Quality parameters and standards for Telecommunications and Broadcasting networks (Study of Specifications and Recommendations)

Bureau Telecommunications and Post St. Maarten

Executive summary

This document is the study report for the 'Quality parameters and standards for Telecommunication networks' for the Bureau Telecommunications and Post St. Maarten. This study is to analyze and describe Quality of Service (QoS) and Quality of Experience (QoE) parameters that are relevant for the St. Maarten Telecommunication Industry.

As part of the study existing standards and recommendation (such as ITU, GSMA etc.) have been inventoried.

The parameters and standards will be consistent with International recommendations and specifications from institutions such as ITU, GSMA, 3GPP, ETSI, and also will be in line with international best practice of how to define such quality parameters.

The set of parameters for inspection purposes have been described in a separate document ('Inspection Guide').

Cannegieter Street 15 – Unit 5.1 I Philipsburg I St. Maarten I Dutch Caribbean I +1(721) 542.4699
info@sxmregulator.sx I www.sxmregulator.sx

Table of Contents

Cannegieter Street 15 – Unit 5.1 I Philipsburg I St. Maarten I Dutch Caribbean I +1(721) 542.4699
info@sxmregulator.sx I www.sxmregulator.sx

1 Introduction

This document is the study report for the 'Quality parameters and standards for Telecommunication and Broadcasting networks' for Bureau Telecommunications and Post St. Maarten (BTPSXM). This study is to describe Quality of Service (QoS) and Quality of Experience (QoE) parameters that are relevant for the St. Maarten Telecommunication and Broadcasting Industry.

These parameters and standards will be consistent with International recommendations and specifications from institutions such as ITU, GSMA, 3GPP, ETSI, IEEE, Broadband Forum and also will be in line with international best practice of how to define such quality parameters.

1.1 Background and current situation

The current situation for St. Maarten is that the Telecommunications Regulator is newly established as a result of the establishment of St. Maarten as a nation within the Kingdom of the Netherlands, and no longer as part of the Netherlands Antilles that was dissolved on October 10th, 2010. The newly established Telecommunications Regulator of St. Maarten, Bureau of Telecommunications and Post St. Maarten (BTPSXM) is preparing to fulfill its tasks and responsibilities. Defining quality parameters and preparation of guidelines for future infrastructure inspections as they relate to QoS/QoE is one of these tasks.

1.2 Purpose of the project

1.2.1 Overall objective

The objective of this document is to analyze and study QoE and QoS parameters, and to establish a basis for (future) regulation and inspection of the telecommunications service provisioning in St. Maarten.

1.2.2 Scope

Quality parameters will be defined for telecommunication networks (mobile communication, local and international fixed line telephony, data communication). Broadcast networks (AM radio, FM radio, Free to Air television (FTA), Cable and Wireless Pay Television (PTV).

The network services concerned for which the quality parameters and standards are described are mobile services (Voice, SMS, and Data), fixed services (voice) and data (internet access, email, web, VoIP, IPTV, Cable TV, AM and FM broadcasting) making use of telecommunication infrastructure such as GSM, UMTS, CDMA, Wi-Fi, and WiMAX.

The descriptions may take into account particular aspects of the service delivery e.g. the effect of coverage (mobile networks) and how to define this.

Network and Service providers in St Maarten that currently have a license or are operating under a concession may have particular requirements for service and network quality in these licenses or concessions. Those requirements – irrespective of which they are - are not taken into account.

1.3 Methodology

An analysis of the available specifications and recommendations will be executed, that will serve as the starting point for the study. Chapter two provides the result of this analysis. Chapter three outlines the options and advices as to how to approach the subject of QoS/QoE in St. Maarten. The set of QoS and QoE parameters for inspection and monitoring purposes is defined in a separate document 'Inspection Guide'.

Cannegieter Street 15 – Unit 5.1 I Philipsburg I St. Maarten I Dutch Caribbean I +1(721) 542.4699
info@sxmregulator.sx I www.sxmregulator.sx

2 Available standards and recommendations

2.1 Standards on Quality of Experience and Quality of Service Framework

In the past years Quality of Service (QoS) and Quality of Experience (QoE) of communication services have been the topic of various studies and research. As an example, the standardization sector of the International Telecommunication Union (ITU-T) has a dedicated study group (SG12) working on 'Performance, QoS and QoE'.

Their purpose is to define clear and accurate measures for the quality perceived by end-users that are required to bridge the gap between the offered end-to-end service and the underlying technology.

2.1.1 Definitions

Matching subjective opinions and experience with measurable objective parameters will in all cases be estimations of the technical reality.

