Assuring Video QoE—Understanding What to Measure and Where to Measure It

By Ron Shanks

The key to measuring quality of service (QoS) in a Video Delivery network is measuring the right parameters at the appropriate places in the network.

No Second Chances to Get Video Right

Video Delivery networks are very complicated with many different unique elements, very complex interactions, and diverse services. Compared to other services such as data and voice, video is much more susceptible to impairments and problems. The main difference is that unlike data, typically no retransmissions or second chances are available for getting it right. A single lost video packet is typically visible to the subscriber; data is just resent and the subscriber never knows. With voice over Internet Protocol (VoIP) subscribers can experience a sustained packet loss rate of 1 percent and they could potentially be completely unaware of the impairment. While 0.01-percent packet loss rate in a Video Network could render the service unusable.

A Lengthy and Complicated Delivery Chain

Conditions or impairments that impact the video service can be introduced at any point along a lengthy content delivery chain—starting from video sources at the headend, complex Motion Picture Experts Group (MPEG) manipulations through the edge, several network elements in the IP transport network, error prone Hybrid Fiber Copper (HFC) or various digital subscriber loop (xDSL) access networks. Even problems in the home network environment including wiring and equipment like the set top box (STB) can affect the video service.

The fundamental issues in monitoring a Video Delivery network become:

- Is there a problem?
- Where is the problem?
- Does the problem impact the customer?

