
Voice Quality Testing

(POLQA v3, POLQA v2.4, PESQ)

 ***GL Communications Inc.***

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Fundamentals of Perceptual Modeling

Opinion Scale for Speech Quality Tests

Grade	Impairment	Quality of Speech
5	Excellent	Imperceptible
4	Good	Perceptible but not annoying
3	Fair	Slightly annoying
2	Poor	Annoying
1	Bad	Very annoying



- The common idea behind perceptual quality measures is to mimic the situation of a subjective test, where human beings would have to score the quality of sound samples in a listening laboratory environment
- Requires large number of subjects, very costly and time consuming; analysis based on human perception not accurate or repeatable

PESQ - Perceptual Evaluation of Speech Quality

Voice Quality Algorithm based on ITU-P.862

- PESQ (introduced in 2001) incorporates many new developments that distinguish this algorithm
- Level alignment
 - Input filtering
 - Auditory transform
 - Time alignment
 - PESQ LQ –closer to the Listening Quality subjective opinion scale – customer’s perception of quality
 - PESQ LQO (P.862.1) – Listening Quality Objective, correlating better to subjective test results
- PESQ WB (P.862.2) – support for WB codecs. However, PESQ had limitations with WB VoIP codecs where it was scoring too low

GL's PESQ Analysis

Measurement Results Manual Measurement **Analysis** Rating Criteria

Jitter
 Clipping
 Level
 PESQ/Utterance
 Delay/Utterance

Report

	Utterance 1	Utterance 2	Utterance 3	Utterance 4	Utterance 5	
PESQ	4.5	4.5	4.5	4.5	4.5	
PESQ LQ	4.5	4.5	4.5	4.5	4.5	
PESQ LQO	4.55	4.55	4.55	4.55	4.55	
PESQ WB	N/A	N/A	N/A	N/A	N/A	

graphical: off degraded: raw reference: raw Excellent: 7 Good: 0 Fair: 0 Poor: 0 Total Measurements: 7

POLQA

Perceptual Objective Listening Quality Assessment

(POLQA v3, POLQA v2.4)

Voice Quality Algorithm based on ITU-P.863

POLQA (introduced in 2011) produces very similar scores as PESQ for NB codecs (uses similar mathematical techniques). However, POLQA was mainly introduced for SWB (and WB) support.

Operations Performed by POLQA

- Temporal alignment
- Sample rate estimation
- Resample
- Level alignment
- Frequency response and time alignment

Results Provided by POLQA

- MOS-LQO
- G.107 R-Factor / E-Model
- Attenuation
- Level and Background Noise Measurements
- Signal to Noise Ratio (SNR)
- Active Speech Ratio (ASR)

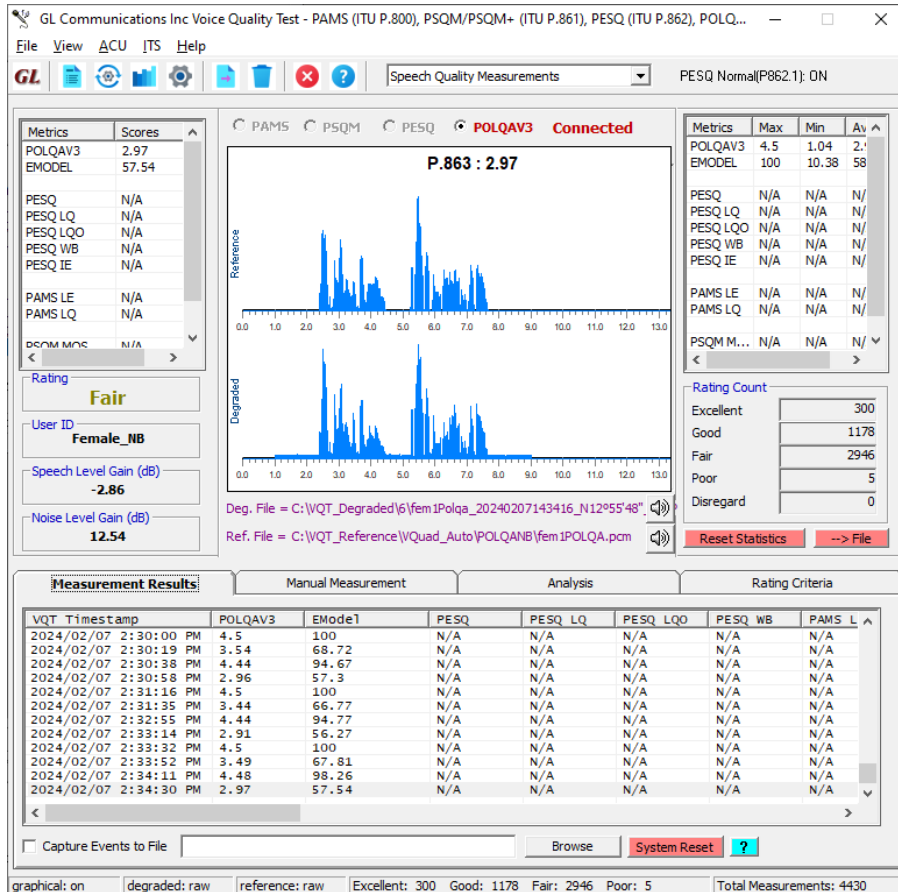
POLQA Algorithm

- POLQA is an objective model of subjective Listening Only Tests
- VQT POLQA supports analysis of 16-bit uncompressed PCM and WAV files, including NB (8000 sampling), WB (16000 sampling), SWB (48000 sampling)
- Revised Psycho-Acoustic and Cognitive Model
- Supports:
 - EVRC type codecs
 - Noise Reduction
 - Time-warping
 - VoIP
 - Non-optimal presentation levels
 - Filtering and spectral shaping
 - Recordings made at an ear simulator

