for faults on access lines - Time to repair 80 % and 95 %, and %age on target date for all other faults - Hours for reporting faults and stated accuracy for appointments
Unsuccessful call ratio	Percentage for national and international calls (separately)
Call set-up time	Mean value (in seconds) Time in seconds within which the fastest 95 % of calls are set-up Values should be provided separately for national and international calls.
Response time for operator services	- Mean time to answer - % answered within 20 seconds
Response time for directory enquiry services	- Mean time to answer - % answered within 20 seconds
Public-pay telephones in working order	% in working order
Bill correctness complaints	% of bills resulting in a customer complaint

ITU-T Recommendation E.721 proposes the following traffic GOS parameters for circuit-switched calls in ISDN (may also be applicable to PSTN). It is to be noted that delays or blocking

within the customer premises equipment or subscriber terminal are not part of the following definitions for GOS parameters.

- ***Pre-selection delay (overlap sending)***

Pre-selection delay (overlap sending) is defined as the time interval from the instant the first bit of the SABME message is passed by the calling terminal to the access signalling system until the last bit of the SETUP ACK message is received by the calling terminal.

- ***Post-selection delay***

Post-selection delay (overlap sending)

Post-selection delay (overlap sending) is defined as the time interval from the instant the first bit of the INFORMATION message containing the last selection digit is passed by the calling terminal to the access signalling system until the last bit of the first message indicating call disposition is received by the calling terminal (ALERTING message in case of successful call).

Post-selection delay (en bloc sending)

Post-selection delay (*en bloc* sending) is defined as the time interval from the instant the first bit of the initial SETUP message containing all the selection digits is passed by the calling terminal to the access signalling system until the last bit of the first message indicating call disposition is received by the calling terminal (ALERTING message in case of successful call).

Note1: en-bloc signaling is when complete called number is included in the IAM while overlap signaling is when IAM includes only those digits that are needed for outgoing trunk selection at the next exchange.

Note 2: Post-selection delay comprises basically of delays associated with Initial Address Message (IAM), Address Complete Message (ACM) as well as processing delays of exchanges involved **[ITU Rec E.723]**.

- ***Answer signal delay***

Answer signal delay is defined as the time interval from the instant that the called terminal passes the first bit of the CONNECT message to its access signalling system until the last bit of the CONNECT message is received by the calling terminal.

- ***Call release delay***

Call release delay is defined as the time interval from the instant the first bit of the DISCONNECT message is passed by the user terminal which terminated the call to the access signalling system, until the last bit of the RELEASE message is received by the same terminal (indicating that the terminals can initiate/receive a new call).

- ***Probability of end-to-end blocking***

The probability of end-to-end blocking is the probability that any call attempt will be unsuccessful due to a lack of network resources. It is to be noted that:

-Blocking because of lack of B-channels between the customer premises equipment and the network is not part of this definition.

-The lack of control plane resources during the call setup phase may also contribute to end-to-end blocking. This aspect is for further study.

A.1.2 Target Values for GOS Parameters in Fixed Telephony Service

ITU-T Recommendation E.721 specifies some target values for GOS parameters for circuit-switched services. Call set-up delay is expressed as Post Dialling Delay in some standards. In

ISDN, the equivalent term is designated as Post-Selection Delay[25]. The call set-up delay for local, toll and international connections have been specified in the aforesaid recommendation.

Note: **ITU-T Recommendation E.431** can be referred for an indication of the average contribution to Post Dialling Delay of different signalling types:

- CCITT No. 5: 5 seconds
- CCITT No. 6: 3 seconds
- CCITT No. 7: less than 3 seconds (for further study)
- CCITT R2: 5 second

Table A2: Target Values for GOS parameters for circuit-switched services in the evolving ISDN[26]

GOS parameter	Normal load		High load	
	Mean	95%	Mean	95%
Pre-selection delay	0.6 sec	1.0 sec	1.0 sec	2.0 sec
Call release delay	0.4 sec	0.6 sec	0.6 sec	1.0 sec
Post-selection delay (*en bloc* sending)				
• Local connection	3.0 sec	6.0 sec	4.5 sec	9.0 sec
• Toll connection	5.0 sec	8.0 sec	7.5 sec	12.0 sec
• International connection	8.0 sec	11.0 sec	12.0 sec	16.5 sec
Answer signal delay				
• Local connection	0.75 sec	1.5 sec	1.0 sec	2.0 sec
• Toll connection	1.5 sec	3.0 sec	2.0 sec	4.0 sec
• International connection	2.0 sec	5.0 sec	3.3 sec	6.5 sec
Probability of end-to-end blocking				
• Local connection	2%	NA	3%	NA
• Toll connection	3%	NA	4.5%	NA
• International connection	5%	NA	7.5%	NA
NA Not applicable.				