The ITU defines Quality of Experience as 'The overall acceptability of an application or service, as perceived subjectively by the end-user' in ITU-T P.10/G.100 [1]. There are two notes with this definition:

NOTE 1 – Quality of experience includes the complete end-to-end system effects (client, terminal, network, services infrastructure, etc.).
NOTE 2 – Overall acceptability may be influenced by user expectations and context.
Curiously, other standardization institutes seem to disagree regarding this definition. In, what is possibly an attempt towards a quantifiable measurement, ETSI uses: 'A measure of user performance based on both objective and subjective psychological measures of using an ICT service or product' [2].

This discussion may be a good illustration of the complexity of the matter: in an attempt of standardization institutes, service providers, equipment suppliers and regulatory bodies to catch the desires of the customer, it becomes clear that numerous aspects influence this subjective view of the experience of the end-to-end communication. Supporters of the ITU-T definition propose to measure QoE solely with a subjective assessment method, such as the Mean Opinion Score (MOS). Others propose to combine MOS with more objective methods.

In a different recommendation, ITU-T Rec. E 800, [3], the ITU defines Quality of Service as: Totality of characteristics of a telecommunications service that bear on its ability to satisfy stated and implied needs of the user of the service'. This definition allows for objective quantification of the quality of service as a set of service parameters.

Alcatel-Lucent Bell Labs in the Bell Labs Technical Journal 15, [3] illustrates the difference between QoE and QoS as follows: 'QoE focuses on user-perceived effects, such as degradation in voice or video quality, whereas QoS focuses on network effects such as end-to-end delays or jitter. Of course, QoE is directly related to QoS, but the challenge for a service provider is to have the right set of tools and processes to map the QoS at the network level to the QoE at the user and session levels and have the ability to control these. Another important point to note is that measurements in individual nodes may indicate acceptable QoS, but end users may still be experiencing unacceptable QoE.

Cannegieter Street 15 – Unit 5.1 I Philipsburg I St. Maarten I Dutch Caribbean I +1(721) 542.4699
info@sxmregulator.sx I www.sxmregulator.sx

Assume, for example, that there is an edge router with an inadequately engineered Voice over Internet Protocol (VoIP) buffer size; also assume that packet overflow is monitored at the aggregate queue level. The VoIP buffer may be overflowing quite frequently, but because the VoIP traffic volume is relatively low compared to other types of traffic and because other buffers do not overflow, aggregate buffer statistics may still appear to be satisfactory (acceptable QoS). This, however, is no consolation for the VoIP subscriber, who is consistently experiencing service interruptions (poor QoE because of dropped packets).'

2.1.2 Overview of standardization

Various standards exist that are defining frameworks, end-to-end service metrics, measurement methods and/or system metrics. What becomes clear from all these standards is that there is no stable set of standards covering the services in an undisputed way. The standards are subject to change, improvement and refinement. The next sections identify some of the initiatives per service area. First an overview of more generic or framework like standards is provided, from a user/QoE perspective and from a network/QoS perspective.

End-to-end frameworks

The ITU-T produced a substantial number of recommendations on the subject of QoE/QoS. Recommendation E.800-E.899 focus on the quality of more traditional telecommunication services such as voice, where G.1000-G.1999 focus on multimedia services in general and more specifically services over IP networks. G.1000 provides a framework, intended to be suitable from different perspectives (customer, service provider, achieved/delivered QoS and customer survey ratings of QoS). This is illustrated in Figure 1.

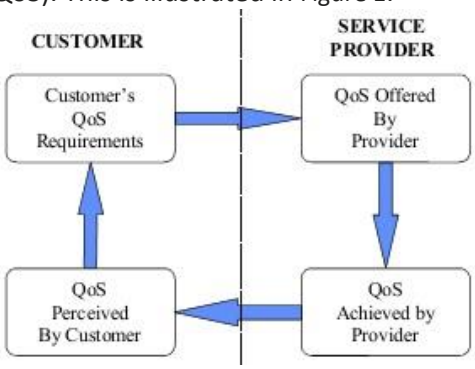

Figure 1 G.1000/ETSI ETR 003 – The four view points of QoS

A further implementation of this framework is provided with G.1010 [5]. It 'defines a model for multimedia Quality of Service (QoS) categories from an end-user viewpoint. By considering user expectations for a range of multimedia applications, eight distinct categories are identified, based on the tolerance to information loss and to delay. It is intended that these categories form the basis for defining realistic QoS classes for underlying transport networks, and associated QoS control mechanisms.'

