



Video over IP Quality Specialists™

MDI / QoE for IPTV and VoIP

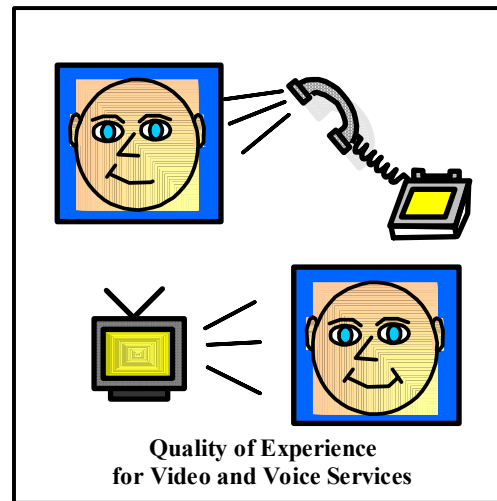
Quality of Experience for Media over IP

Service Providers are not just selling VoIP and IPTV services; they are selling consistent, high quality VoIP and IPTV services. Quality is a fundamental property of VoIP and IPTV service. If not why would anyone buy it?

Quality of Experience (QoE) is the customers' perception of how good of a job the Service Provider is doing delivering the service. Often the QoE of a customer is only known when he calls to complain or when subscription revenue drops.

Given the highly competitive market for VoIP and IPTV, Service Providers cannot afford to find out the customers QoE after the fact.

Therefore, Service Providers are asking for QoE measurements to assist in determining QoE within their networks or service areas. QoE measurements help quantify quality improvements, disputes, and repairs as well as monitor quality to know when there is an issue *before* the customer calls or leaves. QoE measurements are also instrumental in service agreements (SLAs).



So how do you measure the QoE of VoIP and IPTV? VoIP and IPTV QoE are made up several components including equipment quality, human factors, environmental factors, and transport quality.

And because VoIP and IPTV are dynamic the QoE must be measured per unit time over time. For example, if a customer subscribes to an IPTV service that delivers the Super Bowl in High Definition and the QoE was very high for 3 quarters and poor for the last quarter, what is the QoE for the customer? Most likely, very poor. The same is true with a phone call that lasts 30 minutes; if the last minute quality is poor then the entire QoE for the call is most likely going to be poor.

Because QoE is dynamic and situational factors are (for the most part) none deterministic, QoE must be measured per unit time, all the time. So what are the factors for QoE?

**Voice Stream QoE = (Quality of the Network Delivery System +
Quality of the Encoding Components to the Network +
Quality of the Decode from the Network +
Human Factors) per unit time**

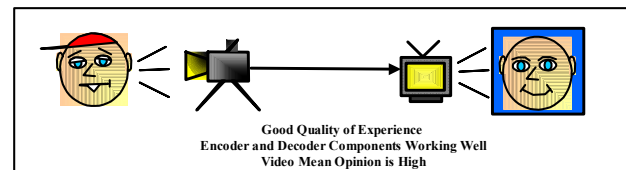
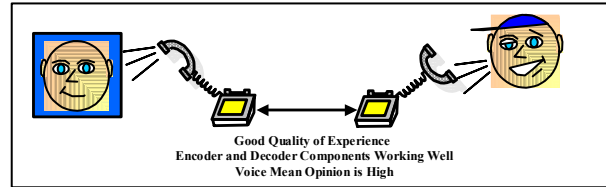
**Video Stream QoE = (Quality of the Network Delivery System +
Quality of the Encoding Components to the Network +
Quality of the Decoder from the Network +
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Attempts have been made to quantify the human experience, QoE, as related to telephony by the means of using a Mean Opinion Score or MOS score. MOS was originally employed to aid in the design, research and development of digital phone systems, translating and reconstituting analog voice signal to digital and back. The term MOS has become synonymous with QoE for voice calls.

MOS is a qualitative measurement calculated by having many human subjects listen to a range of phone calls and rank them from 0 to 5 (5 being the best) in terms of Quality of Experience.

MOS was very powerful in determining which digital phone systems worked well. When digital phones were created, the components of encode, decode and human factors were the challenge of attaining high MOS scores. Transport was more advanced. TDM and ATM networks were designed with many parameters and functions for high quality of service.

