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TELEPHONE SERVICE, SERVICE OPERATION AND
HUMAN FACTORS

**ITU-T E.800-series – Guidelines on regulatory
aspects of QoS**

ITU-T E-series Recommendations – Supplement 9

ITU-T



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Supplement 9 to ITU-T E-series Recommendations

ITU-T E.800-series – Guidelines on regulatory aspects of QoS

Summary

This Supplement 9 to the ITU-T E.800-series Recommendations provides information on regulatory aspects of quality of service (QoS) supplementary to guidelines provided in the Recommendations of the E.800 series of the ITU-T. The intent of these Recommendations and of this supplement is to assist regulators or administrations who need desired levels of QoS for one or more ICT services to be achieved within the area for which they are responsible.

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FOREWORD

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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

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Supplement 9 to ITU-T E-series Recommendations

ITU-T E.800-series – Guidelines on regulatory aspects of QoS

1 Scope

This Supplement provides information on regulatory aspects of quality of service (QoS) supplementary to guidelines provided in the ITU-T E.800 series Recommendations. The intent of these Recommendations and of this Supplement is to assist regulators or administrations who need desired levels of QoS for one or more ICT services to be achieved in the area for which they are responsible.

This Supplement focuses on end-to-end QoS as perceived by the user when using mobile and fixed networks.

Network performance is outside the scope of this Supplement.

2 References

- [ITU-T E.800] Recommendation ITU-T E.800 (2008), *Definitions of terms related to quality of service.*
- [ITU-T E.803] Recommendation ITU-T E.803 (2011), *Quality of service parameters for supporting service aspects.*
- [ITU-T E.804] Recommendation ITU-T E.804 (2014), *Quality of service aspects for popular services in mobile networks.*
- [ITU-T E.804.1] Recommendation ITU-T E.804.1 (2020), *Application guide for Recommendation ITU-T E.804 on quality of service aspects for popular services in mobile networks.*
- [ITU-T E.805] Recommendation ITU-T E.805 (2019), *Strategies to establish quality regulatory frameworks.*
- [ITU-T E.805.1] Recommendation ITU-T E.805.1 (2021), *QoS operational strategy for improved regulatory supervision on providers of mobile telecommunication services.*
- [ITU-T E.806] Recommendation ITU-T E.806 (2019), *Measurement campaigns, monitoring systems and sampling methodologies to monitor the quality of service in mobile networks.*
- [ITU-T E.807] Recommendation ITU-T E.807 (2014), *Definitions, associated measurement methods and guidance targets of user-centric parameters for call handling in cellular mobile voice service.*
- [ITU-T E.812] Recommendation ITU-T E.812 (2020), *Crowdsourcing approach for the assessment of end-to-end quality of service in fixed and mobile broadband networks.*
- [ITU-T P.10] Recommendation ITU-T P.10/G.100 (2017), *Vocabulary for performance, quality of service and quality of experience.*

3 Definitions

3.1 Terms defined elsewhere

This Supplement uses the following terms defined elsewhere:

3.1.1 quality of experience (QoE) [ITU-T P.10]: The degree of delight or annoyance of the user of an application or service [b-Qualinet].

3.1.2 quality of service (QoS) [ITU-T E.800]: Totality of characteristics of a telecommunications service that bear on its ability to satisfy stated and implied needs of the user of the service.

4 Abbreviations and acronyms

This Supplement uses the following abbreviations and acronyms:

CSV	Comma-Separated Values
JSON	JavaScript Object Notation
KML	Keyhole Markup Language
KPI	Key Performance Indicator
M2M	Machine-to-Machine
OTT	Over The Top
QoE	Quality of Experience
QoS	Quality of service
SDO	Standards Development Organization
SLA	Service Level Agreement
XML	extensible Markup Language

5 Conventions

None.

6 Overview of concepts around quality of service

The characteristics of a telecommunication service that affect QoS can be measured by objective means (e.g., by a level meter or a delay counter). QoS is frequently confused with elements of network performance because (signalling) functions inside the networks are sometimes referred to as "services"; the Internet Engineering Task Force (IETF) uses QoS to describe the performance of functional services in network layer models. In order to avoid that confusion, QoS is often more precisely expressed as "end-to-end QoS".