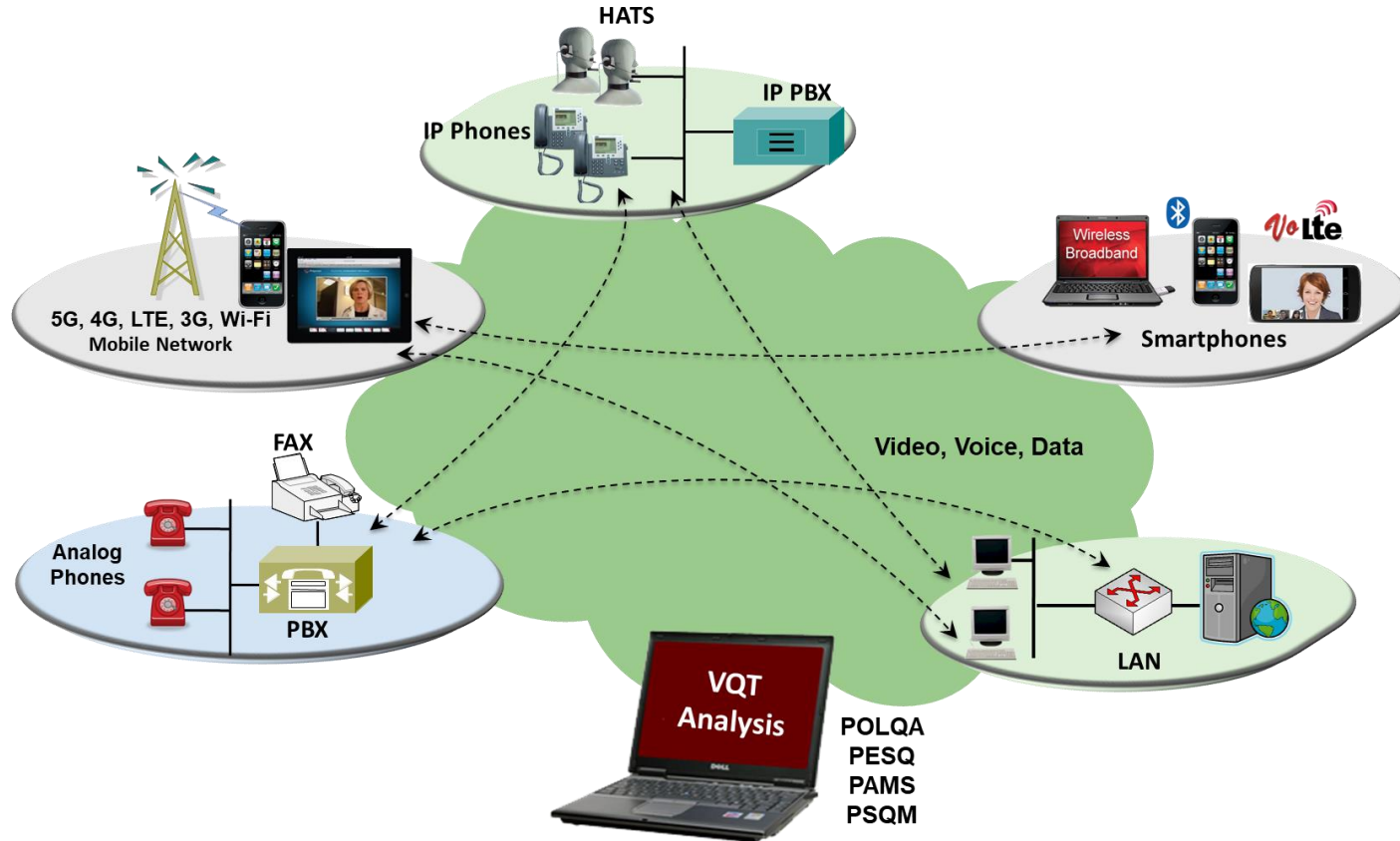
POLQA v3 Algorithm

- POLQA v3 Upgrade Enhancements
- POLQA v3 Super Wideband (SWB) supports 14kHz to full audio bandwidth up to 24kHz.
- Full band analysis improves accuracy in assessment of codecs such as EVS, OPUS, AAC and LC3, as these codecs are used in many OTT applications
- With Full band support the discriminative power of POLQA at the upper high-quality range of the MOS scale is increased
- Current OTT voice services using VoLTE/5G include highly dynamic delay jitter which leads to variations of the duration of very short pauses during speech. POLQA v3 handles these variations with increased precision
- POLQA v3 reacts with less sensitivity to linear frequency distortions than POLQA v2.4. This makes measurements less dependent on the frequency characteristics of headsets
- Perceptual model of POLQA v3 is significantly improved and streamlined