NOTE 1 – Except for mean delay at normal load, all other target values are provisional and require further review.

NOTE 2 – The concept of "normal load" and "high load" in a network that may be geographically distributed with non-coincident busy hours needs further study.

NOTE 3 – International connections are assumed to include one satellite link in the user as well as the control (SS No. 7) plane.

NOTE 4 – For calls requiring database lookup, an additional delay will need to be added to the post-selection delay for each database lookup. This additional delay will depend on the type of connection used for database lookup.

NOTE 5 – The subject of allowable end-to-end blocking for the worst treated traffic relations, for instance an all final route path, is for further study.

NOTE 6 – The target values in this table are to be interpreted as design objectives.

A.2 Mobile Telephony Services

A.2.1 Definition of QoS Parameters for the Mobile Telephony Service

[25] ITU-T Recommendation E.600
[26] Source : ITU-T Recommendation E.721

The **ETSI EG 202 057-3 V1.1.1 (2005-4)** may be referred to for QoS parameters specific to the PLMN. As stipulated in the said document, the performance criteria to be considered for the PLMN are as follows:-

- Network Coverage: (Is *there sufficient radio signal strength to make and receive calls?)*It is the ability to provide services where they are required by the user and is normally predicted from radio modelling and checked by the network operator;
- Network Availability: It is perceived by the user as a lack of service where it was expected;
- Service Accessibility: It is the accessibility to a service where there is network access. Service access may not be possible due to, for instance, unavailability of radio channels;
- Service Retainability: Ability to retain service after it has been successfully established.

The parameters defined under this guide are:-

- ***Unsuccessful Call Ratio***

Unsuccessful call ratio is defined as the ratio of unsuccessful calls to the total number of call attempts in a specified time period.
An unsuccessful call is call attempt to a valid number, while in a coverage area, where neither the call is answered nor the called party busy tone nor ringing tone is recognised at the access of the calling user within 40 seconds from the instant when the last digit of the destination subscriber number is received by the network.

- ***Dropped Call Ratio***

It is the proportion of incoming and outgoing calls, which once they have been correctly established and therefore have an assigned traffic channel, are dropped or interrupted prior to their normal completion by the user, the cause of the early termination being with the operator's network.

The objective of this parameter is to obtain a measurement of the ability of the mobile network used by the service provider to maintain a call once it has been correctly established. This parameter measures failures in coverage, problems with the quality of signal, network congestion and network failures.

The **ETSI ETR003** paper reviews the factors that affect the QoS as perceived by the user. For a mobile service, the most significant are **call set up delay**, **probability of blocking** and the **effective bandwidth**. These factors can be both network and terminal dependent.

The ***call set up delay*** can be defined as the time interval from the instant the user initiates a connection request until the complete message indicating call disposition is received by the calling terminal.

The call set up delay comprises the ***post-selection delay*** (authentication, transfer of routing number, paging) and the synchronisation delays of the interworking elements of the network. (*In the case of GSM, the post-selection delay is usually less than 5 seconds, but acceptable system synchronisation delays of the interworking elements for data calls via PSTN are difficult to achieve. Solutions with ISDN seem more adequate to the GSM protocol architecture*).[27]

The lack of network resources at the user plane as well as the control plane can cause unsuccessful call attempts. The probability of ***end-to-end blocking*** can occur at the radio link, at the interworking units between the mobile and the fixed networks or at the transit network.

[27] ITU-T RecommendationE.771

The concept of ***effective bandwidth*** has been developed over recent years to provide a measure of resource usage, which adequately represents the trade-off between sources of different types, taking account of their varying statistical characteristics and the QoS requirements. However, there is not yet a generally accepted definition of an effective bandwidth. The quality of the radio link could be improved by the operator in increasing the cell density, although intrinsic system limits (radio spectrum, signalling speed, etc.) increase the planning complexity when the traffic increases dynamically. Moreover, additional operational cost and extension of licence are the main preoccupation of the mobile operators.