Overtime digital phone algorithms, microphone, speaker technology and semiconductors advanced.

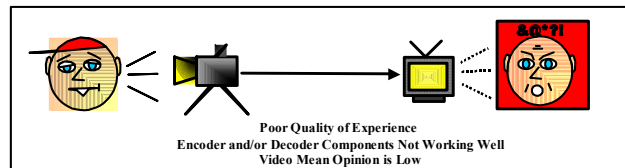
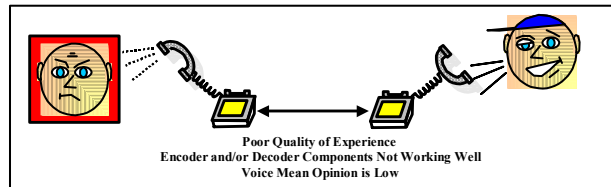


In a similar way digital video also advanced in the Broadcast industry. The metrics were different but in much the same way standards for finding the optimum encoding and decoding algorithms and a mechanism to transport the digital video was focused on quality.

Overtime digital video algorithms, cameras, TVs, set top boxes and semiconductors advanced.

Today, given a highly reliable transport network, digital encoding and decoding of voice is quite stable. Many digital phones are now built on a single semiconductor.

These systems have set the bar for a customers' QoE tolerance. If a phone call suffers from poor quality, customers instantly know it.



Again, video is very similar in that the quality of the equipment has matured overtime and many of the algorithms have been built into semiconductors.

There are many delivery mechanisms of high quality video, like satellite, DVD, cable, that have also set the bar for a customers' QoE tolerance. If a video program suffers from poor quality, customers instantly know it.

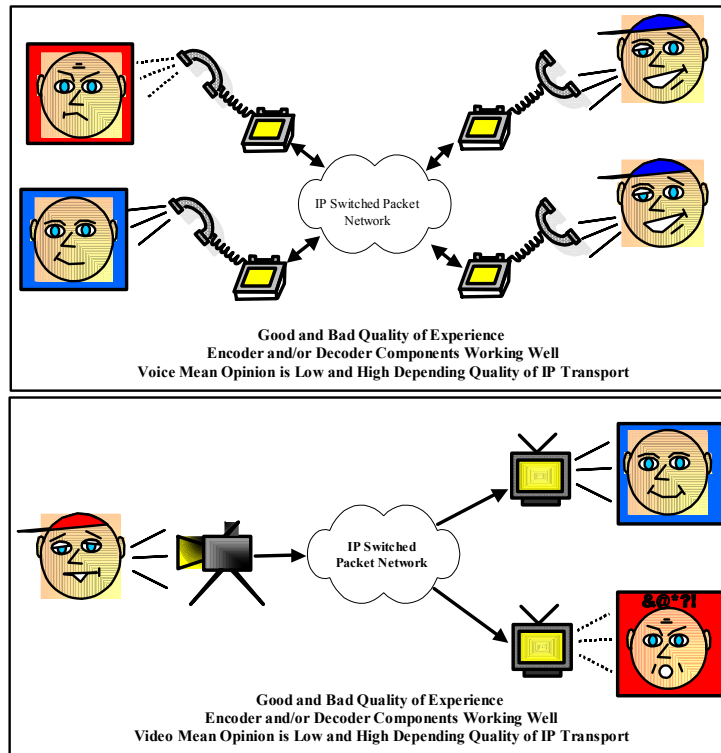
As technology has progressed the end point equipment for voice and video has advanced becoming more robust and high quality while the transport network changed.

IP Networks are being used for the distributed transport between end points. Adding an IP network into the supply chain of Video and Voice over IP services does not change the expectations of the consumer. In fact expectations may increase as new technology is often expected to have higher Quality.

These networks are excellent for interoperability. There are many edge devices that are IP ready off the shelf and often getting voice and video services up and running can happen relatively quickly.

However Ethernet based IP networks introduce a new set of transport challenges for the Service Provider. Attaining top QoE may require “tuning” network for QoS (Quality of Service) and it cannot be taken for granted that the customer is getting high QoE.