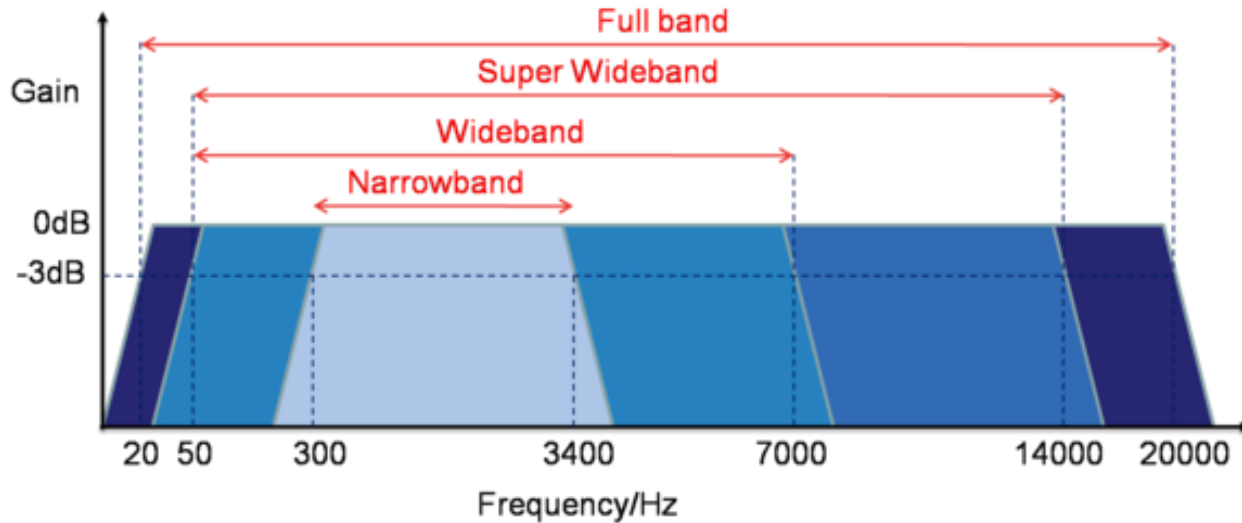
GL's POLQA Analysis



POLQA Testing

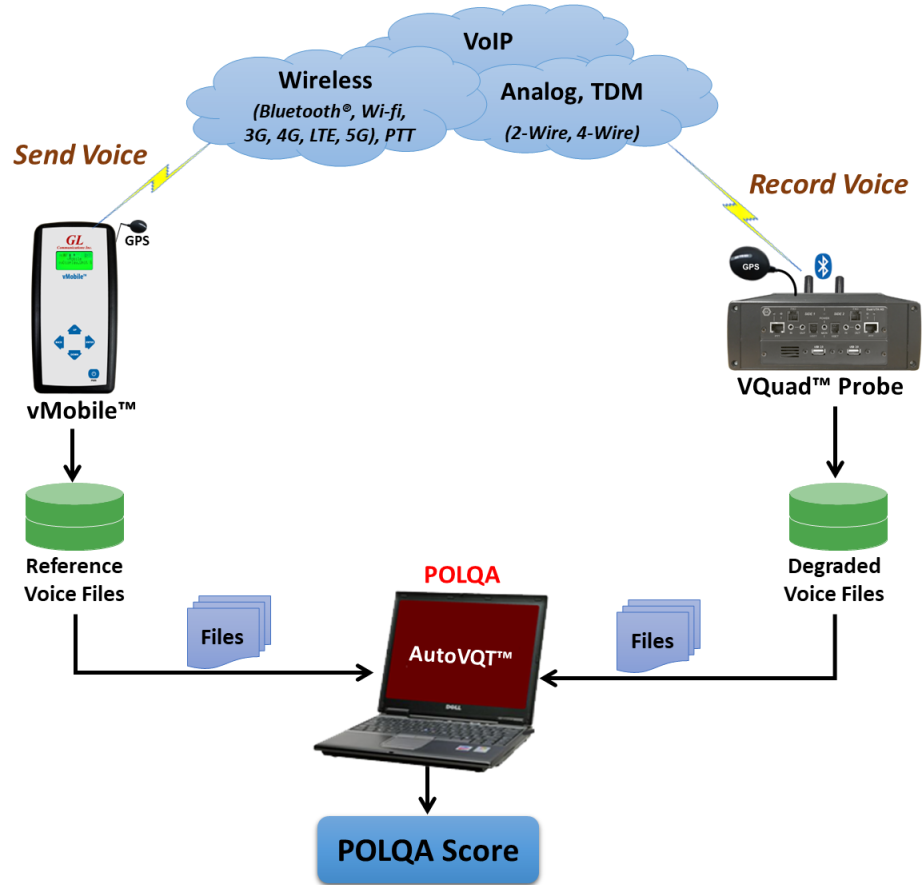


POLQA WB and SWB



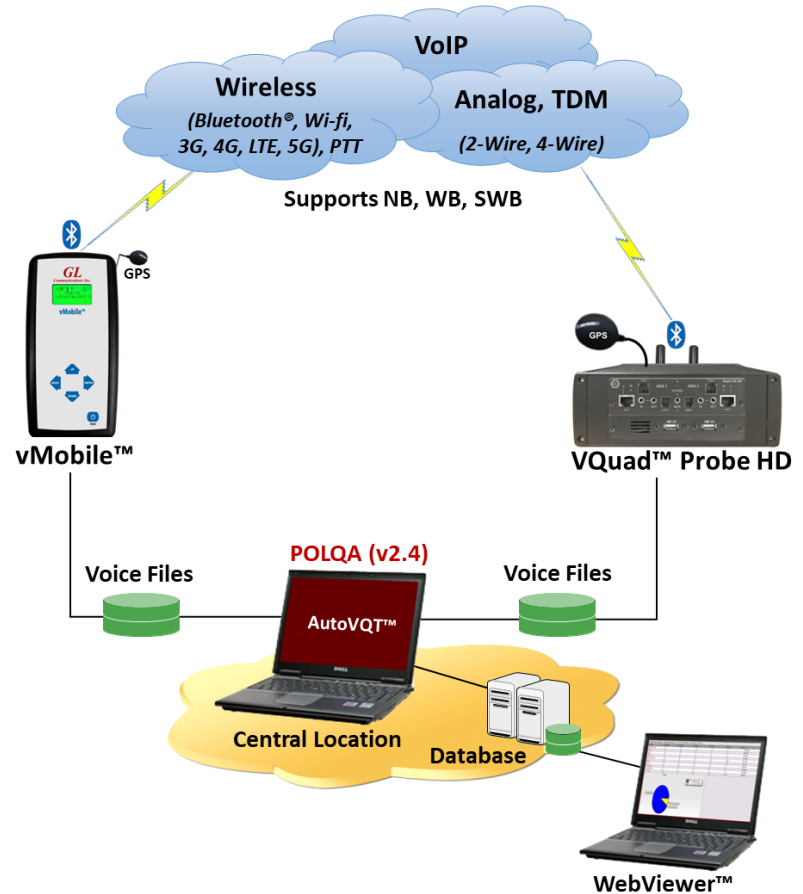
- Support for WB (7kHz) and SWB (14kHz) codecs/networks
- Support for networks delivering HD-quality voice services including VoIP and Mobile
- Supports networks with variable delay and time scaling