Furthermore, the end-to-end QoS that is perceived at the user interface, which basically summarizes the characteristics of the underlying in-service media streams, should not be mistaken for the QoS of non-utilization stages of ICT services.

The QoS of non-utilization stages of ICT services describe the "customer service aspects" of the ICT services offered by service providers and which are outside the actual usage of services, e.g., the quality and content of information on a service and its features, the contractual conditions offered by the service provider, provisioning facilities, documentation, and service support after contract with customers (see [ITU-T E.803] on the quality of service parameters for supporting service aspects).

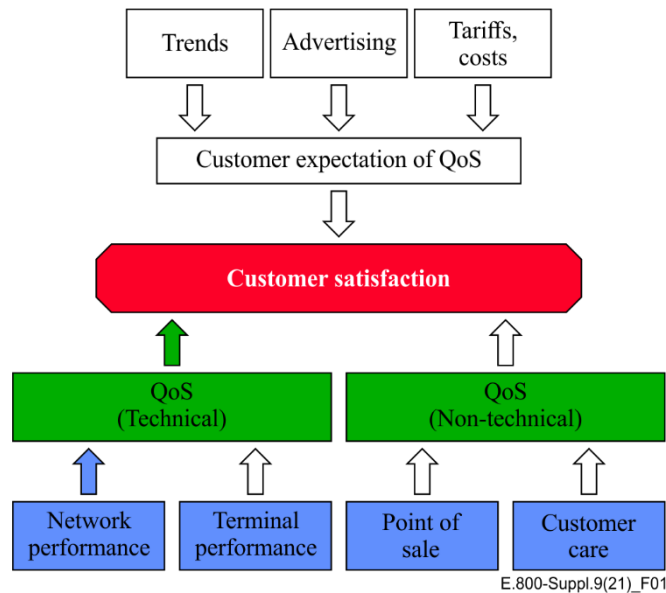


Figure 1 – Factors influencing customer satisfaction

The user perception of quality is, however, not limited to the objective characteristics at the human-machine interface, summarized in the QoS concept. What counts for end users is their personal quality of experience (QoE) during their use of a telecommunication service. QoE takes into account additional subjective parameters stemming from user expectations and the context from which the user is experiencing the use of the service; typical examples of context-related influences are personal mood and environment. In addition, QoE covers the potential discrepancy between the service offered and individual users reading additional features into the service.

7 Global challenges

The view on QoS related challenges depends strongly on the role of the stakeholders involved. They are described below.

Standards development organizations (SDOs) such as the ITU-T, the European Telecommunications Standards Institute (ETSI), the 3rd Generation Partnership Project (3GPP) and the IETF have the collective knowledge and expertise with respect to the QoS related problems inherited with the change of paradigms in networks and terminals and also with the aspects of planning and possible regulation of end-to-end QoS.

However, SDOs are contribution-driven, which means that if stakeholders decide to rely on proprietary solutions instead of globally recognized standards, and if stakeholders wish to keep control of their intellectual property and furthermore wish to avoid investing resources in globally recognized standards, then there is not very much for SDOs to do except to try to convince industry leaders at, for example, dedicated events such as conferences. Hopefully, such a situation will be very rare.

Network equipment manufacturers have to rely on the QoS related performance requests (of network and system functions) from network operators and service providers. Ideally, network equipment manufacturers will participate in the QoS work of SDOs in order to standardize the QoS and performance requirements between several parties involved in the network business. Unfortunately, for many network equipment manufacturers there is no visible incentive that encourages them to participate in the work of SDOs related to end-to-end QoS, i.e., the return on investment from this kind of engagement cannot easily be seen. If this is not carried out inside SDOs, it can be undertaken through participation in industry forums, where a common understanding of new technologies is built before being translated into standards.

Terminal device manufacturers are today confronted with a mass market. In the past, terminal standards, issued by SDOs, were targeting minimum attachment requirements, for example, which were intended to avoid harm to the network. Nowadays, there are terminal standards, mostly issued by the Global Certification Forum (GCF), often based on 3GPP specifications, which target the possibility of provision of high level end-to-end QoS to the customer. This is a challenge for terminal device manufacturers since the acceptance of terminals in the market is based on other factors, e.g., price, other functions of terminals (such as MP3 players, GPS), applications available for a particular terminal (such as games, etc.) and other attributes, such as handset colour, rather than end-to-end QoS.