ITU-T Recommendation E.771 proposes network Grade of Service (GOS) parameters for current and evolving land mobile services. The definitions of these traffic GOS parameters, specified for mobile circuit switched, services are given below. The delay GOS parameters are based on the message flows in Recommendation Q.931 (DSS 1) and Signalling System No. 7 (ISUP) protocols.

- **Post-selection delay**

Post-selection delay (*enbloc* sending) is defined as the time interval from the instant the first bit of the initial SETUP message containing all the selection digits is passed by the calling terminal to the access signalling system until the last bit of the first message indicating call disposition is received by the calling terminal (ALERTING message in case of successful call).
NOTES
-In the case of mobile-originated (i.e. M-F or M-M) connections, the starting instant is the activation of the "Send" key in the calling terminal.
-In case of automatic answering terminals, the ALERTING message is replaced by the CONNECT message.
-The post-selection delays comprises delays associated with operations such as authentication, paging/alerting and transfer of routing number.

- ***Answer signal delay***

Answer signal delay is defined as the time interval from the instant that the called terminal passes the first bit of the CONNECT message to its access signalling system until the last bit of the CONNECT message is received by the calling terminal.

- ***Call release delay***

Call release delay is defined as the time interval from the instant the DISCONNECT message is passed by the user terminal which terminated the call to the access signalling system, until the RELEASE message is received by the same terminal (indicating that the terminals can initiate/receive a new call).

- ***Probability of end-to-end blocking***

The probability of end-to-end blocking is the probability that any call attempt will be unsuccessful due to a lack of network resources. This includes the following:
– probability of blocking on radio links;
– probability of blocking on PLMN-to-fixed network circuits;
– probability of blocking in the fixed (transit) network,

- ***Probability of unsuccessful land cellular handover***

This parameter is the probability that a handover attempt fails because of lack of radio resources in the target cell, or because of a lack of free resources for establishing the new network connection. The failure condition is based either on a specified time interval since the handover request was first issued or on a threshold on signal strength.

In addition to the above, **speech quality** is also important. It is important to note that speech in GSM is coded at a lower rate than in the PSTN-13kbps compared to 64kbps. This is an attempt to

pack in more users on a given bandwidth; hence quality is lower than in PSTN. However the coding algorithm used is able to predict future values and sends only correction signals, reducing bandwidth considerably with only a small loss of perceived speech quality.

A.2.2 Target Values for GOS Parameters in Mobile Services

ITU-T Rec. E.771 specifies target values that apply primarily to second generation digital mobile systems. They should generally be considered as minimum requirements for evolving third generation systems, i.e. the target GOS for third generation systems should be equal to, if not more stringent than, the targets specified in this Recommendation.

Table A3: Proposed (average) target values for post selection delays[28]

Post-selection delay (secs)			
Call type	F-M	M-F	M-M
Authentication/ ciphering	0.0	2.5	2.5
Paging/alerting	4.0	0.0	4.0
Routing number transfer	2.0	0.0	2.0
Post-selection delay (fixed network)			
local connection	3.0	3.0	3.0
toll connection	5.0	5.0	5.0
international connection	8.0	8.0	8.0
Total			
local connection	9.0	5.5	11.5
toll connection	11.0	7.5	13.5
international connection	14.0	10.5	16.5

NOTES

1 The following assumptions apply:
- all values represent mean delays;
- an M-M call uses PSTN/ISDN as the transit network;
- for F-M and M-M calls the called terminal is already authenticated;
- the percentage of M-M calls is generally very low (less than 10%).

2 Values in the table relate to normal traffic conditions. Target values for overload conditions are for further study.

3 The influence of the satellite segment in satellite-based land mobile networks is for further study.

4 Individual component delays for authentication, paging, routing number transfer are for reference only and do not represent GOS limits, only the total post selection delay values are GOS targets.

The values in the above table include the time consumed in acquiring the radio resources. Typical (average) times for acquiring radio resources in second generation systems, as related to the whole post-selection process range from 2-3 seconds, depending on the operating environment

Table A4: Proposed (average) target values for answer signal delays

[28] Source: ITU-T Recommendation E.771

Answer signal delay (secs)			
Call type	F-M	M-F	M-M
local connection	1.0	1.0	1.25
toll connection	1.75	1.75	2.0
international connection	2.75	2.75	3.0

NOTES

1 The following assumptions apply:
- all values represent mean delays;
- an M-M call uses PSTN/ISDN as the transit network;
- target values apply to first and second generation public land mobile networks;
- the percentage of M-M calls is generally very low (less than 10%).