Generate POLQA Score

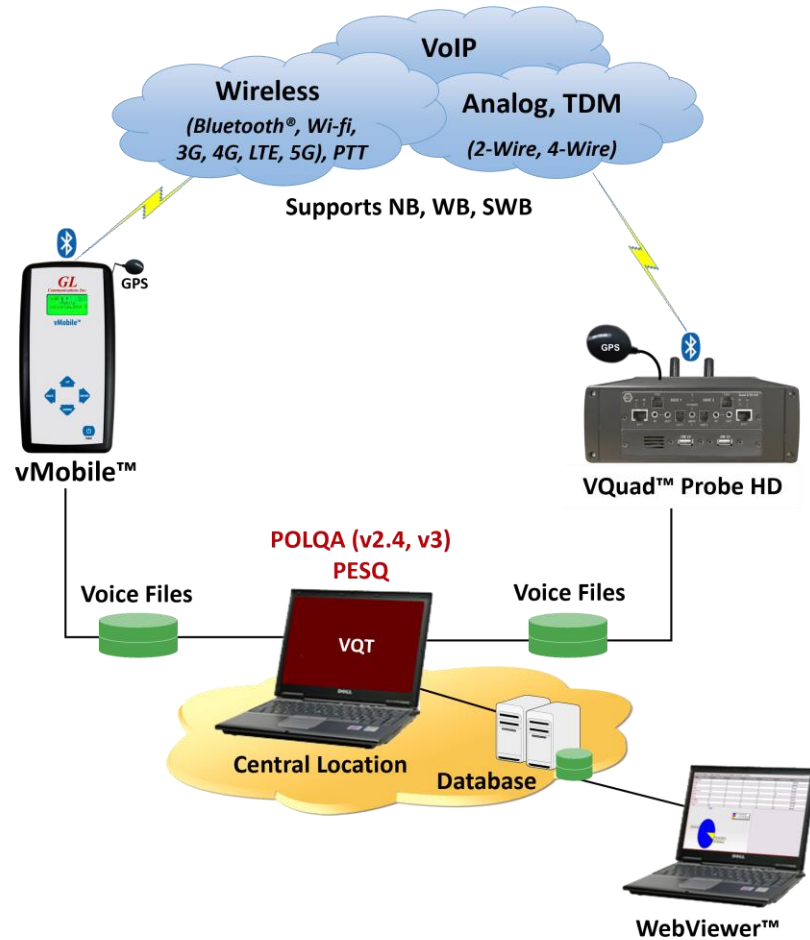


AutoVQT™

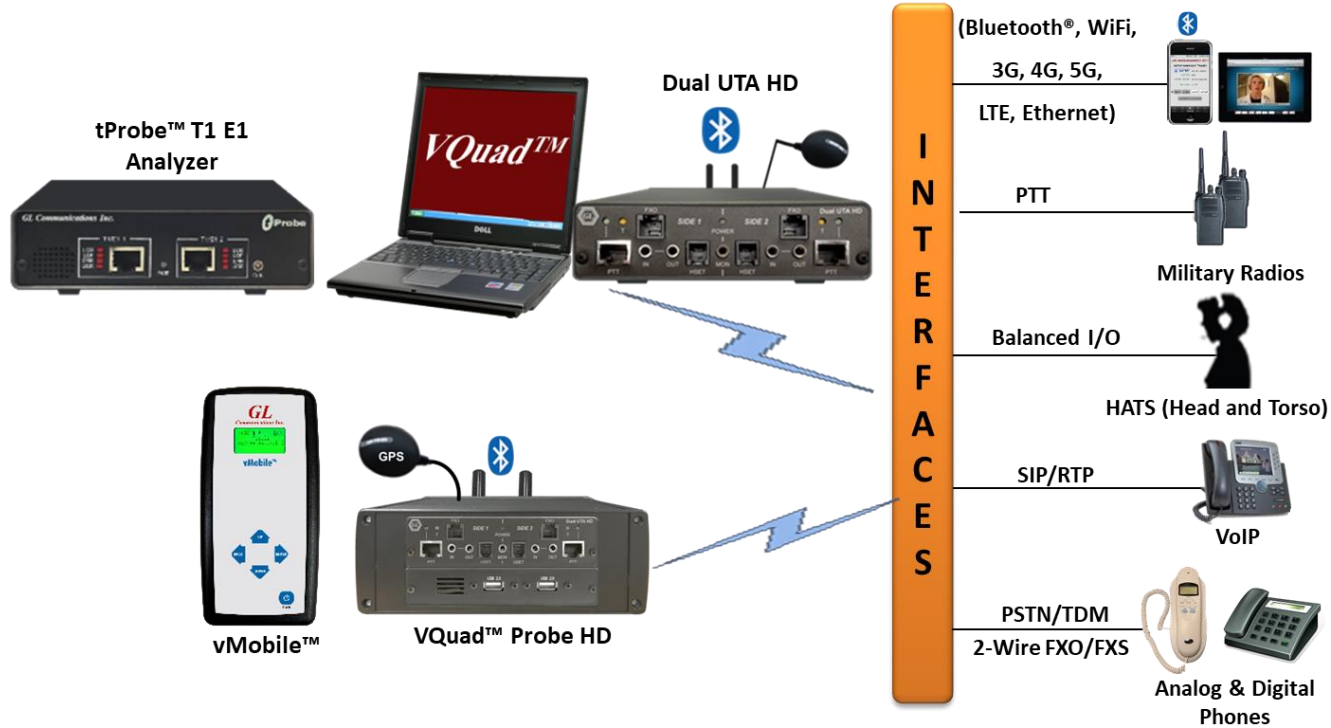
- Thousands of voice files analyzed in mere minutes
- Supports Command Line Interface (CLI) for Windows® and Linux
- Any application that can send POLQA Reference audio and record it to PCM or WAV is acceptable
- Supports ITU Standards (POLQA v2.4)
- Detailed Results / Statistics
 - POLQA MOS
 - E-Model R-Factor
 - Signal Level
 - Noise Level
 - Delay
 - Jitter
 - Clipping
 - Criteria Rating System