Cannegieter Street 15 – Unit 5.1 I Philipsburg I St. Maarten I Dutch Caribbean I +1(721) 542.4699
info@sxmregulator.sx I www.sxmregulator.sx

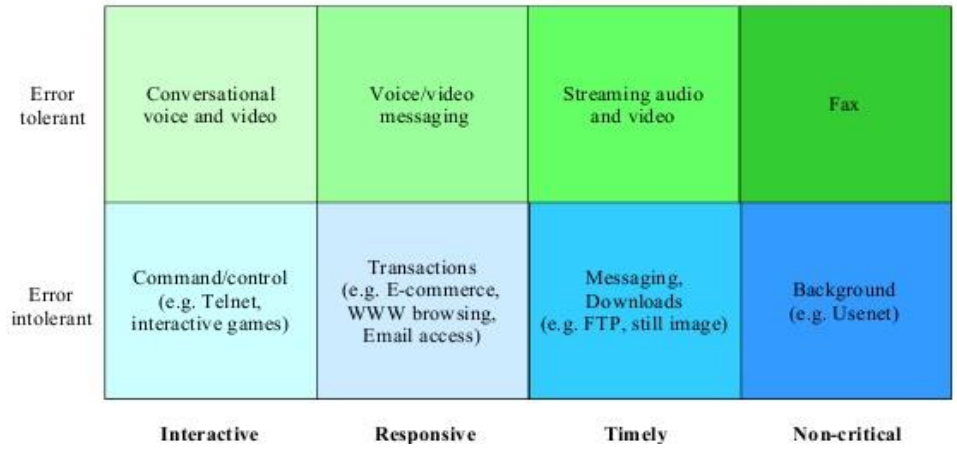

Figure 2 G.1010 – Model for user-centric QoS categories

Tele Management Forum standards have not been reviewed for this study[1]. According to Alcatel-Lucent Bell Labs [3] , the TM Forum defines Key Quality Indicators (KQIs) and Key Performance Indicators (KPIs) as measurements of perceived quality rather than network performance. KQIs are constructed from KPIs, and KPIs are derived from network performance measurements. For instance, an example KQI is the "percentage of sessions that experience delay of X or above," and a corresponding KPI is the session start-up delay, which is derived from network performance measurements on such delays.'

ETSI provides a more detailed QoS framework based on the more general ITU 800 series. This framework clearly distinguishes between the different phases of the customer experience:

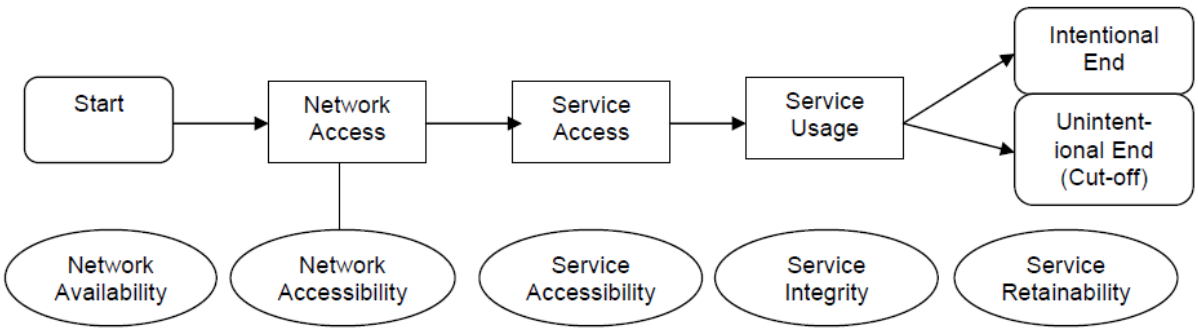

Figure 3 ETSI ETSI TS 102 250-1 V2.2.1 QoS model

The meaning of these phase related QoS aspects (Figure 5.7) is:

1. Network Availability: Probability that the services are offered to a user via a network infrastructure.
2. Network Accessibility: Probability that the user performs a successful registration on the network which delivers the service. The network can only be accessed if it is available to the user.
3. Service Accessibility: Probability that the user can access the service he wants to use. A given Network. Accessibility is a precondition for this phase.

[1] TM Forum standards are only available to members.

Cannegieter Street 15 – Unit 5.1 I Philipsburg I St. Maarten I Dutch Caribbean I +1(721) 542.4699
info@sxmregulator.sx I www.sxmregulator.sx

4. Service Integrity: This describes the Quality of Service during service use and contains elements like the quality of the transmitted content, e.g. speech quality, video quality or number of bit errors in a transmitted file. The Service Integrity can only be determined if the service has been accessed successfully.
5. Service Retainability: Service retainability describes the termination of services (in accordance with or against the will of the user). Examples for this are all kinds of cut-off parameters, e.g. the call cut-off ratio or the data cut-off ratio. Again, a previously performed successful service access is a precondition for this phase.