2 Values in the table relate to normal traffic conditions. Target values for overload conditions are for further study.

3 The influence of the satellite segment in satellite-based land mobile networks is for further study.

Table A5: Proposed (average) target values for call release delays

Call release delay (secs)	
Call type	F-M, M-F, M-M
Calling, or called, party clears	1.0

NOTES

1 Values in the table relate to mean values; percentile values, where applicable, are for further study.

2 Values in the table relate to normal traffic conditions. Target values for overload conditions are for further study.

3 The influence of the satellite segment in satellite based land mobile networks is for further study.

Table A6: Proposed (average) target values for blocking on the radio channels

Probability of blocking on the radio channels		
Call type	F-M, M-F	M-M
Probability of blocking on the radio links	(10^{-3})	f.s.
NOTES 1 Values in the table relate to mean values; percentile values, where applicable, are for further study. 2 Values in the table relate to normal traffic conditions. Target values for overload conditions are for further study. 3 The influence of satellite-based land mobile domain is for further study. f.s. Further study		

Table A7: Proposed (average) target values for blocking on PLMN-to-fixed network circuits

Probability of blocking on PLMN to fixed network circuits		
Call type	F-M and M-F	M-M
Probability of blocking on PLMN to fixed network circuits	(5)(10^{-3})	f.s.
NOTES 1 Values in the table relate to mean values; percentile values, where applicable, are for further study. 2 Values in the table relate to normal traffic conditions. Target values for overload conditions are for further study. 3 The influence of satellite-based land mobile domain is for further study. f.s. Further study		

Table A8: Proposed (average) target values for unsuccessful land cellular handover

Probability of unsuccessful land cellular handover	
Call type	F-M, M-F, M-M
Probability of unsuccessful land cellular handover	$(5)(10^{-3})$

NOTES

1 Values in the table relate to mean values; percentile values, where applicable, are for further study.

2 Values in the table relate to normal traffic conditions. Target values for overload conditions are for further study.

3 The influence of satellite-based land mobile domain is for further study.

f.s. Further study

A.2.3 QoS Parameters for SMS and MMS

Short Message Service (SMS) and Multimedia Message Service (MMS) are two services generally provided by mobile service providers. The **ETSI EG 202 009-V1.2.2 (2007-01)** specifies some user-related parameters for the SMS and MMS. Some of these parameters and their definitions are summarised herein.

Table A9: Parameters for SMS

Parameter	**Measure**
Successful SMS Ratio	Probability that a user can send a SMS successfully from a terminal equipment to a SMS Centre: - % of successfully sent short messages; - Number of observations used and the absolute accuracy limits for 95% confidence calculated from this number.
Completion Rate for SMS	Ratio of correctly send and received SMS between two terminal equipments. The following statistics should be provided separately: - Ratio of successfully send and received short messages; - Number of observations used and the absolute accuracy limits for 95% confidence calculated from this number.
End-to-end delivery time for SMS	It is the period starting when sending an SMS from a terminal equipment to an SMSC and finishing when receiving the very same SMS on another terminal equipment. The following statistics should be provided separately: - The mean value in seconds for sending and receiving short messages; - The time in seconds within which the fastest 95% of short messages are sent and received; - The number of observations performed.
Delivery time of the message delivery notification	Maximum, mean value and standard deviation of the time to receive the delivery notification

Table A10: Parameters for MMS

Parameter	Measure
Successful MMS Ratio	Probability that a user can send a MMS successfully from a terminal equipment to a MMS Centre: - % of successfully sent MMS; - Number of observations used and the absolute accuracy limits for 95% confidence calculated from this number.
Completion Rate for MMS	Ratio of correctly send and received MMS between two terminal equipments. The following statistics should be provided separately: - Ratio of successfully send and received multimedia messages; - Number of observations used and the absolute accuracy limits for 95% confidence calculated from this number.
End-to-end delivery time for MMS	It is the period starting when sending a MMS from a terminal equipment to an MMSC and finishing when receiving the very same MMS on another terminal equipment. The following statistics should be provided separately: - The mean value in seconds for sending and receiving MMS; - The time in seconds within which the fastest 95% of MMS are sent and received; - The number of observations performed.
Delivery time of the message delivery notification	Maximum, mean value and standard deviation of the time to receive the delivery notification