Network operators and service providers are faced with the necessity of huge investments in both infrastructure and access technology, while maintaining or increasing the revenues coming from the usage made of their services by their customers. Even though they may not have full responsibility for the end-to-end QoS, it is a key asset for them to differentiate from competitors and keep customers satisfied and loyal to their network.

Furthermore, the services used by network operators' customers are not fully under the said network operators' control:

- Some of these services are provided by third parties (over the top (OTT) players), often under circumstances where several interconnected networks are implied.
- The contribution of terminal devices to the end-to-end QoS perceived by end users is also crucial. Operators must carefully select the devices they accept to provide to their customers and grant access to their networks only to these devices and not to counterfeit ones.

In conditions where the access to spectrum has a high cost (licence fees, heavy processing approvals), this may undermine the capacity of operators to invest in adequate network resources (frequency bands, core network capacity, renewal and upgrade of network equipment) in order to respond to high traffic growth.

Other external factors that can be considered as challenges to the QoS delivered to customers in some countries include:

- Poor power supply and frequent outages, especially in rural areas.
- Poor signal quality due to interference, especially in border areas.
- Vandalism, including theft and cable cuts during road and other construction works.
- Seasonal fading, especially during the wet season.
- Low smartphone adoption and lack of digital skills.
- Local legislation for infrastructure deployment.

The GSM Association, in a recent publication targeting a specific geographical context but with a broader actual footprint [b-GSMA-I], provides more details on these challenges and on the limitation of responsibility for operators on end-to-end QoS.

Regulators and administrations today face the challenge of addressing the issue of QoS in terms of the licensing of network operators and service providers.

In determining the licensing parameters or the limits, objectives or both for the networks and for the services provided in any other legislation, the following should be taken into account:

- The new technologies and their characteristics (e.g., architecture, spectrum usage techniques);
- The cost of developing and maintaining a network;
- The existing level of competition;
- The new services (e.g., OTT, IoT and machine–machine); and

- The protection of consumers' interest in receiving the contracted QoS.

Nowadays, QoS regulation can be targeted to two types of services [b-ITU-RM]:

- 1) An individual service, session or connection, with QoS guarantees. These services, such as QoS-enabled VoIP and QoS-enabled IPTV or mission-critical services (specialized services over IP networks) are provided with QoS guarantees by the operator (e.g., IoT, machine-to-machine (M2M) services), etc. Individual services have different sets of key performance indicators (KPIs) (per service). [ITU-T E.804]. [ITU-T E.804.1] and [ITU-T E.807] provide lists and definitions of such metrics. When these services are provided over IP-based networks, the common KPIs for IP-based services can also be applied to these individual services.
- 2) Internet access service. By enforcing KPIs for this type of service, the regulatory authority may ensure that end users will experience satisfactory quality when using OTT services provided in a best effort manner based on principles of network neutrality. Examples of KPIs are:
 - Maximum IP layer capacity of the access network;
 - Congestion in the backbone or backhaul;
 - End-to-end delay (latency);
 - Delay variation (jitter);
 - Packet loss (loss of information);
 - Service availability.

Consequently, regulators and administrations have to take a close look at the conditions under which access to these services is provided as compared with access to the network, for example, there may be a certain percentage of the bandwidth or of the capacity reserved for the on-net services which then are not available for access to the Internet; similarly the packet-based backbone of the network operator may serve for both the provision of their proprietary services (which are intended to secure their revenues) and for the carriage of open Internet traffic (which gives lower revenues); this may lead to a tendency to give lower priority to the open Internet traffic.

Consumers face challenges when using telecommunication services in their personal lives (e.g., when there is a discrepancy between the advertised and actual delivery speeds of the network). In the communications between the European Commission and the Body of European Regulators for Electronic Communications (BEREC), the need for clear and transparent communication of QoS parameters and network management practices has been a recurrent theme.

In particular, in order to continue providing adequate QoS, network operators and service providers may make a claim for the need to undertake traffic management when the networks become congested. This may include data restrictions, traffic throttling, filtering, the use of data caps of thresholds, or a combination of any of these. Once the cap has been exceeded, customers or end users may, knowingly or unknowingly, be confronted with the fact that the "Internet access" provided to them is not unrestricted Internet access, but a service provided by their ISP.