IP packets are non deterministic and can be dropped. Loss and delivery rate variations are potential problems of QoE for voice and video over IP.



Many IP Service Providers have already started to deploy VoIP and IPTV services over their network. This has created a huge increase in the demand for quality measurements for these media services on an IP network.

So it is natural that people look to MOS and other opinion based scores for QoE of IP based voice and video streams, but consider what has really happened. From the IP Service Provider’s prospective there are limited components that he has control over. If a packet containing digital video or voice payload enters the network, there are only a few things the IP Service Provider can do to that packet, drop it, delay it or re-sequence it. As far as the digital video or voice payload is concerned, the quality is already determined (garbage in – garbage out).

The IP network is only part of the supply chain, although a large component of the QoE for both video and voice. A Service Provider’s IP network is not unlike a delivery service. Take the analogy of a delivery service picking up produce and delivering to a chain of restaurants. How does the delivery service affect the customer’s Quality of Experience eating in the restaurant? In three ways, on time delivery, delivery to the wrong place, loss of shipment, what the delivery service does not control is the quality of the food it is delivering or the way the food is prepared. It would however make sense to ensure that the food being delivered is fresh when it is picked up.

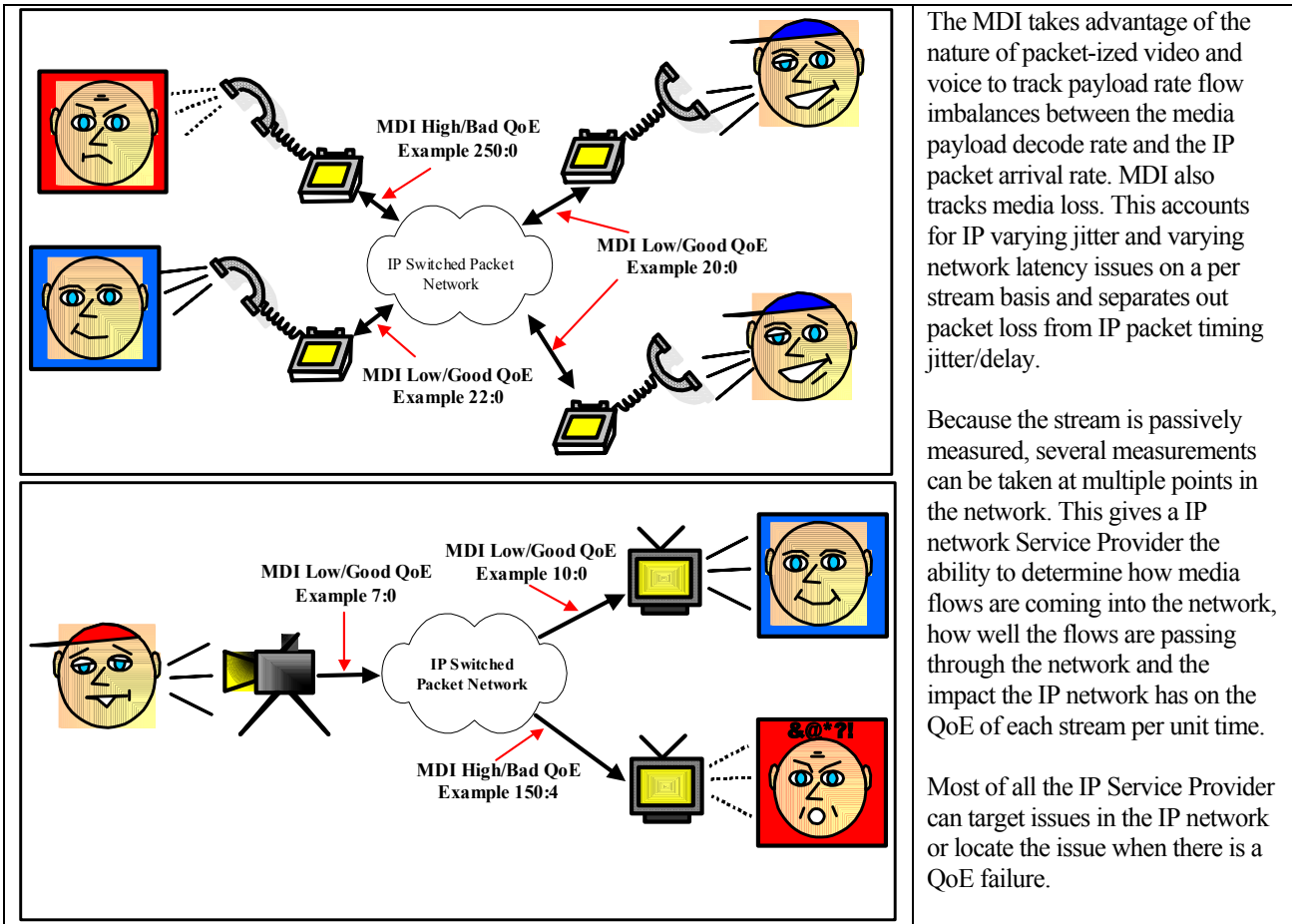
The Media Delivery Index, MDI, is a new measure that can help Service Providers monitor the Video over IP and VoIP services for the component of QoE they have under their control. The MDI can be used to passively or activity monitor live voice and video over IP flows. The MDI is done per media flow basis and can be measured 24/7 for complete coverage of the media service.