A.3 Internet Services

Users' expectations of service quality of the Internet vary from application to application. For instance QoS for real-time applications (e.g. voice) differ from QoS for non-real-time applications (e.g. email). As mentioned earlier, for the Internet-based applications, user's perspective of quality and reliability is characterised by the Accessibility (A), Continuity (C) and Fulfilment (F) framework. Therefore the approach for identifying and defining performance parameters is to define the ACF parameters impacting the quality of the specified transaction for each of the corresponding applications. In monitoring performance parameters, monitors may involve users in making measurements by distributing test tools and collecting test results.

A.3.1 Classes of Service

ITU-T groups IP telecommunication transactions into six unique classes defined according to the desired performance QoS objectives. Definition for each class of service is given in ITU-T Recommendation Y.1541.

Table A11: Classes of Service

Class	Application type	Mean Delay Upper Bound	Delay Variance	Loss Ratio	Application examples
Class 0	Real-time, highly interactive, sensitive to jitter	100 ms	<50ms	$<10^{-3}$	Voice over IP, Videoteleconference
Class 1	Real-time, interactive, sensitive to jitter	400 ms	<50ms	$<10^{-3}$	Voice over IP, Videoteleconference
Class 2	Highly interactive transaction data	100 ms	Unspecified	$<10^{-3}$	Signalling
Class 3	Interactive	400 ms	Unspecified	$<10^{-3}$	Signalling

	transaction data				
Class 4	Low loss only applications	1s	Unspecified	$<10^{-3}$	Short transactions, bulk data, video streaming
Class 5	Unspecified applications	Unspecified	Unspecified	Unspecified	Default IP networks

A.3.2 QoS Parameters and for Internet Access

ETSI guide EG 202 057-4 V1.1.1 (2005-16-08) defines the following QoS parameters and measurements for Internet access. For further details on the measurement method to be used by the Internet access providers for conducting test calls, the aforementioned guide may be consulted.

- ***Login Time***

The login time is the period starting when the data connection between the Test-PC and the Test-Server has been established and finishing when the login process is successfully completed. An attempt to login is unsuccessful if the login process fails for any reason. If more than 5 consecutive attempts to login fail, an ISP outage is assumed.

- ***Data transmission speed achieved***

The data transmission speed is defined as the data transmission rate that is achieved separately for downloading and uploading specified test files between a remote web site and a user"s computer.

- ***Unsuccessful data transmission ratio***

The unsuccessful data transmission ratio is defined as the ratio of unsuccessful data transmissions to the total number of data transmission attempts in a specified time period. A data transmission is successful if a test file is transmitted completely and with no errors.

- ***Successful log-in ratio***

The successful log-in ratio is defined as the ratio of successful log-ins to access the Internet when both the access network and the IAP network are available in full working order.
NOTE: This parameter is a measure for the availability of the Internet access. The most likely reason for unavailability of the Internet access is caused by congestion or malfunction of the access server of the IAP which leads to unsuccessful log-ins.

- ***Delay (one way transmission time)***

The delay is half the time in milliseconds that is needed for an ICMP Echo Request/Reply (Ping) to a valid IP address.

Table A12: Summary of QoS Parameters for Internet Access[29]

Parameter	Measure
Login Time	number of successful log-ins
Data transmission speed achieved	- maximum data transmission rate in kbit/s achieved; - minimum data transmission rate in kbit/s achieved; - mean value and standard deviation of the transmission rate in kbit/s achieved;
Unsuccessful data transmission ratio	% Unsuccessful data transmission
Successful log-in ratio	% Successful log-ins
Delay (one way transmission time)	Mean value of the delay in ms Standard deviation of the delay

[29] Source : ETSI EG 202 057-4 V1.1.1 (2005-16 08)

ETSI EG 202 009 (2007-01) provides further parameters and measures for Internet access. For instance, among the other parameters defined in the guide are: - rate of successful access to authentication; rate of successful access to generic name translation; outage rate; throughput of dial-up access to the Internet, etc. The said guide further provides definition of parameters with respect to applications such as Email, Web Browsing and Web-page Hosting.

A.4 Quality of Service in International Telephony

A.4.1 Performance Criteria

When determining Quality of Service parameters for International Telephony service, the following performance criteria which reflect the user perception of the service are generally taken into consideration:-

- Connection establishment;
- Connection retention;
- Connection quality;
- Billing integrity.