Regulators should have the appropriate skillset to carry out QoS regulation; continuous capacity building enables regulators to adapt to market and regulatory changes. Regulators can benefit greatly by learning from each other. The argument for cooperation between regulators is very strong and such cooperation can bring substantive benefits through the sharing of best practices and mutual learning [b-ITU-RM]. The best direction for QoS is still being discussed in national and international forums, with stakeholders exploring the most appropriate methods for addressing changing customer expectations [b-GSMA-I].

8 Selecting the appropriate regulatory approach

[ITU-T E.805] gathers and provides many elements of information in order to plan and set up a regulatory strategy for QoS management and enforcement adapted to a given market. It acknowledges "that there are several different approaches that can be used to attain quality improvements where needed and mechanisms to help consumers make informed choices, depending on market maturity, level of competition, consumer rights awareness, enforcement of the regulator, etc."

This provision in [ITU-T E.805] supersedes most of the content of this clause in the previous version of this supplement. What follows complements the information available in [ITU-T E.805].

8.1 Options and principles

8.1.1 Facilitation of regulatory consultations

Regulatory consultations require a transparent feedback process to foster stakeholder buy-in. The following are sample steps in the process regarding consultations with the operators and public in development of the QoS regulations:

- Preparation of the consultation document;
- Publication of the consultation document;
- Consolidation of responses from consultation;
- Collation of responses from stakeholders by the regulator for each article and reflection on them;
- Publication of the final draft of the regulations.

NOTE – The regulatory consultations may be carried out with engagement of independent advisers. For instance, associations of users can be involved to represent the voice of the target population and trade unions of operator employees can give feedback on the consequence of proposed new rules on working conditions.

In general, QoS obligations are only likely to be fulfilled if legitimate concerns are addressed.

To monitor QoS successfully, regulatory authorities should take into account the opinions of operators and consumers fully and openly. This can be achieved through a consultation process, for obligations in licences as well as for obligations in regulations. Typically, at the start and end of a consultation process, the regulator circulates documents that discuss policy options and proposals.

8.1.2 Ensuring QoS by regulatory measures

8.1.2.1 Encouraging QoS

The basic principle to follow can be summarized in a few words: start by encouraging QoS and if this fails, try to enforce QoS.

As explained in clause 7 of [ITU-T E.805], there is currently a noticeable difference in ensuring QoS delivery between countries with competitive (i.e., mature) telecommunication markets and countries with less competitive (i.e., less mature or developing) markets. A market may be deemed mature when three or more independently operating service providers are covering the same region, and none has a market share bigger than the sum of the remaining operators.

As a general principle, it is recommended that regulatory measures ensuring QoS delivery should be graduated and proportional. Whenever feasible, the regulator should engage in constructive dialogue with operators on quality problems. This should not be seen as a process of telling the operator how to run their business, but of asking targeted questions that can trigger operators to review and reconsider their approach in areas with specific problems.

8.1.2.2 Enforcing QoS

Enforcement techniques should be dynamic, owing to market changes and evolving technologies. In particular, the following aspects regarding QoS enforcement mechanisms may be considered:

- Publishing measurements and unattained targets helps to show that the regulator is fair and open. Publishing at least a representative subset of measurements enables customers to make informed choices; this is often the main technique for encouraging compliance with QoS obligations. Publishing all measurements and unattained targets can be laborious.
- Demanding extra measurements and detailed targets may come at a cost to the operators, especially when responding to such requests would not create solutions to the problems. Requesting measurements for a representative sample of deployments may suffice.
- Monitoring the implementation of remedial plans may require external agencies skilled in network design and operation to assist regulators. However, accompanying this with direct intervention in the activities of operators could lead to confusion about responsibilities and duties.
- Requiring compensation to customers may not be feasible. It could be useful when customers have provable information about the quality they have received and can request compensation directly without recourse to regulators or arbitrators and when they notice different quality levels very easily (so compensation can vary with the severity of the deficiency). For example, compensation is more likely to be paid for long fault repair times in fixed wireline networks (or in similar examples) than in other cases of QoS degradation.
- Imposing fines can involve extensive legal processes and may take a long time (as may various other techniques for enforcing compliance with QoS obligations), which is dependent upon the laws in the given country.
- Price changing (by introducing quality factors into price controls, with rewards for good quality as well as penalties for bad quality) needs careful design if it is to act as an incentive to improving quality. The relation between QoS and price controls is not always clear.
- Excluding access to government contracts (e.g., licences) can be difficult to enact proportionately to failures by operators, and may not be applicable to several operators at once.