Centralized Voice Quality Testing



GL Supported Connections



POLQA Test Results

VoIP Network (NB and WB)



Polycom VoIP through G.722 Network

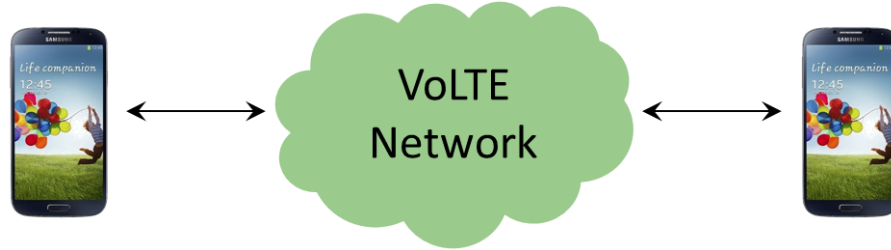
Polycom Tx/Rx WB Files	
Fem Outbound	4.59
Fem Inbound	4.51
Male Outbound	4.15
Male Inbound	4.07

Polycom VoIP through NB (Skype) Network

Polycom Tx/Rx WB Files	
Fem Outbound	3.84
Fem Inbound	3.74
Male Outbound	3.58
Male Inbound	3.55

POLQA Test Results (Contd.)

VoLTE (NB and WB)



Samsung4 to Samsung4 through AMR-WB Network

Samsung4 to Samsung4	
Fem Outbound	3.46
Fem Inbound	3.58
Male Outbound	4.2
Male Inbound	4.19

Samsung4 to Samsung4 through AMR Network

Samsung4 to Samsung4	
Fem Outbound	2.27
Fem Inbound	1.96
Male Outbound	3.08
Male Inbound	2.69

GL VQT Highlights

- Supports ITU Standards (POLQA v2.4 / POLQA v3.0, PESQ LQ/ LQO / WB)
- Auto-Measurement Capabilities
- Detailed Results / Statistics
 - Delay Measurement
 - Noise/Signal Levels (Activity, Peak, etc.)
 - Jitter (Min, Max, Average per Utterance)
 - Clipping (front, back, all) (PESQ Only)
 - PESQ/Delay per utterance
 - Impairment Factor (Ie) measurement (PESQ only)
- Criteria Rating System
- Remote Access Capabilities

GL VQT Software

GL Communications Inc Voice Quality Test - PAMS (ITU P.800), PSQM/PSQM+ (ITU P.861), PESQ (ITU P.862), POLQA (IT...

File View ACU Help

GL Speech Quality Measurements PESQ Normal(P862.1): ON

Metrics	Scores
POLQA	3.21
EMODEL	62.06
PESQ	2.9
PESQ LQ	2.59
PESQ LQO	2.68
PESQ WB	N/A
PESQ Ie	44.22
PAMS LE	3.9
PAMS LQ	3.43
PSQM MOS	3.53
PSQM+ MOS	3.49

PAMS PSQM PESQ POLQA Connecting

Reference Surface

Degraded Surface

Error Surface

Metrics	Max	Min	Avg.
POLQA	4.18	1.02	3.56
EMODEL	84.44	8.71	69.3
PESQ	3.5	0	2.96
PESQ LQ	3.51	0	2.82
PESQ LQO	3.56	0	2.9
PESQ WB	0	N/A	N/A
PESQ Ie	139.4	0	41.09
PAMS LE	4.22	1.33	3.61
PAMS LQ	3.83	1	3.17
PSQM M...	3.82	1	3.46
PSQM+ ...	3.81	1	3.36

Rating: Good

User ID: _____

Speech Level Gain (dbv): **-3.93**

Noise Level Gain (dbv): **-1.75**

Rating Count:

