

First Media m-Flow™ Video Analyzer Calibration & Performance Tests

Introduction

First Media commissioned EANTC to conduct an independent calibration test of First Media's video monitoring solution, certifying that the m-Flow system reports appropriate QoS (Quality of Service) and QoE (Quality of Experience) parameters of live video streams. The test evaluated first and second priority ETSI TR101/290 parameters and perceived quality metrics (MOS) for video under various operating conditions. The calibration test was conducted under realistic, scaling network conditions.

First Media is a technology based services company focused in providing solutions to next generation triple/quad play network providers in enhancing end user experience. First Media's technology platforms address end to end monitoring of video delivery on the entire spectrum of IP based video delivery.

Test Highlights

- Quality of Experience measurements for network impairments according to ITU-T G.1050
- Calibration against industry standard solution from Spirent
- Verification of ETSI TR 101 290 quality parameter measurements
- Video-MOS calculation
- High performance analyzing

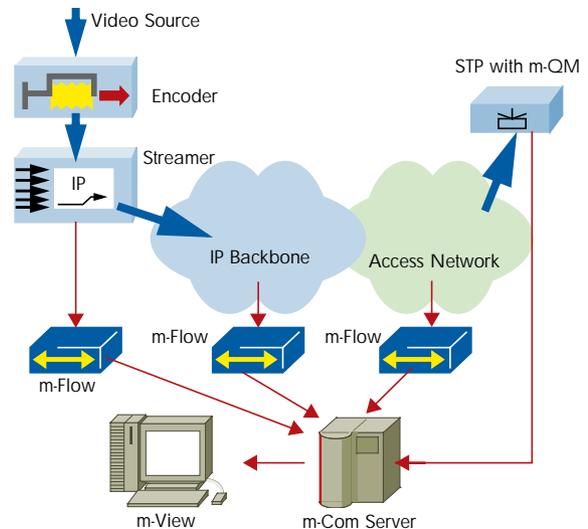
Tested Devices

First Media's technology platform includes m-Flow - an inline video analyzer; m-QM - a thin client on the IP set top box to monitor the video QoE of the home users; m-View - an intelligent fault correlation engine and m-Assure (patent pending technology) - a field technician tool for IPTV provisioning.

First Media m-Flow™ Video Analyzer

- Calibrated
Against industry standard
- Quality of Experience
Verified correct analyzing of ETSI TR101/290 parameters & MOS values
- Analyzing Performance
Verified for accurate analysis on heavy loaded links

Test Period: May 2008
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First Media m-Flow (we tested software version 2.08) is a software based Video over IP analyzer that provides real time statistics of the video delivery system for service provider networks.

It provides complete details from the IP transport to the MPEG4 AVC layers. m-Flow captures the IP datagrams and analyses the payload information for the RTP or MPEG2 Transport Stream.

To gain video quality metrics, m-Flow calculates a Mean Opinion Score (MOS), which is based on Subscriber Viewing Experience (SVE) model, a patent pending technology. The following parameters have impact on the MOS calculation:

m-Flow MOS Calculation includes:

- IP packet loss rate, IP packet jitter
- RTP loss/duplicates/ jitter/ out of sequence
- Transport Stream (TS) bitrate
- Continuity Count (CC) loss
- Sync loss
- Transport Error Indicator (TEI)
- Program Clock Reference (PCR) jitter
- Presentation Time Stamp (PTS) loss
- I-, P- and B-frame loss/impairment

image entropy and video content information such as I, B, and P frames for accurate real time video quality analysis.

V-Factor is a patent pending technology for IPTV derived from MPQM (Moving Picture Quality Metrics) research, which is based on Human Vision System.

To emulate real network conditions usually found at service provider networks, we used the high performant Gigabit Ethernet network emulator GEM from Spirent. The Spirent network emulator is able to accurately insert the delays and impairments that occur over live production 10/100 Mbps, 1Gbps and 10Gbps Ethernet networks for validating and evaluating new products and technologies. Before we used the GEM system for the calibration tests, we verified that this device was able to operate at Gigabit Ethernet line speed and that the configured impairment operations worked precise.

The Spirent GEM also provides bandwidth shaping, dynamic search filter (user-defined string pattern) and up to 16 different impairment profiles. It has built-in predefined impairment models defined in TIA-921 and ITU-T G.1050, which provide a common reference emulating the effects of live networks in the lab.

