Quality of Service Analysis and Testing

June 2006

INTRODUCTION

The convergence of traditional PSTN and the new wireless 3G technologies towards the IP technology is obliging Service Operators and Manufacturers to face new quality of service challenges.

The adoption of packet-switched technology for the entire core network allows the Service Operator to focus on a single network instead of different networks for voice and data services, so that it can achieve what has been promised for many years: 'Voice, video and data convergence' or 'triple play'.

However, in contrast to the legacy circuit-switched approach where each call secured a fixed bandwidth to carry the service, VoIP and 3G equipments code voice flows in streams and transmit them across a packet-switched IP network.

The target to be achieved within this brand new architecture is to provide the same quality of service (QoS) that customers were used to with traditional circuit-switched networks.

Packet loss, jitter and delay, which mainly arise from network congestion, tend to be major causes of lost voice signal. Codecs used to encode/decode and compress digitally sampled audio signals try to mask packet loss by replaying the last packet, interpolating from previous packets or adding noise.

These loss-concealment techniques suffice when packets are lost individually or at random, but are ineffective with burst loss, in which much more signal is lost. Packet loss may also occur at different rates during a call, so call quality varies most of the time.

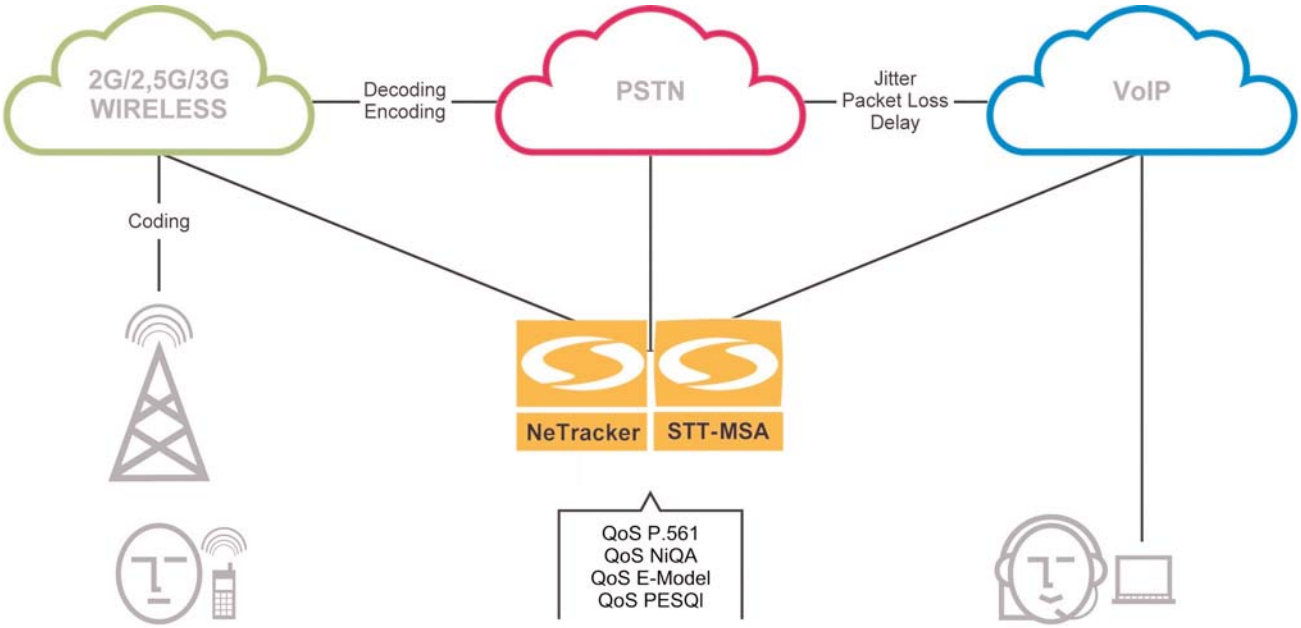
VOICE QUALITY: THE SUNRISE TELECOM SOLUTION

Sunrise uses two different approaches to evaluate voice quality:

- Intrusive testing
- Non-intrusive analysis

The intrusive solution consists of generating loop-back voice calls during which an audio file is sent and received back; voice quality can be assessed with appropriate algorithms by comparing the source and received audio files. Intrusive testing allows highly accurate objective testing, but potentially valuable network resources are used during the tests, which means they will not be available for the customer's traffic.

The non-intrusive solution entails monitoring live user traffic to determine the quality perceived by the customers themselves. Non-intrusive techniques allow for a larger number of tests at a much-reduced operational cost compared with intrusive monitoring. However they are slightly less accurate then intrusive techniques.