Based on this ETSI Framework a selection of the key QoS/QoE indicators has been made from a St Maarten end-user/consumer perspective. This framework consists of two components:

- General requirements related to providing service, customer support etc.
- QoS/QoE of the actual telecom service

The general requirements cater for indicators such as:

- Supply time for initial connection
- Faults rate
- Fault repair time
- Billing correctness complaints

In ETSI TS 102 250-2 [9] also an extensive set of end user focused parameters is specified for the QoS/QoE of the actual telecom service. See 4: 'The first layer is the Network Availability, which defines QoS rather from the viewpoint of the service provider than the service user. The second layer is the Network Access. From the service user's point of view this is the basic requirement for all the other QoS aspects and parameters. The third layer contains the other three QoS aspects Service Access, Service Integrity and Service Retainability. The different services are located in the fourth layer. Their outcome is QoS parameters.

Cannegieter Street 15 – Unit 5.1 I Philipsburg I St. Maarten I Dutch Caribbean I +1(721) 542.4699
info@sxmregulator.sx I www.sxmregulator.sx

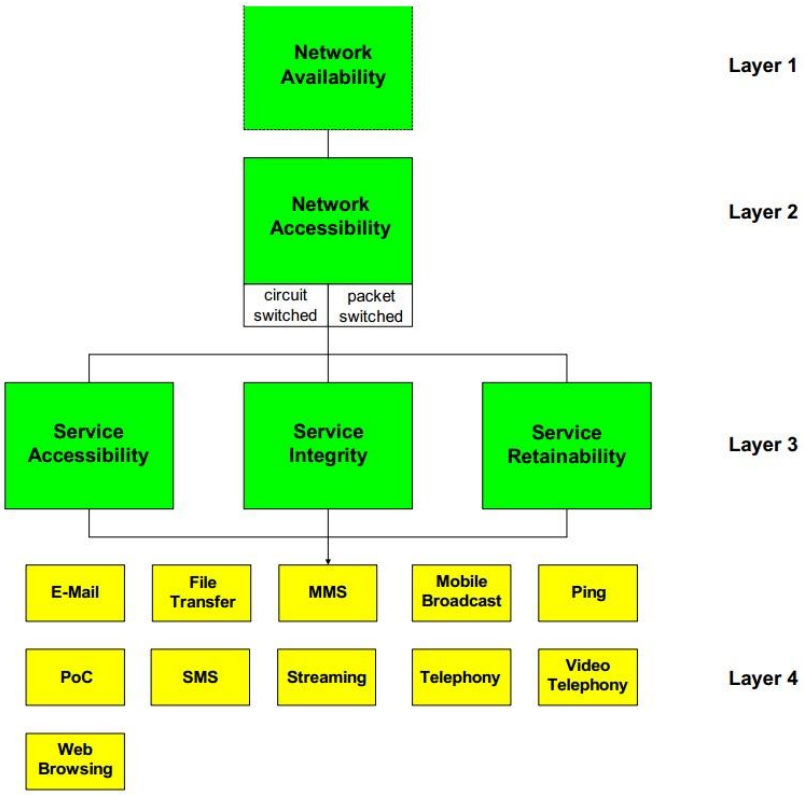

Figure 3 ETSI QoS model

For the actual telecom service QoS/QoE indicators network centric indicators have been avoided as much as possible but could not be eliminated all together since in some cases the measurement of the real end-user QoE is too complex, not standardized or too costly to implement. Only in those cases a network indicator has been included in the list of QoS/QoE indicators

	Network availability	Network accessibility	Service accessibility	Service integrity	Service Retainability
Fixed Voice	Network availability	Unsuccessfull call rate	Unsuccessfull call rate	Voice quality Call set-up time	
Mobile Voice	Network availability Coverage	Unsuccessfull call rate	Unsuccessfull call rate	Voice quality Call set-up time	Dropped call rate
Fixed Broadband	Network availability	IP Service availability	IP Service availability	Network latency Throughput DNS time Web browsing E-mail	
Mobile Broadband	Network availability Coverage	IP Service availability	IP Service availability	Network latency Throughput DNS time Web browsing E-mail	
SMS	Network availability	Completion rate for SMS	Completion rate for SMS	Completion rate for SMS	
Cable TV	Network availability			Video quality Zap time	
IPTV	Network availability			Video quality Zap time	
Broadcasting	Network availability Coverage			Video quality Zap time	

Cannegieter Street 15 – Unit 5.1 I Philipsburg I St. Maarten I Dutch Caribbean I +1(721) 542.4699
info@sxmregulator.sx I www.sxmregulator.sx

In a number of cases a service accessibility or a service integrity indicator actually also covers other aspects such as network or service accessibility. If the overall service from an end-user perspective performs well it implies all the underlying indicators are good enough as well and become less relevant.

Two obvious examples thereof:

- Web page loading. If the web page loading time is good it also implies that the throughput is good, DNS functions good enough, latency is low enough. Overall the end-user expects a good web browsing experience.
- Video quality in for example IPTV services. If the video quality is good the underlying IP packet transport network, bit error rates, packet loss, jitter, latency, etc. are all good enough to deliver a good end-user experience.