Test Equipment and Environment

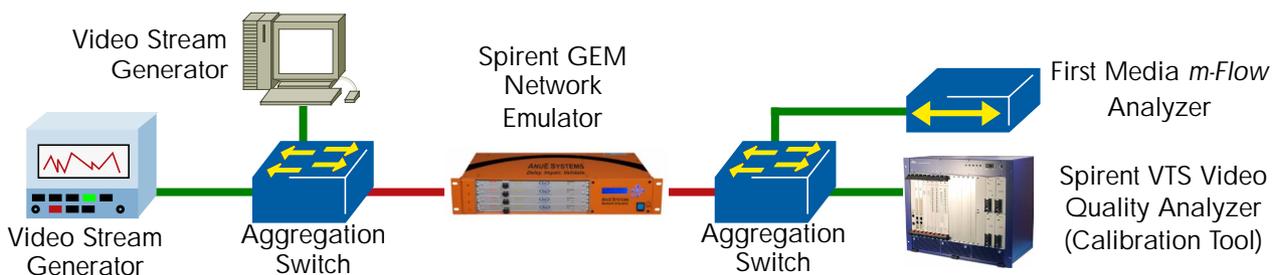
As the industry reference system for the calibration tests we used the Video Test System (VTS) from Spirent Communications (software version 3.272).

Spirent's VTS inspects the content of incoming video data and applies algorithms to give an accurate assessment of video quality when the source of the reference video is unavailable. VTS includes both network metrics and video content metrics for more accurate video quality measurements and frame-based statistics. VTS performs deep packet inspection, measures audio MOS (Mean Opinion Score) and video V-Factor, looks at packet impairments, packet loss rate, program clock, image compression ratio,

Test Setup

We built a layer 2 network with two switches from Extreme Networks and Cisco Systems. We connected a high performance video stream generator and a PC based video stream generator to an Alpine 3800 switch and connected the two video measurement solutions to the Cisco Catalyst 6509 switch, see graph below.

We generated video streams to be monitored with the m-Flow system from First Media and with the Video Test System from Spirent (reference system) in parallel. After each test run we compared the m-Flow statistics with the statistics of the VTS to ensure conformance and to gain calibration information.



Test Results

Using the Spirent network emulator GEM we introduced network impairments to emulate real network scenarios typically found at service provider networks. We defined a total of nine different impairment profiles (see table in the right column) and compared the video quality analysis results provided by both systems, the Spirent VTS and the First Media m-Flow.

Test Highlights

- passed Calibration test without impairment
- passed Calibration test with network impairment
- passed Quality analysis for low encoding bitrates
- passed High performance video analyzing

Calibration Reference Test

Before we introduced any impairment to the network, we first performed a reference test and compared the results of the video quality analysis from both test systems. The test results for both systems were very similar. The largest difference on the MOS and V-Factor chart, ranging from 1 to 5, was 0.1.

We also compared quality parameters defined by ETSI TR 101 290. The first priority parameters are considered necessary to ensure that the Transport Stream (TS) can be decoded. The second parameter set lists additional parameters, which are recommended for continuous monitoring, see table below:

TR 101 290 First Priority		TR 101 290 Second Priority	
No.	Indicator	No.	Indicator
1.1	TS_sync_loss	2.1	Transport_error
1.2	Sync_byte_error	2.2	CRC_error
1.3	PAT_error	2.3	PCR_error (note)
1.3.a	PAT_error_2	2.3a	PCR_repetition_error
1.4	Continuity_count_error	2.3b	PCR_discontinuity_indicator_error
1.5	PMT_error	2.4	PCR_accuracy_error
1.5.a	PMT_error_2	2.5	PTS_error
1.6	PID_error	2.6	CAT_error

We saw some differences in the results of the PCR related values, which result from different implementations of PCR error counting algorithms. m-Flow only uses the PCR values within the TS packets and calculates the difference between consecutive packets. The VTS system also takes the arrival time into account, at which consecutive PCR containing packets arrive. If a

PCR containing packet arrives later than 40 milliseconds as the previous, the PCR error counter will be incremented. Considering the different implementations, both systems provided accurate results.

Network Impairment Emulation

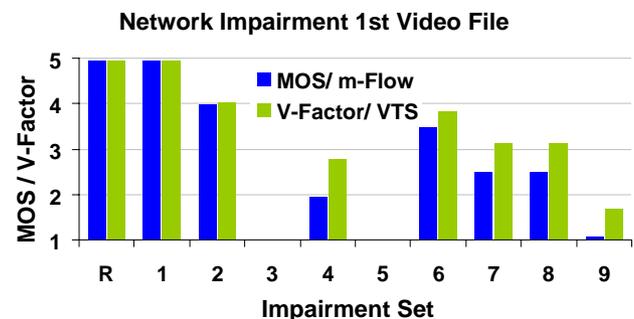
Using different sets of impairment parameters we emulated the behavior of an Internet service provider (ISP) network infrastructure under different load conditions. We have chosen our parameters according to the ITU-T recommendation G.1050, the network service profile A (well managed IP network) and profile B (partially managed IP network).