$$\text{Voice Stream QoE} = (\text{Quality of the MDI Per Stream} + \text{Quality of the Encoding Components to the Network} + \text{Quality of the Decode from the Network} + \text{Human Factors}) \text{ per unit time}$$

$$\text{Video Stream QoE} = (\text{Quality of the MDI Per Stream} + \text{Quality of the Encoding Components to the Network} + \text{Quality of the Decoder from the Network} + \text{Human Factors}) \text{ per unit time}$$

MDI provides the user an “at-a-glance” indicator of IP cumulative jitter and media loss. MDI is expressed as Delay Factor & Media Loss Rate. The Delay Factor, DF, is the amount of time the media stream will need to buffer to subtract the delivery rate differences versus the payload decode rate. For example if a DF for a video stream was measured to be 150 ms and a decoder was placed at that point in the network it would need a buffer of 150 ms to accommodate the rate over and under flows caused by the IP packets. Media Loss Rate, MLR, tracks the amount of media lost per second.

Knowing the timing and loss of each video and voice stream over the extent of the media service gives the Service Provider knowledge of network performance, at any point in the network.



The MDI takes advantage of the nature of packet-ized video and voice to track payload rate flow imbalances between the media payload decode rate and the IP packet arrival rate. MDI also tracks media loss. This accounts for IP varying jitter and varying network latency issues on a per stream basis and separates out packet loss from IP packet timing jitter/delay.

Because the stream is passively measured, several measurements can be taken at multiple points in the network. This gives a IP network Service Provider the ability to determine how media flows are coming into the network, how well the flows are passing through the network and the impact the IP network has on the QoE of each stream per unit time.

Most of all the IP Service Provider can target issues in the IP network or locate the issue when there is a QoE failure.

In the future, IP networks could be rated to provide a maximum MDI footprint given a maximum MDI input. Additionally, edge devices could rate the amount of MDI they will handle, telling the network Service Provider the amount of quality per stream that must be maintained. Other QoE type measurements, like MOS and R factor, could be derived assuming known payload and using MDI as the *live, quantitative measurement* of the IP timing and loss of passive measured voice and video streams.

Alarm conditions and thresholds can be set on the ingress and egress of the network and at critical points off critical routers within a network or metro ring. Then this information can be linked into existing Network Management Systems (NMS) to inform the Service Provider of dynamic voice and video service issues and even predict and stave-off QoE/MDI issues by monitoring the trends of media flow versus the network capacity.

Quality is the degree of excellence to which a particular system or item delivers expected results. For IP networks the maximum degree of excellence that can be expected is to pass its packets exactly as received with minimum delay. For data, the packet in front and the packet behind did not matter as much, but for video and voice there is an extra requirement to keep the same packet spacing, directly effecting stream flow rates, without loss. MDI provides a comprehensive and qualitative passive or active measurement that can be performed on live traffic per unit time for the duration of the media flow. MDI can help Service Providers, who deliver Video and Voice over IP, achieve maximum transport quality which is the foundation of QoE for their customer.



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