2.2 Standards on Quality of Experience and Quality of Service for specific services

2.2.1 Fixed and mobile voice services

ETSI EG 201 769 V1.1.2 specifies both unsuccessful call rate and call set-up time. Both are important end-user indicators since the consumer expects to be able to make a call and to set-up that call within a reasonable time

ETSI EG 202 057-3 specifies the dropped call rate. Dropped calls are a major end-user concern since it is very annoying to have a dropped call.

Further the voice quality is very important end-user indicator. Recommendation ITU-T P.863 [7], that was formerly known as POLQA, can be used to assess speech quality for mobile (both GSM/UMTS and CDMA based standards), fixed and VoIP services. It describes a so-called 'intrusive' method, meaning that it compares the resulting signal with the original one. It can be used for end-to-end assessments. It is: 'an objective method for predicting overall listening speech quality from narrowband (300 to 3400 Hz) to super wideband (50 to 14000 Hz) telecommunication scenarios as perceived by the user in an ITU-T P.800 or ITU-T P.830 ACR listening only test.' 'ITU-T P.863 is the next-generation voice quality testing technology for fixed, mobile and IP-based networks. ITU-T P.863 has been selected to form the new ITU-T voice quality-testing standard. This Recommendation was developed between 2006 and 2010 in a competition carried out by ITU-T, in order to define a technology update for [b-ITU-T P.862].' 'It should also be noted that the ITU-T P.863 algorithm does not provide a comprehensive evaluation of transmission quality. It only measures the effects of one-way speech distortion and noise on speech quality. The effects of delay, side-tone, echo, and other impairments related to two-way interaction (e.g., centre clipper) are not reflected in the ITU-T P.863 scores. Therefore, it is possible to have high ITU-T P.863 scores, yet poor overall conversational quality.

2.2.2 Mobile services

The association representing the GSM/UMTS operators GSMA, defined in the IR.42 QoS parameters [8] for mobile voice, SMS and data.

Cannegieter Street 15 – Unit 5.1 I Philipsburg I St. Maarten I Dutch Caribbean I +1(721) 542.4699
info@sxmregulator.sx I www.sxmregulator.sx

Aimed at the GSM/UMTS/LTE standards, 3GPP has also defined performance metrics. (For completeness, there is 3GPP TS 32.425 (RAN PM), 3GPP TS 32.410 (KPI's), 3GPP TS 32.814 (RAN KPI's), and 3GPP TS 26.944 (PM)).

For the main end-user centric QoS/QoE indicators the ETSI QoS framework covers the main aspects. This includes indicators for SMS.

Coverage requirements are country specific in nature and industry practice is linking them to land area covered as well as population coverage. In built-up areas a stronger signal is required to provide a reasonable level of indoor coverage as well.

2.2.3 Fixed services

For local and international fixed line telephony services the relevant documentation for Quality of Service in ITU-T P.800 and in ITU-T I.350: 'General aspects of quality of service and network performance in digital networks, including ISDNs'. Recommendation ITU-T P.863 [7], that has been referred to 2.2.1, besides for mobile services, can also be used to assess speech quality of fixed and VoIP services.

2.2.4 Data services

Internet access

Public IP networks are in fact still best effort networks. This may be problematic for offering of real time services over IP, such as VoIP. There are some solutions available for providers to deliver these types of service and care is to be taken to enable the imposing of target QoS values. The most straight forward solution is over-provisioning of the network. While a low bandwidth utilization for instance will result in better real time services, it also means an inefficient and therefore possibly a more expensive network.

ITU-T Y.1540/1541

According to the ITU: 'Recommendations ITU-T Y.1540 and Y .1541[2] together provide the parameters needed to capture the performance of IP networks, and specify a set of "network QoS" classes with end-to-end objectives specified. It is widely accepted (i.e., beyond the ITU-T) that the network QoS classes of Recommendation ITU-T Y.1541 should be supported by next generation networks, and thus by networks evolving into NGNs.

Difficulty with most studies and standards is that they're not focused on regulation. An exception to this is a proposal outlined in a recent publication in IEEE Communications Magazine [15]. It proposes a new model using a set of Key Quality Indicators (KQI's) derived from earlier studies, e.g. from ETSI.

These KQI's are divided in categories: network QoS, service availability and customer care. The KQI's are derived from measurable Key Performance Indicators (KPI's).

The Internet Engineering Task Force IETF is the community shaping the Internet and IP standards or Request for Comments (RFC's). IETF has several possibly relevant documents, for example:
RFC 2330, Framework for IP Performance Metrics, 1998
RFC 2678, IPPM Metrics for Measuring Connectivity, 1999
RFC 2679, A One-way Delay Metric for IPPM, 1999

[2] ITU-T Y.1541 has just been updated and is at the moment of writing available as pre-release. This version is not freely accessible and for that reason an older (superseded) version has been used.