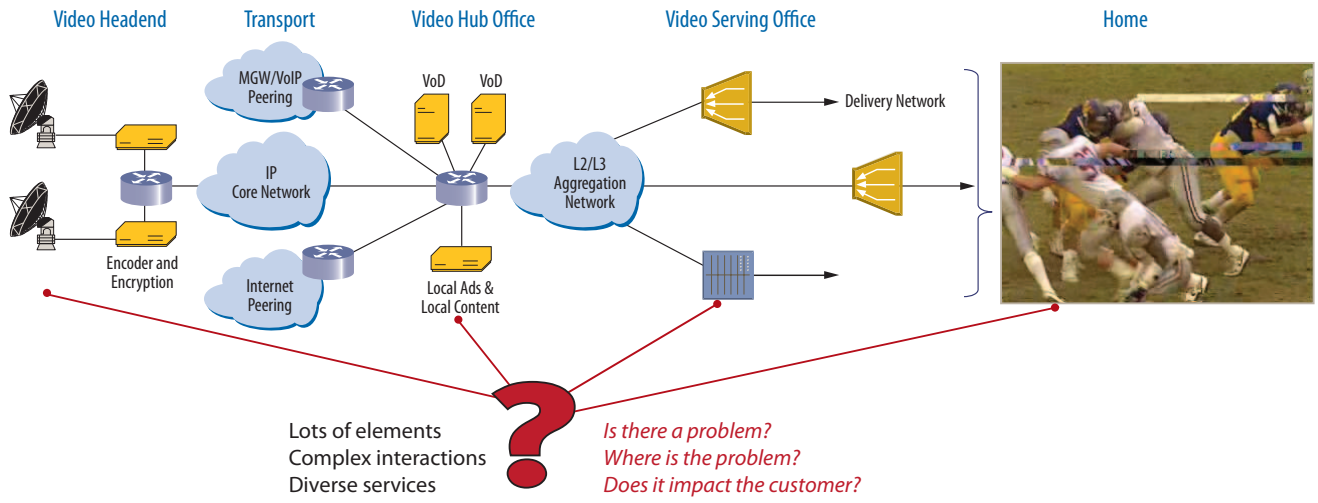

Figure 1. Typical Video Delivery Network

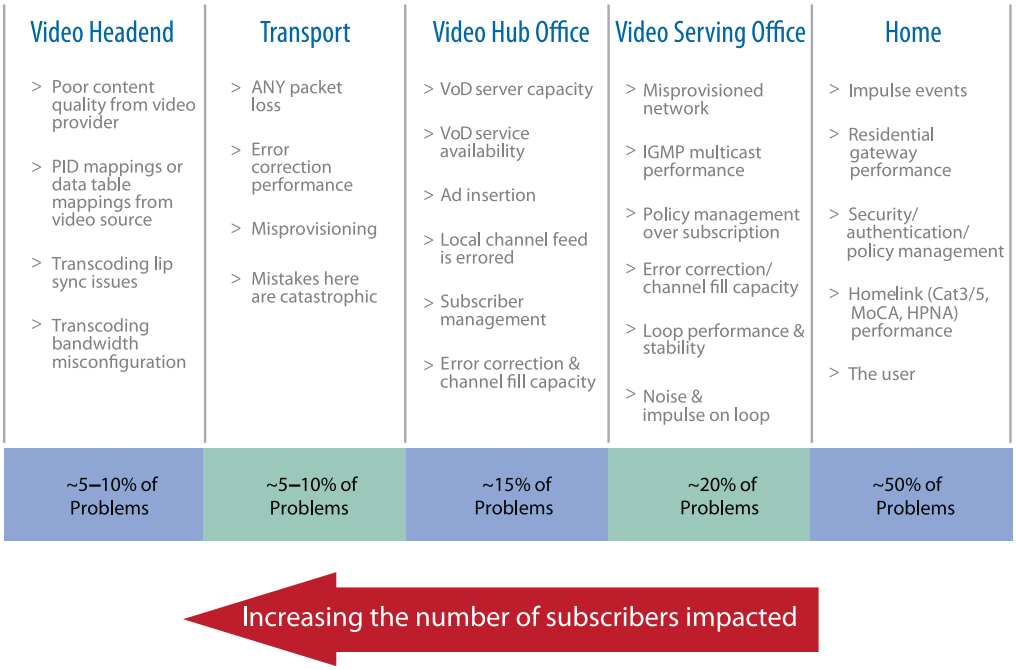

Figure 2. Typical Quality Issues by Video Segment

Figure 2 lists potential quality issues at each major segment of the video delivery chain. At the video headend, some of the common problems that may cause viewing quality issues can arise from poor content coming from the video provider, improper Program ID (PID) mappings or data table mappings in the video source, as well as lip synch issues or bandwidth configuration issues caused by the transcoder. In the transport network—any packet loss may cause a loss of picture quality, and misprovisioning of equipment can also result in poor service quality. The hub office can introduce issues with local ad insertion, local channel feeds, video on demand (VoD) availability, or server capacity. Misprovisioned networking equipment, over subscription and policy management, loop performance and stability, as well as noise and impulse on the loop in the video serving office may also cause issues. Isolating the root cause of impairments requires monitoring for a multitude of metrics at multiple points in the network.

Note that while most of the problems occur in the access portion of the network and the home, these individual problems only affect a few subscribers and, in many cases, only a single subscriber. The number of impacted subscribers greatly increases as problems are revealed higher up in the video delivery chain. Issues in the headend will impact every, or almost every, subscriber, while problems at a serving office may only impact a small percentage of customers. Typically service providers tie problem or issue severity to the number of subscribers impacted by an event or outage. Given this, most operators will put a much higher emphasis on service monitoring in the "Northern" most portions of the network where network failures and problems have the most significant impact on customers. However, new technologies are evolving, such as TR-069 and TR-135, which allow the devices in the home such as the residential gateway and the STB itself to act as service-level monitoring probes in the network as well.

The Difference between QoS and QoE

To identify and isolate the before-mentioned problems, the industry has created a multitude of metrics for measuring the quality of video service. Industry standards or metrics now dictate the acceptable tolerances for creation (encoding) and transcoding video service. Metrics govern the acceptable quality of transmission of these services through an IP transport network. Other metrics govern the interactive nature of the system elements, such as STB communications with the network elements for VoD. Associated with these QoS metrics is an accepted tolerance or value that can predict the presence of a problem that might impact a subscriber. Quality of Experience (QoE) indicators are directly related to what a subscriber experiences when looking at their television and evaluating the service quality. QoS indicators are predictors of QoE issues. For example, the QoS indicator known as program clock reference (PCR) jitter if excessive could predict the presence of the QoE indicator, tiling or blocking.

