Symmetricom

PERCEPTUAL VIDEO QUALITY

Delivering High Quality Video over IP

Why Your Digital Video Service Must be Monitored

white paper

APRIL 2008

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EXECUTIVE SUMMARY

For years, network and service monitoring tools have been providing operations engineers with invaluable information for troubleshooting, diagnosis and problem resolution. With the introduction of new high bandwidth, real-time video services that stress IP network infrastructure-monitoring solutions become even more critical. Escalated end-user expectations for video quality—especially for HD—combined with the negative business impacts of delivering a poor quality service, are driving demand for higher quality and new video-focused monitoring solutions.

With the introduction of new high bandwidth, real-time video services that stress IP network infrastructure-monitoring solutions become even more critical.

Impairments to video services can come from a wide variety of sources. Having not been designed for large volumes of real-time video traffic, "best effort" IP networks do not meet the quality requirements of today's digital video services. In addition, video architectures are becoming more complex and constant content manipulation from the content owner down to the end-user also adds additional corruption risk—encoding/transcoding, digital ad-insertion, splicing, statistical multiplexing, and up/down conversions are examples of such manipulations.

With the wide range of complex video equipment, and aggressive compression goals to ensure lowest bandwidth and network impacts, providers face challenges to ensure video service quality meets the growing end-user quality expectations or face high operations costs, high customer churn and slower service deployment.

Ensuring high quality video is a critical component of any successful IP-based video offering and, based on their proven ability to affect bottom line business metrics (such as lower churn, lower operations costs and faster growth), monitoring solutions bring significant value to IP video services. Monitoring is an essential activity, that time-and-time again more than justifies its return on investment, drastically improving IP video service offerings, and enabling rapid growth in overarching business and service objectives.

THE CURRENT IP VIDEO BUSINESS ENVIRONMENT

In short, this is a great time to be in the video business. Video on the Internet is more popular than ever, responsible for driving huge traffic levels, along with large subscription and advertising revenue. Companies across the board, including Telcos and Multi-Service Operators (MSO) stand to benefit a great deal from including IP video into their offerings. IP video creates new more attractive service offerings, lowers delivery cost for end-to-end content management, enables expanded catalogues of long tail niche content, delivers higher performance, and enables more targeted and more effective advertising models.

There is, however, a catch. While video represents a great opportunity and traffic is growing by leaps and bounds, IP networks fundamentally were not designed for such large quantities of real time sensitive video content. Below we explore some of these challenges in more detail.

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VIDEO DELIVERY CHALLENGES

Below are four key inherent aspects of video responsible for large number of today's video quality challenges.

Demanding Traffic Profiles

Video traffic is real time with strict delay, delay variation and loss requirements. High bandwidth streams (2-3Mbps SD, 6-12Mbps HD) further stress the network's ability to deliver video in high quality. As an example, 10M viewers of some particular video content at 6Mbps per stream, results in 60Tbps of total traffic. Even the largest providers would struggle to deliver 60Tbps—especially at the quality needed for video and this is only one video and not counting other video, voice and data services that needs to be delivered.

High End-User Expectations

Not only is video traffic stretching the envelope, but what's worse is end users are more sensitive to errors with video. This of course is based on years of history and experience watching TV. Problems are not tolerated at all and users get frustrated and complain. This becomes especially true when talking about HD services, as improved quality is the primary driver for these offerings. High user expectation for video quality is a major point fueling the drive behind the need for video monitoring.

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IP Network Effects

Internet protocols, having been built primarily with scalability, ubiquity and fairness in mind, do not perform well with large volumes of real-time video traffic and have traditionally been considered "best effort" networks. Packet loss, designed into IP networks to maintain overall performance objectives, has adverse affects on video.

Having been constructed under strict economic constraints, IP networks are bandwidth limited environments resulting in packet loss episodes which can adversely affect video. In addition, the drive toward higher compression ratios, as an effort to lower bandwidths and reduce

costs, can have unfavorable effects on video quality—especially for action-based video content.

When it comes to bursty loss, video reacts very differently than other services. For instance, 10ms of loss for a data service (email, browsing, etc.) is undetectable. For VoIP, 10ms of loss is about 80 bytes, which is well inside the 50ms failover standards and is very tolerable from the end-user perspective. However for HD video, 10ms is about 10,000 bytes and when lost can be extremely noticeable. Operators, putting video on their IP networks (which were previously carrying voice and data services), often discover fundamental problems they never knew existed.

New Network Architectures

State-of-the-art video architectures contain new video equipment including encoders, middleware, servers, management systems and other devices. The introduction of these new elements has not been a seamless process and some investment of time and operational effort will continue to be necessary to stabilize these devices.

terminal. As a result, too often the end user becomes the monitoring system, putting operators in "reactive mode" and often resulting in very angry customers. The chart below, taken from Symmetricom's 2007 Operator Video Quality Study, confirms the primary method for issue identification is via customer calls.

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Some providers have resorted to doing things like off-line surveys to determine end-user experience but this is clearly not real time and does not provide operators with timely information needed for network and service maintenance. Unless operators can gain better understanding of their services, and remove the customer from becoming the monitoring tool, they will continue to struggle with lowering churn and operations costs.