Cannegieter Street 15 – Unit 5.1 I Philipsburg I St. Maarten I Dutch Caribbean I +1(721) 542.4699
info@sxmregulator.sx I www.sxmregulator.sx

RFC 2680, A One-way Packet Loss Metric for IPPM, 1999
RFC 3357, One-way Loss Pattern Sample Metrics, 2002
RFC 3393, IP Packet Delay Variation Metric for IP Performance Metrics (IPPM), 2002
RFC 3432, Network Performance Measurements with Periodic Streams, 2002

The ETSI TS 102 250 and ETSI EG 202 057 series provide an extensive framework as well as details on measurement methods for IP services.

For completeness ATIS 0100522.2000 (formally known as ANSI T1.522-2000) is mentioned here. It specifies classes of Quality of Service for Business Multimedia Conferencing on IP networks. It appears to be[3] outdated as its scope is limited to H.323 applications. H.323 is the ITU standardized protocol suite. However Session Initiation Protocol (SIP) has become the more popular signaling solution.

Web

ITU-T G.1030 provides a model for estimating the performance of data applications over Internet Protocol (IP) networks. 'This model consists of three steps: 1) network performance assessment, 2) application performance assessment, and 3) perceptual performance assessment. The third step is the one that introduces the idea of user experience (perception). This can be viewed as an "opinion model" which maps end user experience from the network layer up to the application layer. The recommendation includes a model for Web browsing, but other applications are left for further study.
On the topic of web browsing, currently the ITU has Quality of Experience for further study in Study Group ITU-T SG 12 with provisional name: G.QoE-Web.

ETSI TS 102 250-5 V2.4.1 provides the QoS/QoE guidance for web browsing.

Email

QoS/QoE definitions for email can be found in ETSI EG 202 009-2 and in ETSI TS 102 250-2
In particular ETSI EG 202 009-2, (Speech Processing, Transmission and Quality Aspects (STQ); User related QoS parameter definitions and measurements), part 4 deals with Internet access.

ETSI TS 102 250-5 V2.4.1 specifies the E-mail QoS/QoE indicator.

VoIP

For VoIP QoS/QoE parameters the recommendations ITU-T P.863 and ITU-T P.563 are applicable in order to estimate speech quality.

The Recommendation ITU-T P.563 describes a method for predicting the subjective quality of 3.1 kHz (narrow-band) telephony applications. The Recommendation presents the high level description of the method, and a conformance testing procedure. The Recommendation includes an electronic attachment containing an ANSI-C reference implementation.

The ITU-T P.563 algorithm is applicable for speech quality predictions without a separate reference signal (other than ITU-T P.862 and P.863). Real systems may include background noise, filtering and variable delay, as well as distortions due to channel errors and speech codecs. Up to now, methods for speech quality assessment of such systems require either a reference signal or they calculate only quality indexes based on a restricted set of parameters like level, noise in speech pauses and echoes.

[3] The document has not been reviewed; ATIS publications are not freely accessible.

Cannegieter Street 15 – Unit 5.1 I Philipsburg I St. Maarten I Dutch Caribbean I +1(721) 542.4699
info@sxmregulator.sx I www.sxmregulator.sx

The P.563 approach is a method for measurement applications that takes into account the full range of distortions occurring in public switched telephone networks and that is able to predict the speech quality on a perception-based scale like MOS.

Recommendation ITU-T P.862 describes and objective method for predicting overall listening speech quality (PESQ).

Recommendation ITU-T P.863 (POLQA) is the latest in the series of objective voice quality measurement methods and describes an objective method for predicting overall listening speech quality from narrowband (300 to 3'400 Hz) to super-wideband (50 to 14'000 Hz) telecommunication scenarios as perceived by the user.

It should also be noted that the ITU-T P.863 algorithm does not provide a comprehensive evaluation of transmission quality. It only measures the effects of one-way speech distortion and noise on speech quality. Not all effects of delay, side-tone, echo, and other impairments related to two-way interaction are reflected in the ITU-T P.863 scores. Therefore, it is still possible to have high ITU-T P.863 scores, yet poor overall conversational quality.

Modern test equipment is typically already supporting POLQA measurements as the latest standard for objective voice quality measurements.

IPTV

QoS/QoE definitions for IPTV can be found in several sources.

The Recommendation Y.1541 (Network performance objectives for IP-based services) defines classes of network Quality of Service (QoS) with objectives for Internet Protocol network performance parameters. Two of the classes contain provisional performance objectives. These classes are intended to be the basis for agreements among network providers, and between end users and their network providers. A specific appendix (Appendix VIII) provides a discussion concerning the digital television transport on IP Networks.