Enforcement mechanisms or techniques likely require various sorts of effort and expertise, along with processes that operate efficiently and regularly whenever operators report measurements. In many countries, several techniques are applied to allow for graduated penalties.

Serious and persistent failures to fulfil many obligations might be handled by using even more drastic enforcement techniques that are not related directly to QoS, such as withdrawing licences or transferring franchises.

NOTE – The legislation of a country should guide whether the QoS monitoring approach should be one of encouragement, enforcement, mixed or neither.

8.1.3 Including service level agreements (SLAs) in contracts

The inclusion of "service level agreements" (SLAs) in contracts has become popular but such agreements are not always effective as their formulation may be vague and compensation terms may not be stated.

To be effective, an SLA should state the minimum level of performance offered to the customer, not the average level to be achieved for all customers.

The service provider may be asked by the regulator to submit an SLA containing the minimum QoS standards to which customers are entitled, and the remedies and compensation available when service falls below such standards.

- The regulator, on receipt of the SLA, should review it and where the former determines that the SLA does not meet a pre-set requirement, the regulator may direct the service provider to amend the SLA accordingly.

- It is suggested that the service provider notify customers of the terms and conditions of the SLA. It may then provide licensed services based upon the agreement.
- All modifications made to existing SLAs should be submitted to the regulator by the service provider for approval.
- The service provider should be obliged to notify the customer of the modified SLA following approval granted by the regulator.

9 Fundamentals of QoS regulation

This clause highlights the fundamentals and related activities of QoS regulation.

9.1 Justifications for QoS regulation

QoS regulation can have several aims that justify it; some are more important when competition is strong, and others are more important when competition is weak. These aims are:

- Helping customers to make informed choices. Price is an important factor in choosing a service, but once customers have settled on a price, they want the best quality available at that price. Indeed, quality can be more important than price, especially for business customers, because problems with quality may create other costs. For services that are bundled together, with one price covering several services, the quality of specific aspects of the services can influence choices greatly. Publishing quality levels can help customers with such choices.
- Checking claims by operators. Operators sometimes make claims in advertisements about their services or the services of their competitors. Publishing quality levels can enable people to check this and help to ensure accurate claims.
- Understanding the state of the market. Figures about rollout may not be enough to show whether policies are succeeding as they say nothing about how well equipment is maintained after installation. Monitoring and publishing quality levels can show gaps in performance that could be filled by market entry or that need new policies for particular groups of people, geographical areas or operating conditions (such as during emergencies).
- Maintaining or improving quality in the presence of competition. Even in fully competitive markets, quality may be poor because of rapid expansion or overstretched management. In various countries both the customer interface and the network infrastructure have become overloaded during aggressive marketing campaigns. Competition can also reduce quality if price cutting leads to cost cutting; quality reductions due to cost cutting can be difficult to reverse, as new staff might need to be trained or deferred investments might need to be brought forward. Publishing quality levels and having targets can help to maintain quality in these cases.
- Maintaining or improving quality in the absence of competition. A dominant operator might introduce price adjustments, demonstrate an unwillingness to boost supply or become insensitive to customer wishes. This may be due to such influencing factors as market and technology maturity, demand side growth, demand elasticity, countervailing buying power, cost structure and market share similarities and supply side shortages. Such an operator may then try to maintain margins by cutting costs and reducing quality; it might even introduce an "enhanced" service and lower the quality of the "standard" service to encourage customers to move to the "enhanced" service. Monitoring quality levels and having targets for the retail services of the dominant operator can help to maintain quality in these cases.
- Helping operators to achieve fair competition. An alternative operator often depends crucially on interconnecting with or reselling the facilities of a dominant operator. For competition to be fair, the alternative operator should receive the same quality level from those facilities as the dominant operator receives. This is very difficult to ensure without firm regulation of the

structure of the dominant operator. Having targets for the wholesale services of the dominant operator can help in this regard.