Figure 3. Examples of Macro Blocking and Tiling

QoS Indicator Examples	*QoE Indicator Examples*
Continuity Counter Errors	Black or Frozen Screen
PCR Accuracy or Jitter	Missing Programs
Sync Byte Errors	Low or High Audio Levels
Stream, Program and PID Bandwidth	Chroma/Color Issues
IP Jitter and Packet Loss	Program Guide Problems

Figure 4. Examples of QoS and QoE Indicators

Consider the gauges and indicator warnings in your automobile as QoS indicators. Some are more important than others; although, they all may indicate some problem, some of which must be addressed immediately, such as a coolant temperature alarm, while others, such has an oil change indicator, can wait. QoS indicators represent the car indicator lights going off, whereas the QoE indicator represents the engine seizing up and leaving you stranded on the highway.

Identifying Problems at Multiple Different Points in the Network

Figure 5 depicts the most common approach which is to properly instrument your network at various points along the video delivery chain with probes that measure the appropriate QoS indicators for each network segment. These probes continuously monitor the video service and the appropriate QoS metrics. When a particular metric goes out of an acceptable tolerance, the probe sends an alarm or alert to the operator's service quality management system or operating support system (OSS). Note that these alerts are only predictors or indicators of QoE or issues that might affect subscribers. While certain QoS indicators are strong indicators of QoE, (similar to the temperature gauge in the car), others are not.

This methodology for video service management is well understood. Place enough probes in the network to evaluate industry-prescribed QoS indicators and alerts from the probes will alert operators to issues immediately. Placing multiple probes in the network allows operators to isolate the location of a problem. Note that this could include using the customer premises equipment (CPE) in the subscriber's home as a QoS monitoring probe. More probes allow for more visibility and thus better opportunities for specifically isolating a fault or problem. It's as simple as looking at the monitoring probes along the service path to see where the service was last indicated as "Good" and then indicating where it went "Bad". Chances are the source of the fault is between those monitoring points.

This approach has become the standard for Service Assurance Monitoring systems that service providers use. In addition is the evolution of the QoE-based monitoring probe which observes the video service at the same point in the network that the subscriber does—the output of the STB. These QoE probes consider parameters such as black screen, frozen screen, and high and low audio levels. Integrating these QoE probes with traditional QoS probes proves to be a powerful combination. When a QoS parameter goes out of tolerance, the QoE probes can record and evaluate the video to see if there is a true impact to the customer.

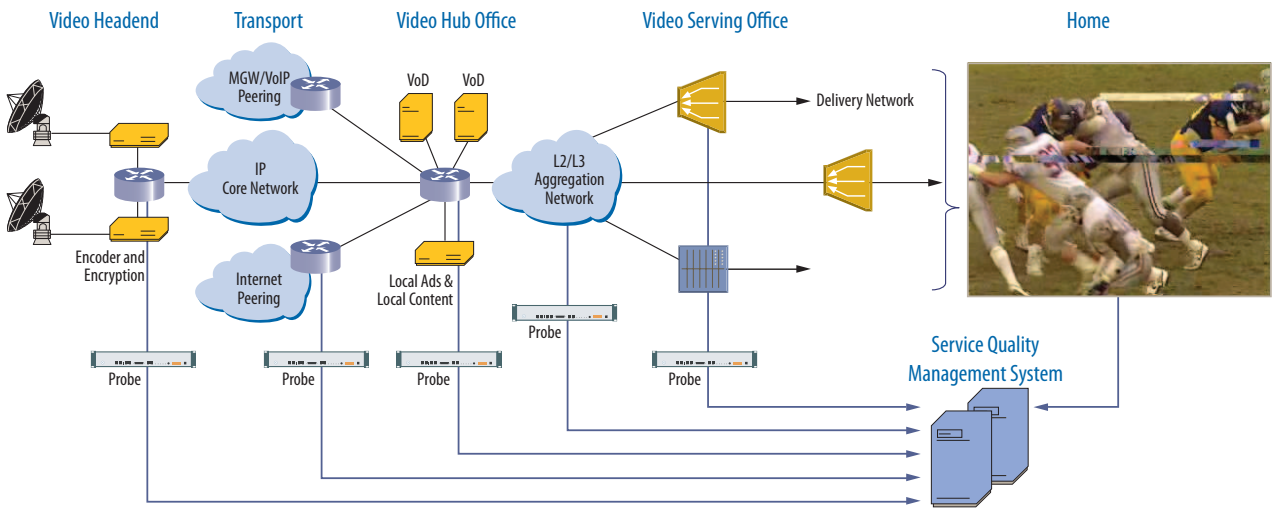

Figure 5. Video Service Management Methodology

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