Excellent	35
Good	111
Fair	1
Poor	4
Disregard	0

Reset Statistics --> File

Deg. File = C:\VQT_Degraded\1\dem_20130304033927_0000000000_0c

Ref. File = C:\VQT_Reference\VQuad_Auto\Raw\dem1.pcm

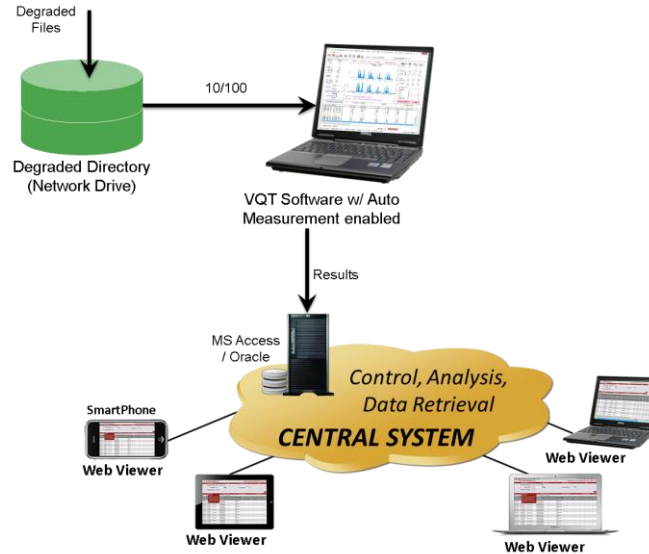
Measurement Results		Manual Measurement		Analysis			Rating Criteria	
VQT Times	tamp	POLQA	EMode1	PESQ	PESQ LQ	PESQ LQO	PESQ WB	PAMS LE
2013/06/07	12:2...	4.07	81.28	3.48	3.47	3.53	N/A	4.06
2013/06/07	12:2...	3.92	77.33	3.36	3.3	3.36	N/A	3.77
2013/06/07	12:2...	3.87	76.2	3.24	3.11	3.18	N/A	3.88
2013/06/07	12:2...	2.86	55.41	2.76	2.37	2.48	N/A	3.39
2013/06/07	12:2...	3.62	70.6	3.13	2.94	3.01	N/A	3.62
2013/06/07	12:2...	4.09	81.83	3.35	3.27	3.34	N/A	4.14
2013/06/07	12:2...	1.47	26.56	2.07	1.39	1.69	N/A	1.33
2013/06/07	12:2...	3.91	77.06	3.27	3.16	3.22	N/A	4.08
2013/06/07	12:2...	3.98	78.81	3.21	3.07	3.14	N/A	3.79
2013/06/07	12:2...	3.62	70.42	2.76	2.36	2.47	N/A	3.52
2013/06/07	12:2...	3.93	77.66	3.16	2.99	3.06	N/A	4.03
2013/06/07	12:2...	3.51	68.19	3.13	2.95	3.02	N/A	3.77
2013/06/07	12:2...	3.21	62.06	2.9	2.59	2.68	N/A	3.9

Capture Events to File Browse System Reset

graphical: always degraded: raw reference: raw Excellent: 35 Good: 111 Fair: 1 Poor: 4 Total Measurements: 191

Auto Measurement

Automatically analyze the degraded files using GL VQT Software



- Detailed results including Jitter (min / max / avg), Clipping (front/back/all), Latency, and Noise / Signal Measurements (activity / peak)
- VQT uses the File Monitor to perform automated measurements on remote locations

Auto Measurement

VQT Auto-Measurement: Full_Test

File Help

Degraded Directory	Reference File	Type	Option	Inventory	User ID	Counts
● C:\WQT_degraded\1	C:\WQT_Reference\WQuad_Auto\Raw\fem1.p...	Raw ...	Auto Del		fem1	
● C:\WQT_degraded\2	C:\WQT_Reference\WQuad_Auto\Raw\fem2.p...	Raw ...	Auto Del		fem2	
● C:\WQT_degraded\3	C:\WQT_Reference\WQuad_Auto\Raw\fem3.p...	Raw ...	Auto Del		fem3	
● C:\WQT_degraded\4	C:\WQT_Reference\WQuad_Auto\Raw\male1....	Raw ...	Auto Del		mal1	
● C:\WQT_degraded\5	C:\WQT_Reference\WQuad_Auto\Raw\male2....	Raw ...	Auto Del		mal2	
● C:\WQT_degraded\6	C:\WQT_Reference\WQuad_Auto\Raw\male3....	Raw ...	Auto Del		mal3	

Options

Degraded Directory *

Reference File *

Auto-delete the degraded file after measurement
 Save degraded files to the inventory directory after measurement

Inventory Directory*

Saving Criteria (optional)

Excellent Good Fair Poor

User ID Prohibit Graphic Redraw (save processor power)

PESQ + POLQA PESQ Only POLQA Only

PESQ WB POLQA SWB ?

POLQA Only

Enable Level Alignment High Accuracy Mode ITU Version

File Format

Encoding Samples Per Second

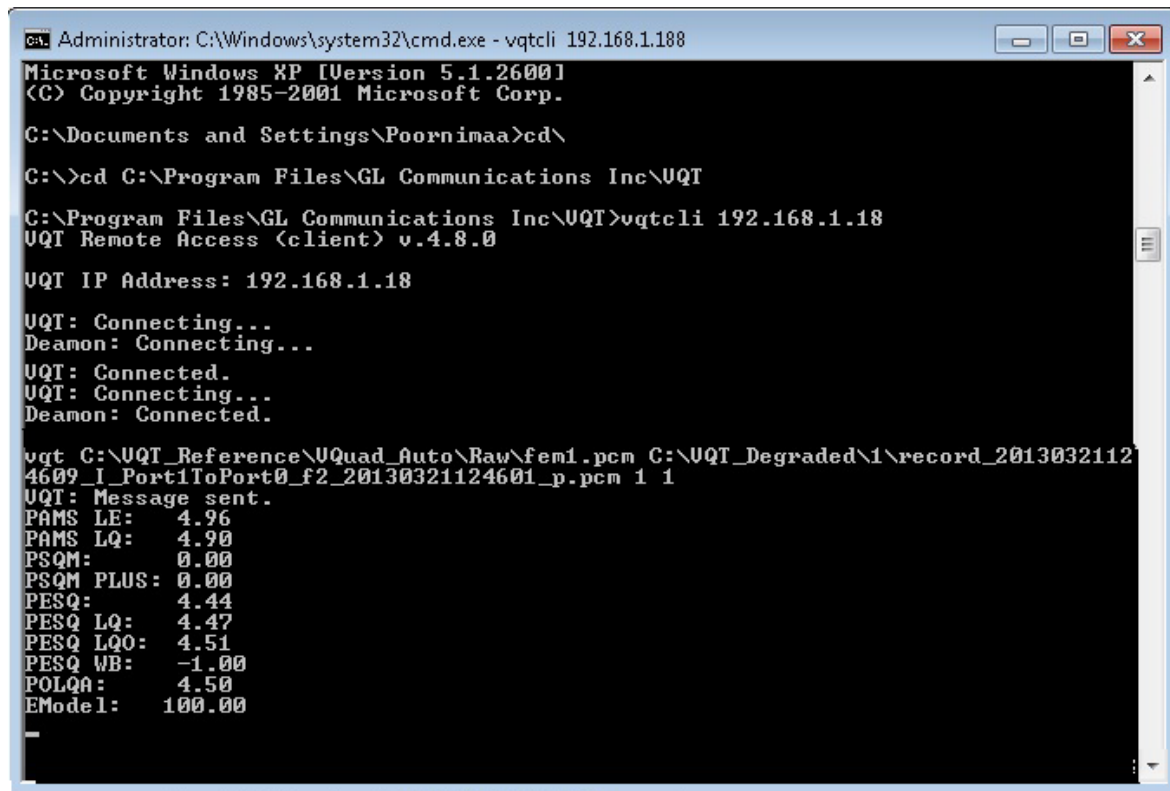
Byte Order (for 16 bit file only) Bits Per Sample