The above can be supervised by QoS indicators (e.g. efficiency rate, call cut-off rate, etc) for which objectives can be set and revised at regular intervals.

- ***Connection Establishment***

ITU-T Recommendation E.426 provides a general guide to the percentage of effective attempts which should be observed for international telephone calls. The success of call attempts is fundamental to an automatic international telephone service of high quality.

The call completion ratio of the national network of a given country, as manifested through its international switching centre(s), affects the efficiency of operation of all countries routing traffic to that country. Call completion ratio information can be provided either internally in a stored program controlled (SPC) international switching centre or externally at the level of the outgoing international circuits in any international switching centre in which access to the circuits is provided for the purpose of establishing the disposition of call attempts.

An effective call attempt is defined, for this purpose, as one for which an answer is received at the originating international exchange[30]. Faults caused by the originating international exchange shall be excluded to the extent feasible. All attempts which succeed in seizing an international circuit shall be included in the results:

a) Low level of effective call attempts: less than 30%;
b) Medium level of effective call attempts: 30% to 60%;
c) High level of effective call attempts: more than 60%.

- **Connection Retention**

The assessment of the connection retention parameter is considered difficult and costly. ITU recommends the investigation of this parameter only after information from sources such as operator trouble reports, subscriber complaints, interviews and/or service observations indicate that there is a problem. The cut-off call ratio is the percentage of the established calls that are released for a reason other than intentional by any of the parties involved in the call. The cut-off call ratio can only be measured by placing test calls.

[30] ITU-T Recommendations E.426

The cut-off call ratio for subscriber-to-subscriber tests should, measured over 24-hour periods, be below 0.5% for 5 minute calls. In any time-consistent hour the call cut-off rate may not exceed 3%.

Cut-off problems have a severe impact on customer's perception of Quality of Service to destinations with a low answer seizure ratio.

A.4.2 Measurement Methods for International Telephony

The following methods of measuring the quality of service are described in **ITU-T Rec. E.420**:
1) service observations by external means;
2) test call (simulated traffic);
3) customer interviews;
4) internal automatic observations.

ITU-T Recommendation E.422 describes service observation in the international service in order to assess the quality of service obtained by the calling subscriber. It is essential to have factual or objective recording of observations (i.e. successful and unsuccessful calls), and to present them in the form of tables.

ITU-T Recommendation E.425 describes internal monitoring of network performance using specific performance parameters such as Answer Seizure Ratio (ASR), Answer Bid Ratio (ABR) and Network Effectiveness Ratio (NER). The advantages of internal monitoring is that a large volume of records can be collected which allows day-to-day evaluation of network performance. The performance parameters ASR and NER are explained below.

- ***Answer Seizure Ratio***

ASR gives the relationship between the number of seizures that result in an answer signal and the total number of seizures[31]. This is usually expressed as a percentage as follows:

$$\text{ASR} = \frac{\text{Seizures resulting in answer signal}}{\text{Total seizures}} \times 100$$

Measurement of ASR may be made on a route or on a destination code basis. The destination ASR is calculated on the total amount of traffic to the destination whichever the outgoing route used. A destination can be a mobile network, a country, a city, a service, etc.

- ***Network Effectiveness Ratio***

NER is designed to express the ability of networks to deliver calls to the far-end terminal. NER expresses the relationship between the number of seizures and the sum of the number of seizures resulting in either an answer message, or a user busy, or a ring no answer, or in the case of ISDN a terminal rejection/unavailability.
NER is calculated as a percentage of seizures, specifically, seizures of international circuits. A seizure will be said to have taken place, if the originating international switch has reserved a trunk for a specific call and has begun the signalling procedure to establish a call over that trunk.

$$\text{NER} = \frac{\text{Seizures resulting in Answer message or User Failure}}{\text{Total Seizures}}$$

[31] ITU-T Recommendations E.425

Unlike ASR, NER excludes the effects of customer behaviour and terminal behaviour.