- Making interconnected networks work well together. An end-to-end path might pass through several networks, each controlled by a different operator. No individual operator has responsibility for the end-to-end path, but a dominant operator might have a serious effect on end-to-end paths set up by other operators. Having targets for the wholesale services of the dominant operator can also help to ensure that end-to-end paths are satisfactory.

9.2 Parameters and targets

The human capacities and technical resources of the telecommunication operators and customer opinions elicited through widespread consultations, working groups and open meetings are a good approach to make monitoring effective [b-ITU-RM]. General aspects helping to determine a set of parameters, measurements and targets are:

- Parameters to be monitored should relate to the aspect of services that have the biggest impact on users; they should be well defined and be cost-effective to operators. For this reason, as far as possible they should employ methods of measurement that are already in use by the operators. They should also reflect differences in, for example, services and geographical areas but should be consistent between services. The parameters chosen should concentrate on only a few aspects of QoS [b-ITU-RM] and an overreaching QoS regulation should be avoided.
- Measurements to be published should relate to aspects of services that users experience directly (not the underlying technical cause). The publication of measurements needs to ensure that they reach beneficiaries, that they are easily understood without being misleading and that they allow for comparison between operators.
- Targets to be set should relate to the quality users want. They should avoid limiting customer choices between quality and price. Furthermore, values need to be determined through sufficient information such as earlier measurements by operators, used in other countries or proposed in international standards.

It has been discussed that some variations of standard parameters may be necessary depending on the specific situation in a country or sector. As a result, the measurements of a parameter might need to distinguish between:

- Market segments: QoS may be different for private consumers, small and large businesses and for wholesale and retail offerings.
- Reporting areas: Another distinction may need to be created if there are reporting areas with likely differences in quality, such as rural and urban areas.
- It is further recommended that to avoid potential abuse of market dominance, target setting, parameter monitoring, and results publication should be fairly applied to all operators irrespective of their market power.
- Services: Parameters may also be specific to services such as voice, text messages, Internet, television and radio broadcasting and leased lines as the main services that have most impact on users. However, it is recognized that even this list may be too long, and it may not always be desirable or necessary to impose QoS regulation on all these.

Targets may be set for all operators; however, the regulator may reserve the right to exercise discretion as to which operator and service classes to focus its compliance enforcement actions on given that there are, for example, cost implications to be considered. This is intended to ensure that the regulatory principle of fairness and creation of a level playing-field for all stakeholders is adhered to.

For parameters to be selected, regulators can refer to [ITU-T E.803], [ITU-T E.804], [ITU-T E.804.1] and [ITU-T E.807].

9.3 Activities in quality of service regulation relating to QoS measurement

[ITU-T E.805.1] addresses the specific cases of countries where the legal or market environment can lead a regulator to enforce QoS by implementing a framework based on the measurement and publication of indicators representative of the level of quality of services as perceived by end users. The concerned regulators are invited to refer to this Recommendation, whose content supersedes the provision of this clause in the previous version of this supplement.

9.3.1 Selection of QoS parameters through information gathering

Regulators may pursue a combined approach of:

- Listening for problems through the press, through occasional meetings with the public and through monitoring the complaint statistics of the operators.
- Requiring regular reporting against parameters that have both high importance and high risk. The selection of these parameters may change over time and will preferably take into account the costs of monitoring and reporting. If costs are low because performance can be monitored easily and cheaply, e.g., automatically within the network, then the parameters concerned can anyway be included, but if they require extra expenditure such as test calls then selection might be much more discriminating.

This could be called a "light touch" approach, i.e., one that focuses on pushing the service providers closer to the consumer on issues where there are problems and that avoids an excessive burden of reporting against all possible parameters.

9.3.2 Reporting and publishing QoS measurements

The regulator should periodically publish results of QoS measurements for every district and/or county in order to ensure customers are provided with information that will enable them to make informed decisions.