Quick Modify Configurations

Start: End:

Note *: Use "*" in reference fields to hold the Number

VQT Command Line Interface



```
Administrator: C:\Windows\system32\cmd.exe - vqtccli 192.168.1.188
Microsoft Windows XP [Version 5.1.2600]
(C) Copyright 1985-2001 Microsoft Corp.

C:\Documents and Settings\Poornimaa>cd\

C:\>cd C:\Program Files\GL Communications Inc\UQT

C:\Program Files\GL Communications Inc\UQT>vqtccli 192.168.1.18
UQT Remote Access (client) v.4.8.0

UQT IP Address: 192.168.1.18

UQT: Connecting...
Deamon: Connecting...

UQT: Connected.
UQT: Connecting...
Deamon: Connected.

vqt C:\UQT_Reference\UQuad_Auto\Raw\fem1.pcm C:\UQT_Degraded\1\record_2013032112
4609_I_Port1ToPort0_f2_20130321124601_p.pcm 1 1
UQT: Message sent.
PAMS LE: 4.96
PAMS LQ: 4.90
PSQM: 0.00
PSQM PLUS: 0.00
PESQ: 4.44
PESQ LQ: 4.47
PESQ LQO: 4.51
PESQ WB: -1.00
POLQA: 4.50
EModel: 100.00
```

POLQA Test Results in WebViewer™

GL Webviewer Version 6.1.11 Refresh admin / Help

Note: For the best experience, press Ctrl + F5 after installation / new version updates to refresh the screen.

Results | Call Events | Status & Statistics | Reports | Load Filters: Select Filter OFF Live Updates: 5 sec OFF

VQT-POLQA Results between 08/16/2023 05:21:17 and 02/16/2024 05:21:17 (Last 6 Months)

Date & Time: Standard 10 Minutes 1 Hour 12 Hours 24 Hours Today Yesterday 7 Days 1 Month 6 Months

Timestamp Type: VQuad / vMobile Timestamp

Event ID Filter: Contains ?

Apply

Actions Records Per Page: 200 ?

Timestamp	Call Timestamp	Call ID	Device ID	GPS	Latitude	Longitude	Degraded Filename	Rating	POLQA v3 MOS	POLQA MOS	EModel (R-factor)	Speech Level Gain (dB)	Noise Level Gain (dB)	Active Speech Level - Ref (dBm)	Active Speech Level - Deg (dBm)	Mean Noise Level - Ref (dBm)	Mean Noise Level - Deg (dBm)	SNR - Ref (dB)	SNR - Deg (dB)	Active Speech Ratio - Ref (%)
02/16/2024 05:18:38	02/16/2024 05:15:41	GLRobFaxVQTTestRobFX02		N39008'37" W077012'57"	39.14	-77.22	Fem1POLQA	Excellent	4.11	82.32	-14.83	-13.7	-24.28	-39.11	-62.79	-76.48	38.51	37.37	57	
02/16/2024 05:18:25	02/16/2024 05:15:41	GLRobFaxVQTTestRobFX01		N39008'37" W077012'57"	39.14	-77.22	Fem1POLQA	Excellent	4.29	88.13	-12.58	-12.67	-24.28	-36.86	-62.79	-75.46	38.51	38.6	57	
02/16/2024 05:18:10	02/16/2024 05:15:41	GLRobFaxVQTTestRobFX02		N39008'37" W077012'57"	39.14	-77.22	Fem1POLQA	Excellent	4.18	84.4	-14.85	-13.42	-24.28	-39.13	-62.79	-76.21	38.51	37.08	57	
02/16/2024 05:17:57	02/16/2024 05:15:41	GLRobFaxVQTTestRobFX01		N39008'37" W077012'57"	39.14	-77.22	Fem1POLQA	Excellent	4.21	85.43	-12.58	-12.67	-24.28	-36.86	-62.79	-75.46	38.51	38.6	57	
02/16/2024 05:14:45	02/16/2024 05:11:53	GLRobFaxVQTTestRobFX02		N39008'37" W077012'56"	39.14	-77.22	Fem1POLQA	Excellent	4.33	89.77	-14.84	-13.55	-24.28	-39.12	-62.79	-76.34	38.51	37.22	57	
02/16/2024 05:14:32	02/16/2024 05:11:53	GLRobFaxVQTTestRobFX01		N39008'36" W077012'56"	39.14	-77.22	Fem1POLQA	Excellent	4.42	93.98	-12.59	-12.3	-24.28	-36.87	-62.79	-75.08	38.51	38.21	57	
02/16/2024 05:14:16	02/16/2024 05:11:53	GLRobFaxVQTTestRobFX02		N39008'36" W077012'56"	39.14	-77.22	Fem1POLQA	Excellent	4.16	83.88	-14.85	-13.39	-24.28	-39.13	-62.79	-76.17	38.51	37.04	57	
02/16/2024 05:14:04	02/16/2024 05:11:53	GLRobFaxVQTTestRobFX01		N39008'37" W077012'56"	39.14	-77.22	Fem1POLQA	Excellent	4.24	86.28	-12.58	-12.42	-24.28	-36.86	-62.79	-75.21	38.51	38.35	57	
02/16/2024 05:10:57	02/16/2024 05:08:06	GLRobFaxVQTTestRobFX02		N39008'37" W077012'57"	39.14	-77.22	Fem1POLQA	Excellent	4.33	89.68	-14.83	-14.01	-24.28	-39.11	-62.79	-76.8	38.51	37.69	57	
02/16/2024 05:10:44	02/16/2024 05:08:06	GLRobFaxVQTTestRobFX01		N39008'37" W077012'57"	39.14	-77.22	Fem1POLQA	Excellent	4.23	86.07	-12.59	-12.79	-24.28	-36.87	-62.79	-75.58	38.51	38.71	57	
02/16/2024 05:10:28	02/16/2024 05:08:06	GLRobFaxVQTTestRobFX02		N39008'37" W077012'57"	39.14	-77.22	Fem1POLQA	Good	3.76	73.49	-14.82	-13.99	-24.28	-39.1	-62.79	-76.78	38.51	37.68	57	
02/16/2024 05:10:16	02/16/2024 05:08:06	GLRobFaxVQTTestRobFX01		N39008'37" W077012'57"	39.14	-77.22	Fem1POLQA	Excellent	4.29	87.96	-12.61	-12.93	-24.28	-36.89	-62.79	-75.73	38.51	38.84	57	
02/16/2024 05:07:10	02/16/2024 05:04:09	GLRobFaxVQTTestRobFX02		N39008'37" W077012'57"	39.14	-77.22	Fem1POLQA	Excellent	4.31	89.02	-14.84	-13.44	-24.28	-39.12	-62.79	-76.24	38.51	37.12	57	