The Recommendation ITU-T G.1080 (Quality of experience requirements for IPTV services, [11]) defines user requirements for quality of experience (QoE) for Internet protocol television (IPTV) services. The QoE requirements are defined from an end user perspective and are agnostic to network deployment architectures and transport protocols. The QoE requirements are specified as end-to-end and information is provided on how they influence network transport and application layer behavior. Specific QoE requirements for video, audio, text, graphics, control functions and meta-data are provided.

There are currently developments under way in ITU in Study Groups SG 12 to define recommendations G.IPTV-PMMM (Measurement methods for performance monitoring parameters) and G.IPTV-PMPD (Definitions of IPTV performance monitoring parameters)

The Broadband Forum has published a technical report TR 126 [10], that presents the recommended minimum end-to-end quality of experience (QoE) guidelines in terms of engineering objective measures for triple play applications delivered through a broadband infrastructure. QoE requirements define the overall, performance at the services level from the perspective of the end user. The establishment of consistent, baseline subjective QoE for end users and corresponding objective engineering targets is critical to the market success of broadband service offerings. The QoE guidelines presented in this document are end-to-end requirements and are agnostic to access technology (xDSL, xPON, etc.), services architecture, and implementation. Initial applications

Cannegieter Street 15 – Unit 5.1 I Philipsburg I St. Maarten I Dutch Caribbean I +1(721) 542.4699
info@sxmregulator.sx I www.sxmregulator.sx

presented are entertainment video (video on demand, and broadcast video), voice, and best-effort data (web browsing, gaming). Other applications such as, video conferencing may be included in a future revision.

ATIS IPTV Interoperability Forum standards have not been reviewed for this study4. According to the standardization committee itself: 'Framework for QoS Metrics and Measurements Supporting IPTV Services (ATIS-0800004) serves as a basis for definitions of Quality of Service (QoS)/Quality of Experience (QoE) related to different segments of the network, different service instances or invocations, network architectures/technologies utilized and modes of service. The document offers an overview and concepts related to the following: measurement model and measurement points; quality layers, protocol stack view and use cases; types, characteristics and definitions of metrics; a QoS/QoE Model; measurement practices and methodologies; and time and frequency synchronization requirements for ensuring QoS/QoE and enabling metrics measurement.'

2.3 Broadcasting

2.3.1 Cable TV

Cable Television networks can be full coaxial cable, a fiber and coaxial combination commonly called HFC short for Hybrid Fiber Coaxial, and Full fiber also called fiber to the home. Coaxial cable is the most old-fashioned method for distributing signals (analog signals) to individual homes. Today the most common services are analogue TV, digital TV (SDTV or HDTV), Video on demand, telephony, and high-speed data. In HFC systems the transport from the head end is split into a large trunk, based on fiber optic transport and a local fiber optic transceiver that converts into the electric-coaxial branches connecting the individual homes. The digital standard to be used is DVB-C or DVB-C2. HFC systems can easily be deployed over large areas and the optical trunks can be used for other digital transport simultaneously. In fiber to the home systems, a passive fiber network is used to connect the head-end to the individual homes allowing for the availability of unlimited bandwidth. All services offered are digital.

2.3.2 AM and FM Broadcasting

AM and FM radio are the primary means to deliver conventional, ('linear'), audio content on the island. These systems have been in use for many years and their strengths and weaknesses are well known. Broadcasting services are planned for fixed, portable outdoor / indoor or mobile (e.g. car) reception and could be of different quality of service (QoS) levels. The reception can be different in different parts of a country based on geographic and topographic conditions like dense urban places, rural areas, mountainous areas and the presence of large water spaces. To achieve the proposed QoS and QoE for AM and FM broadcasting-services the broadcasting infrastructure must comply with the requirements as set by BTPSXM that are inline with ITU and other international standards.

The QoS indicators for broadcasting include both end-user centric indicators as well as spectrum and interference centric indicators since efficient use of the spectrum and avoiding harmful interference is of critical importance for all the services using the radio spectrum.

2.3.3 TV Broadcasting, DVB-T/T2

The standard for Digital Terrestrial Television (DTT) in St. Maarten is Digital Video Broadcasting Terrestrial (DVB-T). Quality of Service (QoS) in digital television broadcasting has been the subject of many studies. This has led to the establishment of various standards and recommendations by

[4] ATIS recommendations are not freely accessible.

Cannegieter Street 15 – Unit 5.1 I Philipsburg I St. Maarten I Dutch Caribbean I +1(721) 542.4699
info@sxmregulator.sx I www.sxmregulator.sx

organizations such as ETSI and the ITU (DVB-T ref ETSI EN 300 744 and DVB-T2 ref. EN 302 755). BTP recognizes that there are multiple parameters and associated measurement methods specified by ETSI and ITU as it relates to DVB QoS. QoS for DTT is meant to ensure that Digital TV service is properly distributed to all viewers with the expected video and audio quality. To achieve the correct QoS performance within the DTT transmission chain, different technical parameters are checked. The guidelines for the QoS measurements in DVB-T networks are outlined in the ETSI TR 101 290.