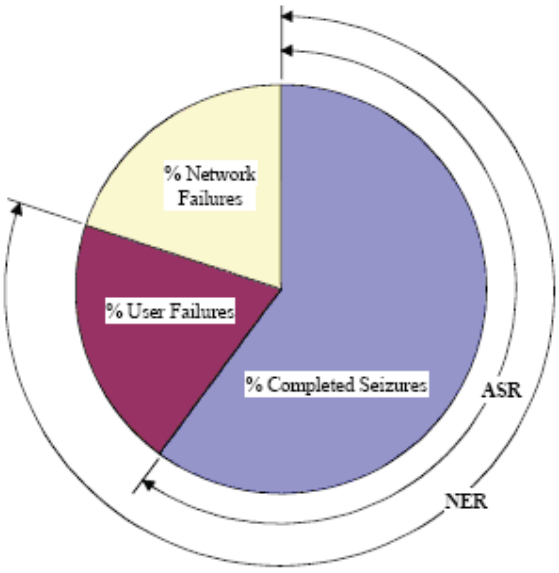


Fig: Difference between ASR and NER[32]

Accurate measurement of NER is more complex and requires more complete signalling than that of ASR. The Cause values provided by ITU-T Signalling System No. 7 TUP and ISUP can be used as a basis for the measurement of NER. This type of data is usually available from systems that capture signalling information. It may also be available on Call Detail Records. The results of the ASR, ABR daily profile should be recorded. This data can be hourly, in groups of hours, or a total day.

A.5 Voice Transmission Quality

Conversation or voice quality can be affected by parameters such as noise, echo, speaking volume, transmission delay, and impairments due to voice compression, packet loss, and jitter. In particular, two-way interactive conversation quality is critically affected by transmission delays. With regard to voice compression, employing low-bit rate codecs in order to save bandwidth has the trade-off of quality reduction. The combined effect of all of the above-mentioned parameters leads to the overall level of speech transmission quality as perceived by the user.

A.5.1 Transmission Delay

Transmission delay (or transmission time) for connections with digital segments includes delay due to equipment processing as well as propagation delay, such that both types of delay can be significant contributors to overall transmission time. Delay starts impeding the naturalness of the back-and forth conversation of the parties on a call, when the one-way connection delay exceeds approximately 150ms[33]. ITU-T recommendation G.114 specifies the following limits for one-way transmission time for connections with adequately controlled echo.

[32] Source: ITU-T Recommendation E.425

[33] Oodan A., Ward K., Savolaine C., Daneshmand M. and Hoath P.: 'Telecommunications Quality of Service Management, from legacy to emerging services', IEE Telecommunications Series 48, 2003.

Table A13: End-to-end transmission time limits[34]

End-to- End Transmission Time Limits		Note
0 to 150 ms	Acceptable for most user applications	Some highly interactive voice and data applications may experience degradation for values below 150 ms. Therefore, increases in processing delay on connections with transmission times even well below 150 ms should be discouraged unless there are clear service and application benefits.
150 to 400ms	Acceptable provided that Administrations are aware of the transmission time impact on the transmission quality of user applications.	For example, international connections with satellite hops that have transmission times below 400 ms are considered acceptable.
Above 400 ms	Unacceptable for general network planning purposes; however, it is recognized that in some exceptional cases this limit will be exceeded.	Examples of such exceptions are unavoidable double satellite hops, satellites used to restore terrestrial routes, fixed satellite and digital cellular interconnections, videotelephony over satellite circuits, and very long international connections with two digital cellular systems connected by long terrestrial facilities.

Transmission delay is a very important parameter for any application whose overall performance is dependent on user or terminal interactivity. Applications such as voice, voiceband data, digital data, and videotelephony may involve user tasks or terminal equipment characteristics that vary substantially in their sensitivity to transmission delay.

A.5.2 E-Model

For transmission planning purposes, the E-model is a useful tool for assessing the combined effect of all of the abovementioned parameters, including transmission delay. ITU-T Recommendations G.108 and G.175 provide detailed guidance for transmission planning using the E-model. The primary output of the E-model is the Transmission Rating Factor R. The following table from ITU-T Recommendation G.109 provides the definition of different categories of speech transmission quality in terms of the Transmission Rating Factor R. The results can be converted into numbers on the MOS scale in ways that can predict to some extent the MOS for conversation.