VQT Results

Analysis Graphics between 02/16/2024 04:28:30 and 02/16/2024 05:28:30 (Last Hour)

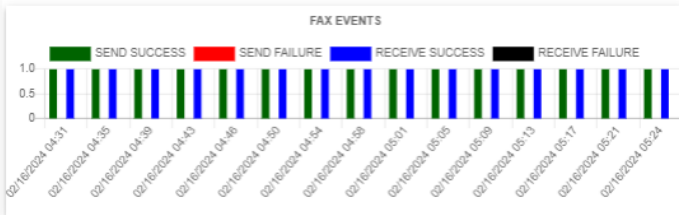
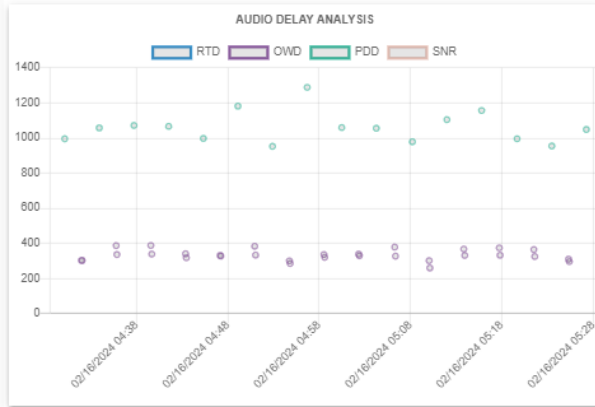
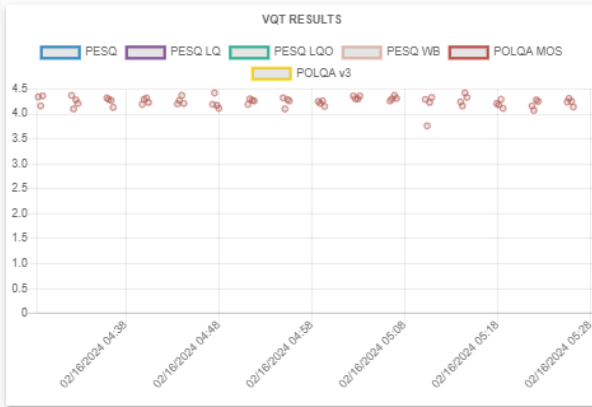
Date & Time **Standard** 10 Minutes 1 Hour 12 Hours 24 Hours Today Yesterday 7 Days 1 Month 6 Months

Timestamp Type VQuad / vMobile Timestamp

Event ID Filter Contains ?

Apply

Actions ▾



Google Map Plotting

Display Options

Use Predefined Config ON OFF

Define results to display

vMobile_DriveTest_Oct2722

Draw route line by Default

ON

Draw line as

Direct Path

Refine your search

Types

- Threshold Settings
- VQuad Call ID
- VQuad Device ID
- Call Events

Results

- VQT PESQ
- VQT POLQA
- VQuad Call Events
- Audio and Delay Analysis
- TCP
- UDP
- VOIP
- ROUTE
- HTTP
- FTP
- DNS
- SMS
- EMAIL
- Phone Info
- SIM
- UE
- EMU

Map Satellite

RESULT

VQuad Timestamp	POLQA
THRESHOLD	2022-05-25 11:51:54
VQuad Device ID	PASS
VQuad Call ID	vmobile2Galaxy
VQuad Call ID	vMobileBeltway
PARAMETERS	POLQA MOS: 3.32

Latitude 39.029
Longitude -77.141
LOCATION 2VH5+HJ North Bethesda, MD, USA

Results Display

Thank you