3 Conclusions

In St. Maarten the choice is made to define and describe a limited set of QoS/QoE parameters selected from international standardization documents, for fixed and mobile telephony networks, for Internet and broadcasting services. An initial selection has been proposed in this document.

Telecommunications Regulator of St. Maarten (Bureau of Telecommunications and Post St. Maarten, BTPSXM) is to make preparations to fulfil its tasks and responsibilities. Defining quality parameters and preparation of guidelines for future infrastructure inspections as they relate to QoS/QoE is one of these tasks.

In the description of the QoS/QoE parameters as much as possible, performance objectives will be defined beforehand. Those objectives need to be validated and evaluated by BTP in practice, and if needed amended. However there may be several parameters that are difficult to set on beforehand as they are relative values to the local network and service performance, and will have to be set as a result of the measurement and monitoring practice.

For St. Maarten this recommendation is of importance as there is limited history and experience in monitoring and inspection based on the premise of QoS and QoE. In the process of establishing a more mature QoS/QoE monitoring and inspection framework, the approach may depend on the perception of the quality that currently is provided by the networks and service providers active on St. Maarten. If the quality is perceived as sufficient (or more than sufficient) then it may be useful to define minimum levels for the quality parameters and to have a low profile monitoring and inspection scheme. However if the quality perceived is not sufficient and subject to significant improvement then a different and more strict approach will be needed. The set of QoS/QoE for St Maarten, as well as the performance objectives will be defined in a separate document. The description of the QoS/QoE parameters will have to be used as the basis for implementing QoS/QoE requirements at St. Maarten, and for monitoring and inspection procedures.

Cannegieter Street 15 – Unit 5.1 I Philipsburg I St. Maarten I Dutch Caribbean I +1(721) 542.4699
info@sxmregulator.sx I www.sxmregulator.sx

4 References

[1] ITU-T Recommendation P.10/G.100 (2006) Amendment 2: 'Vocabulary for performance and quality of service', International Telecommunications Union, 2008

[2] ETSI TR 102 643: 'Human Factors (HF); Quality of Experience (QoE) requirements for real-time communication services', version 1.0.2, European Telecommunications Standards Institute, 2010

[3] BATTERAM, H. *et al.*: 'Delivering Quality of Experience in Multimedia Networks', Bell Labs Technical Journal 15(1), pp. 175-194, 2010

[4] ITU-T Recommendation E.800: 'Definitions of terms related to quality of service', International Telecommunications Union, 2008

[5] ITU-T Recommendation G.1010: 'End-user multimedia QoS categories', International Telecommunications Union, 2001

[6] Tele Management Forum: 'SLA Management Handbook: Volume 2, Concepts and Principles', Rel. 2.5, GB 917-2, TM Forum, 2005

[7] ITU-T Recommendation P.863: 'Perceptual objective listening quality assessment', International Telecommunications Union, 2011

[8] GSM-Association IR.42: 'Definition of Quality of Service parameters and their Computation', version 4.0, 2011

[9] ETSI TS 102 250-2: 'Speech and multimedia Transmission Quality (STQ); QoS aspects for popular services in GSM and 3G networks; Part 2: Definition of Quality of Service parameters and their computation', version 1.7.1, European Telecommunications Standards Institute, 2009

[10] DSL/Broadband Forum Technical Report TR 126: 'Triple-play Services Quality of Experience (QoE) Requirements', 2006

[11] ITU-T Recommendation G.1080: 'Quality of experience requirements for IPTV services', International Telecommunications Union, 2008

[12] Directive 2002/22/EC: 'Universal service and users' rights relating to electronic communications networks and services (Universal Service Directive)', Official Journal of the European Communities, 2002 and amended in 2009 (Directive 2009/136/EC)

[13] SUTHERLAND, E.: 'The regulation of the quality of service in mobile networks', Emerald Info, vol. 9, no. 6, pp. 17-34, 2007

[14] BLACKMAN, C. (*ed.*): 'Telecommunications regulation handbook; Tenth anniversary edition', The International Bank for Reconstruction and Development / The World Bank, InfoDev, and The International Telecommunication Union, 2011

[15] IBARROLA, E. *et al.*: 'Internet QoS Regulation in Future Networks: A User-Centric Approach', IEEE Communications Magazine, pp. 148-155, October 2011

Cannegieter Street 15 – Unit 5.1 I Philipsburg I St. Maarten I Dutch Caribbean I +1(721) 542.4699
info@sxmregulator.sx I www.sxmregulator.sx