Reporting often involves aggregated results. Different methods to aggregate results may be applicable. As an example, two different methods of aggregated results are:

- All parts of the network, or aggregated separately for different areas;
- All customer types, or reported separately for, say, business and residential customers.
- Report information based on operators making data available for free in a specified 'open-data' format [b-GSMA-I]. Some example formats are CSV (comma-separated values), XML (extensible Markup Language), JSON (JavaScript object notation) or Google Earth's keyhole markup language (KML). The preferred format may depend on the way of accessing data (such as human and machine based or completely machine based).

The method of result aggregation should be decided on a case-by-case basis taking account of local circumstances and quality problems.

It is suggested that the measurement results to be published by the regulator contain for each service provider:

- The service(s) provided;
- The reporting area(s) for which the measurements were taken;
- The target for the parameter or service;
- The results of the measurement for each parameter or service.

Service providers may be required to send information periodically to subscribers with their bills as well as charges or rates for service offers.

10 Specifying parameters, target levels and measurement methods

In the specific case of those countries where the national legislation or the QoS framework requires the involvement of regulators in QoS supervision, it becomes necessary to decide relevant quality indicators, adequate associated thresholds and the way to measure and report them. As already stated in clause 9.3, [ITU-T E.805.1] contains interesting provisions in that perspective, which is complemented by the information in clauses 10.1 and 10.2.

10.1 Specifying target levels

Setting target levels is probably the most difficult aspect of QoS regulation. Levels need to be based on both an understanding of what the customers require and what the operator can reasonably be expected to provide. If this is not clear, then it is better not to set a target but only to report the level of performance achieved.

If there is a good understanding, then it is fair practice to set both a minimum level below which compensation is payable and a desired level for achieving good customer satisfaction.

Setting the "target level" to a minimum and the desired level in addition allows operators to be held accountable to their obligations whereas customers can have a point of reference to measure their satisfaction with the services they have subscribed to.

10.2 Specifying measurement tools, mechanism and formulae

Measurement may be approached along three (3) aspects: measurement tools, measurement mechanisms and measurement formulae. Regulations on QoS should provide guidance on which tools and/or concepts of measurement are best-fits for specific KPIs. Measurement mechanisms may include real traffic, test traffic or both, whereas measurement tools may specify test equipment that should be used to assess certain KPIs. [ITU-T E.806] provides a valuable resource for regulatory considerations on measurement systems and tools.

Users should be enabled to access to at least one free and completely independent tool for comparing operator offers in terms of QoS. Such a tool should be certified by the regulator [b-GSMA-I].

Measurements should be objective to the extent possible. For some issues, such as the effectiveness of call centres and helplines, it may not be possible to specify a parameter that can be measured objectively and subjective user assessments are used, e.g., the caller is asked at the end of the call to assess its effectiveness on a scale of 1-5. While this does give some measure of performance, it is not suitable for the application of penalties or compensation.

Measurement may be taken by third parties or reported by the operator itself. They may be based on sampling or include all events. Where measurements can be built into the network or support systems and be automatic, self-reporting covering all events is normally the best approach.

If sampling is used, then consideration needs to be given to specifying criteria for the sample to be representative and comparable between networks.

The measurement formula used is important and should be factored into QoS regulations because it provides information on which trigger points, events or quantifiable variables should be used empirically to assess a particular QoS condition. Regulators should ensure appropriate standards and/or vendor reference materials are used to inform stakeholder discussions on measurement formulae.

Monitoring tasks should be regularly updated regarding measurement tools and applied tests (for example, to test higher bit rates, larger test traffic volumes are needed for up- and downstream rate measurements) [b-ITU-RM].

11 Review of QoS regulations, policy and practices

The telecom/ICT market evolves with technology upgrades and user preferences. These market changes and the latest international standards on QoS could make the assessment of a particular parameter redundant or require modification in its definition and measurement subject to the requisite measurement tools available. Also, as the market becomes competitive in the quality delivery of services, it may not be cost-effective for regulators to pursue QoS regulation and enforcement. Policy-makers and regulators should aim at continuous improvement on delivery of QoS. Therefore, regulators should use their experiences from QoS assessment and enforcement to review their scope of services, the parameters involved, processes, measurement tools, enforcement mechanisms, publicity channels and legal framework. The essence of the review is to ensure that the policy and practices are relevant and effective for the objectives set for the QoS regulations.

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