SUNRISE TELECOM

. . . a step ahead

Quality of Service Analysis and Testing

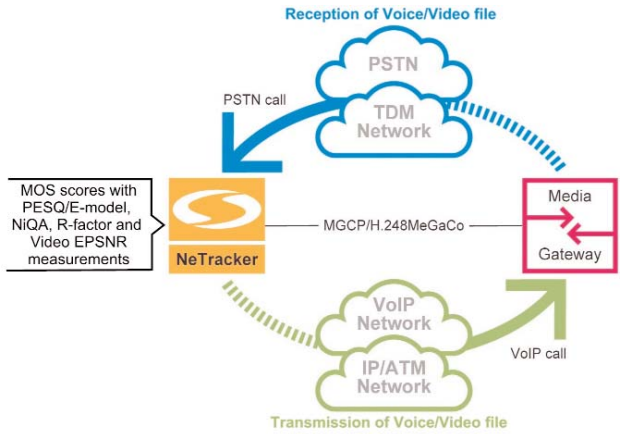
INTRUSIVE SOLUTION FOR VoIP: PESQ TESTING

NeTracker® and STT-MSA tests voice channels for telephony by sending pre-recorded .wav files. The signaling protocols used for carrying voice include:

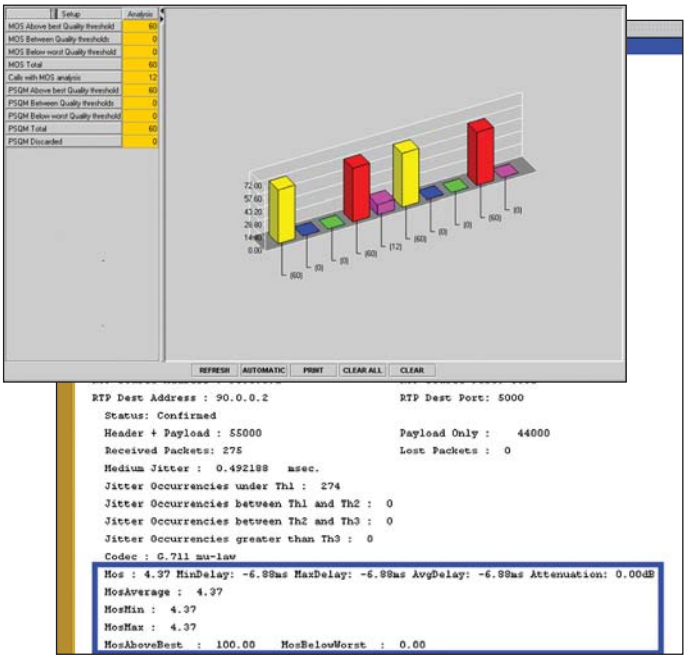
- SS7 ISUP
- ISDN NT/TE
- H323
- SIP
- MGCP
- POTS

PESQ analysis run in real-time and off-line. The Mean Opinion Score (MOS) value is also calculated and provided. Charts and graphs are available in the result pages.

This package (OPT-PESQ) is available for all simulators and allow intrusive testing of the quality provided over a traditional PSTN or VoIP network.



Calls can be originated from PSTN to VoIP and vice versa



Example of a CDR with MOS scores

NON-INTRUSIVE SOLUTION FOR VoIP: E-MODEL

Sunrise Telecom has integrated the state-of-the-art VQmon/SA E-Model algorithm, into its equipment supporting VoIP Monitor to provide a non-intrusive monitoring system. The analysis system provides call quality metrics, including listening and conversational quality scores and detailed information on the severity and distribution of packet loss and discards due to jitter.

Sunrise's implementation is based on the well-established ITU G.107 E Model, with extensions to support time-varying network impairments. The equipment monitors the RTP packet stream containing the voice samples and automatically recognizes individual call streams and the types of CODEC in use. It determines which packets were lost or discarded due to jitter and uses this to estimate call quality (MOS).

It is now possible to gather quality parameters from live traffic to investigate problems reported by the customers and to verify how the network behaves under different load conditions.

MOS scores are added to the Call Details Record and, together with Jitter and Packet Loss measurements, provide an extensive set of scoring for each call.

This package (OPT-VoIP-VQMON) is available as a software option on all Sunrise platforms supporting VoIP Monitor packages and is independent of the underlying signaling protocol.

Features

- Call Quality Measurements on live audio VoIP traffic
- Storage of Call Quality Measurements in the CDR:
  - Listening quality R-factor
  - Conversational (user) quality R-factor
  - G.107 R-factor
  - Nominal (generally accepted maximum obtainable) R- factor for the voice stream given a typical transmission system and voice CODEC selection for the call
  - Listening quality MOS score
  - Conversational quality MOS score calculated for the voice stream
  - Listening quality MOS score normalized to the PESQ scale
  - The nominal (generally accepted maximum obtainable) MOS score for the voice stream given a typical transmission system and voice CODEC selection for the call.
- Customized scoring for the following geographical areas:
  - North America
  - South America
  - Europe
  - Africa
  - Asia
  - Japan
  - Australia

Applications

- Monitoring of the quality of live calls as perceived by the users
- SLAs verification
- Verification of users' complaints about audio quality
- Understanding the network behavior during real usage

A 'BRAND NEW' NON-INTRUSIVE SOLUTION FOR VOICE: NiQA

Sunrise Telecom has also implemented Non-intrusive Quality Assessment (NiQA). This algorithm is designed to assess the listening quality of live customer traffic.