Both our reference video test system VTS from Spirent and the m-Flow implementation from First Media measured video quality metrics (V-Factor and MOS) and quality statistics according to ETSI TR 101 290.

We created a total of nine different impairment profiles, see table below:

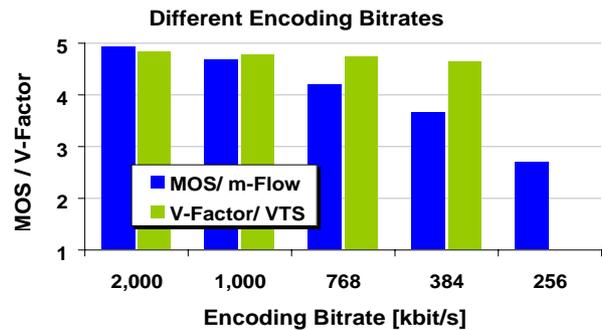
Set	Delay [ms]	Jitter [ms]	Packet [%]		MPEG-Frame Drop [%]		
			Loss	Reorder	I	P	B
R	no	no	no	no	no	no	no
1	100	no	no	no	no	no	no
2	30	30	0.05	0.01	no	no	no
3	50	30	1.0	no	no	no	no
4	30	50	0.1	0.01	no	no	no
5	50	80	0.5	no	no	no	no
6	30	20	0.05	no	0.1	0.1	0.1
7	30	20	0.01	no	no	0.5	no
8	30	20	0.01	0.01	0.5	no	no
9	30	50	0.1	0.01	0.5	0.5	0.5

For most of the impairment profiles the results for the video quality metric were similar, see graphs below. Only for profiles where we introduced high packet loss (≥ 0.1) and reordering, the VTS system showed higher results than the m-Flow system. The MOS calculation of the m-Flow systems obviously rates reordering and packet loss higher than Spirent's VTS.

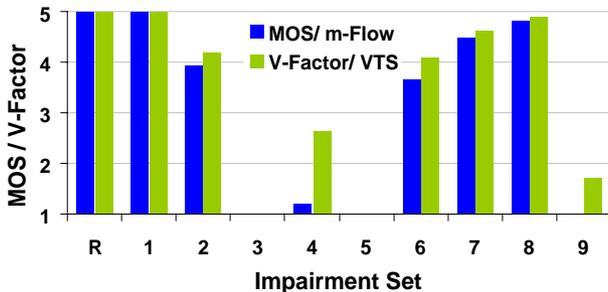


The results also showed, that both systems implement a quality rating taking the bitrate into account, because they calculated higher values for videos with higher encoding bitrates.

Both systems showed a decrease of the quality metric for profiles with increased packet loss (also MPEG frame loss) or reordering.



Network Impairment 2nd Video File



We saw small variations in the Continuity Counter (CC) error values due to different mechanisms for calculating this error for both systems. The Spirent VTS compensates a small packet reordering offset and jitter using an implemented jitter buffer, whereas the First Media m-Flow counts every reordered packet. We came to the conclusion that m-Flow system showed very accurate results of CC error.

We observed the same differences for the PCR related values as we already have seen and explained in the reference test.

Video Quality Analysis for Low Encoding Bitrates

The video quality depends mainly on the used video codec and the coding bitrate of the video. In this test we reduced the bitrate stepwise and compared the measured results for the perceptual video quality of both systems, the m-Flow system from First Media and the VTS from Spirent.

As expected the results for the perceptual video quality for both systems decreased with decreasing encoding bitrates. The MOS calculation of the m-Flow implementation reacts more linear to decreasing video encoding bitrates than the V-Factor calculation from the VTS solution (see following diagram).

Load Test Results

We verified the performance figures and robustness of the m-Flow video analysis system as well as the video measurement accuracy in case of heavy load.

We sent 190 video streams to 190 different multicast addresses with a total bitrate of 906 Mbit/s and compared the video quality measured for all video streams with the results measured in the reference test. We used the same video stream during reference and load testing.

The m-Flow implementation showed excellent performance in this test. The system analyzed all results correctly even with a load of 906 Mbit/s. The results of the quality metrics were identical to the results of the reference test.

Summary

Our tests conclude that the First Media's m-Flow system accurately reports Quality of Experience Parameters of TR 101 290 and Video MOS values based on their SVE model.

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About EANTC

The European Advanced Networking Test Center (EANTC) offers vendor-neutral network test services for manufacturers, service providers and enterprise customers. Primary business areas include interoperability, conformance and performance testing for IP, MPLS, Mobile Backhaul, VoIP, Carrier Ethernet, Triple Play, and IP applications.



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