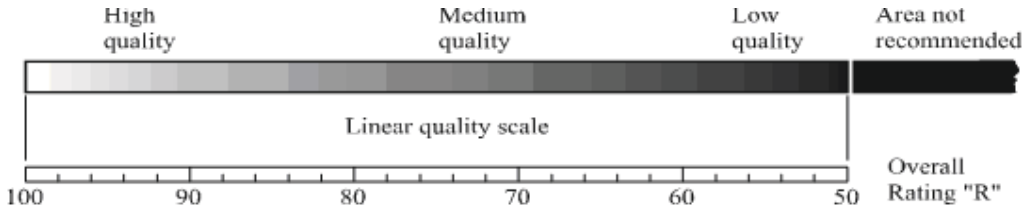
Table A14: Categories of speech transmission quality[35]

R-value range	Speech transmission quality category	User satisfaction
$90 \leq R < 100$	Best	Very satisfied
$80 \leq R < 90$	High	Satisfied
$70 \leq R < 80$	Medium	Some users dissatisfied
$60 \leq R < 70$	Low	Many users dissatisfied

[34] ITU-T Recommendation G.114
[35] Source : ITU-T Recommendation G.109

50 ≤ R < 60	Poor	Nearly all users dissatisfied
NOTE 1 – Connections with R-values below 50 are not recommended. NOTE 2 – Although the trend in transmission planning is to use R-values, equations to convert R-values into other metrics e.g. MOS, %GoB, %PoW, can be found in Annex B/G.107.		

The R-value is thus a measure of a quality perception to be expected by the average user when communication via the connection under consideration: quality is a subjective judgement such that assignments cannot be made to an exact boundary between different ranges of the whole quality scale. The quantitative terms should be viewed as a continuum of perceived speech transmission quality[36].



Examples of speech transmission quality in typical scenarios are provided in ITU-T Rec. G.109; however wideband scenarios are not included in the said recommendation.

Table A15: Examples of Speech Transmission Quality provided in typical scenarios[37]

Service/network scenario	R-value	Deviations from Table 3/G.107
ISDN subscriber to ISDN subscriber, local connection	94	Note 1
Analogue PSTN subscriber to analogue PSTN subscriber, 20 ms delay (average echo path losses; no active echo control)	82	Note 2
Mobile subscriber to analogue PSTN subscriber as perceived at mobile side	72	Note 3
Mobile subscriber to analogue PSTN subscriber as perceived at PSTN side	64	Note 4
Voice over IP connection using G.729A + VAD with 2% packet loss	55	Note 5
NOTE 1 – No deviations. NOTE 2 – TELR = 35 dB, WEPL = 50 dB, T = 20 ms, Tr = 40 ms, Ta = 20 ms. NOTE 3 – TELR = 68 dB, WEPL = 101 dB (EC with ERLE = 33 dB assumed), T = 110 ms, Tr = 220 ms, Ta = 110 ms, Ie = 20. NOTE 4 – TELR = 53 dB, WEPL = 101 dB (EC with ERLE = 33 dB assumed), T = 110 ms, Tr = 220 ms, Ta = 110 ms, Ie = 20. NOTE 5 – T = 300 ms, Tr = 600 ms, Ta = 300 ms, Ie = 19.		

[36] ITU-T Recommendation G.109
[37] Source: ITU-T Recommendation G.109

ANNEX B: CONSULTATION QUESTION LIST

Q.1 Do you agree that the Authority should set performance targets and require operators to meet those values?

Q.2 Do you agree with the proposal of the Authority to publish measurements on a regular basis?

Q.3 Do you agree with the proposed set of QoS parameters for fixed telephony services?

Q4. Do you agree with the target values proposed for fixed telephony services? If not, please suggest other benchmarks.

Q.5 Do you agree with the proposed set of QoS parameters for mobile telephony services?

Q.6 Do you agree with the target values proposed for mobile telephony services? If not, please suggest other benchmarks.

Q.7 Do you agree with the proposed set of QoS parameters for international telephony services?

Q.8 Do you agree with the target values proposed for international telephony services? If not, please suggest other benchmarks.

Q.9 Do you agree with the proposed set of QoS parameters for Internet services?

Q.10 Do you agree with the target values proposed for Internet services? If not, please suggest other benchmarks.

Q.11 Should measurements be made by operators or outsourced to an independent agency?

Q.12 If auditing is to be done, should it be done by the regulator or an independent entity?

Q.13 In the event an independent auditor is to be appointed, what are the main criteria to consider for the said appointment?

Q.14 To what extent should the Authority specify how audits should be carried out?

Q.15 What are the main measurements that need auditing?

Q.16 How frequently should an audit be carried out?

Q.17 Any other suggestions or comments?