The algorithm is non-network specific and can be deployed in a wide range of network (circuit-switched and packet-switched) transport technologies. With multiple locations in a network, it is possible to make comparisons of results between more than one monitoring point located in different geographical areas and running over different protocols.

This allows the performance of specific links or network subsystems to be monitored.

MOS scores are available in the CDRs and as a dedicated statistic.

NON-INTRUSIVE SOLUTION FOR VOICE OVER PCM

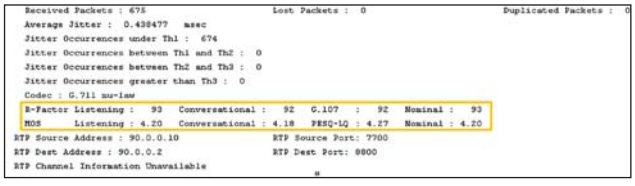
All NeTracker®, 3GMaster® and STT-MSA platforms implement non-intrusive QoS measurement for the **PCM G.711** links according to the specification **ITU P.561** related to the INMD (In-service Non-intrusive Monitor Devices) for voice trunks over E1 and T1. Measurements can be performed over the following protocols:

- GSM-A, ISUP, ISDN, and POTS

Up to 128 Signaling Time-slots can be monitored in real time for each piece of equipment and measurements can be made for up to 25 calls simultaneously.

In addition, all platforms implement, **VQMON**, based on ITU **G.107 E-Model** and providing R-value and MOS scores per call. Measurements can be performed over the following protocols:

- ISUP, and ISDN



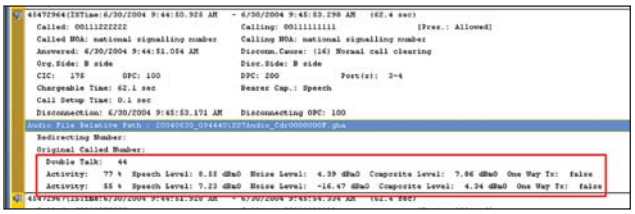
QoS scores in a CDR according to E-model specifications

Signaling CDR and Audio CDR are stored locally in a proprietary format for security reasons.

Results

The following measurements are available in the CDRs:

Activity Factor: the ratio between the active time and the total time elapsed during a measurement



QoS scores in a CDR according to P.561 specifications

Speech Level: the electrical energy generated by the conversion of acoustical talker energy excluding any noise that is not part of the speech

Noise Level: the electrical energy caused by spurious signals

Composite Level: the measurement of the level over the whole waveform

One-way transmission: the temporary loss of one direction of the transmission. One-way transmission can occur in some genuinely connected calls and the probabilities of this situation will be taken into account in deciding whether to classify apparent one-way transmission as a fault or not.

The following results are available in a dedicated statistic:

Doubletalk: is a condition whereby one participant in a telephone conversation starts talking before the other has finished.

Echo Path Loss: the attenuation of the echo signal corresponds to the difference between the levels of the original and of the echo signals.

Echo Path Delay: The delay of the echo corresponds to the time taken by the original signal at a given measurement point to come back as an echo

IP VIDEO SOLUTIONS

Both the intrusive and the non-intrusive solutions involve monitoring live user traffic or simulating traffic to rate and score the quality of the video that is encoded, compressed and then sent over the IP.

The metric used is the **PSNR** (Peak Signal to Noise Ratio). PSNR is currently the most commonly used objective metric for measuring the “noise” level in a video sequence. PSNR is measured on a logarithmic scale and it is strictly related to the Mean Squared Error (MSE) between an original and an impaired image or video frame.

The original version of the standardized PSNR only looks at the luminance value.

Sunrise Telecom has developed an enhanced version of the algorithm: **EPSNR**. In EPSNR the value of the chrominance has been taken onto consideration to score the PSNR value (80% luminance, 10% chrominance red and 10% chrominance blue).

The score is a summary value derived by EPSNR calculation and represents the in a simple way the quality experienced by the end-user.

Note: EPSNR package is available for H.323 and SIP protocols only.

ORDERING INFORMATION

All platforms

Part number	Details
OPT-VoIP-VQMON	Non-Intrusive QoS Analysis based on ITU G107 E-Model (R-Value and MOS)
OPT-PCM-IMPAR	Non-Intrusive Impairments Measurement and Analysis over G711 voice steam into PCM time slots
OPT-NiQA	Non-Intrusive Impairments Measurement and Analysis over PSTN (TDM flows) and VoIP (RTP Flows)
OPT-AUDIO-MON	It enable the audio recording and Listening
OPT-VIDEO-MON	It enable the video recording and play-back
OPT-EPSNR-MON	Non-Intrusive EPSNR
OPT-SIG-AN	Signal Analyzer Package for post analysis of the audio files recorded over the unit

NeTracker® and STT-MSA platforms only:

Part number	Details
OPT-PESQ	Intrusive QoS Analysis based on ITU P.862 (PESQ) algorithm
OPT-VIDEO-SIM	Video over IP simulation suite
OPT-EPSNR-SIM	Intrusive EPSNR

All other suites, protocol packages, options and accessories:

Please contact your local Distributor or Sales Representative.

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