Unable to Improve Service or Fix the Issues

Moreover, because lack of information, operators can't fix quality

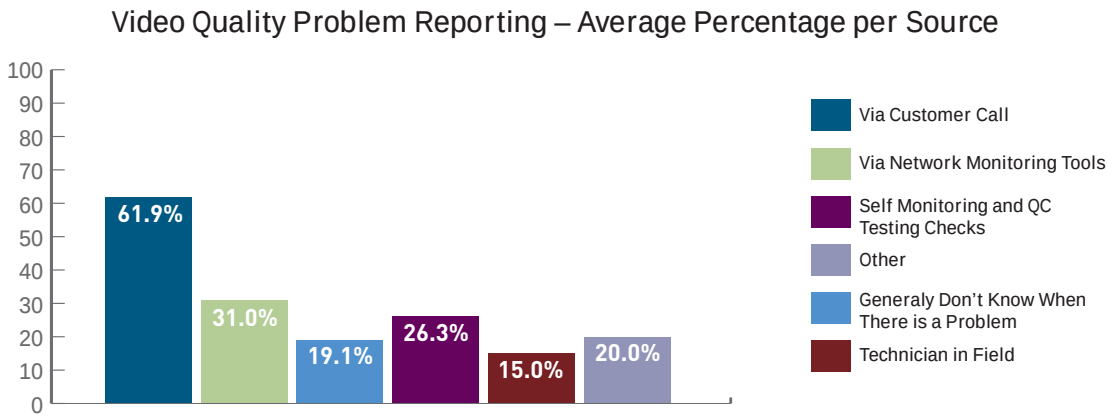

Figure 1 Customer is the Monitoring System

These factors, combined, make video an extremely challenging service, especially at the quality levels required from today's very demanding subscribers.

KEY OPERATIONS CHALLENGES

Understanding What's Going on

Service providers face challenges in understanding their actual video quality as perceived by end-users. Because little information is available about what's happening with the video service, it becomes unclear how the service is actually performing at the end user

problems in a timely manner. Operators often spend hours of valuable time attempting to gather relevant metrics about issues and, with little meaningful data, extended periods are spent debugging and troubleshooting. In addition, longer outages lead to more frequent and longer lasting customer complaints, and ultimately more customer churn.

Being equipped with very little timely and relevant data, operators are unable to improve service levels, diagnose problems and discover solutions to video quality related problems.

DIGITAL VIDEO MONITORING

History and Background

Since the early days of networking, operators have used monitoring tools to help them understand problems with their system. In these early days, continuing through today, operators have relied on invaluable data provided by monitoring systems to understand their networks and services, and rapidly diagnose, troubleshoot and resolve issues.

Network monitoring tools were focused on network quality of service (QoS), represented by four QoS metrics: loss, delay, jitter and bandwidth. For services such as video streaming however, requirements for the monitoring tools have evolved to monitor quality of service from a customer, and content, perspective—an idea which has been termed "quality of experience" (QoE) monitoring. QoE monitoring focuses on the quality of the (video) content than just the network parameters.

The complexity of video delivery systems today has also made it necessary to monitor not just the network, but all the components of the system from end-to-end. This includes the source content, the different devices used for processing it (encoders, transcoders, splicers, multiplexers, streamers), as well as the equipment at the customer premises (STB, home network). End-to-end monitoring is considered essential to identify causes and locate problematic components in an IP video system.

Despite the evolution of IP services, the requirement to obtain real-time, accurate information remains and fuels the need for today's state-of-the-art monitoring approaches.

Bottom line business objectives, including improving and growing the service, lowering operations costs, and reducing customer churn are achieved through implementing a monitoring solution.

Benefits of Digital Video Monitoring

Monitoring is important for the fundamental reason that managers need information to run their businesses. Video quality monitoring solutions allow operators to determine where issues are coming from and how service issues are impacting the business. Bottom line business objectives, including improving and growing the service, lowering operations costs, and reducing customer churn are achieved through implementing a monitoring solution. The importance of monitoring is further evidenced from the chart below, from Symmetricom's 2007 Video Quality Study.

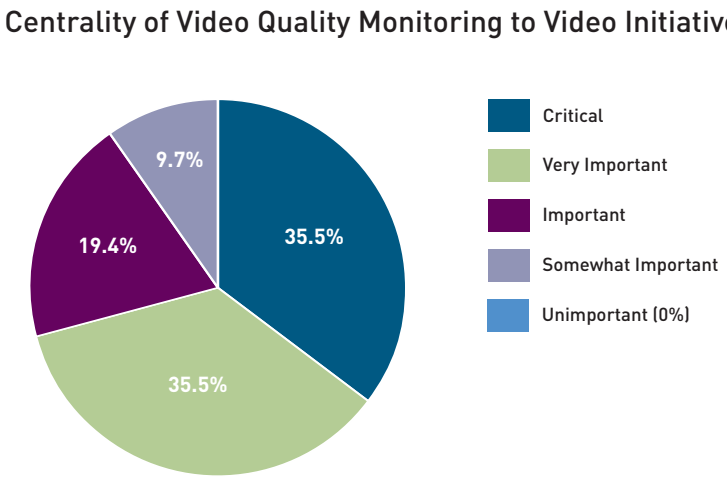

Figure 2 Monitoring Video is Extremely Important

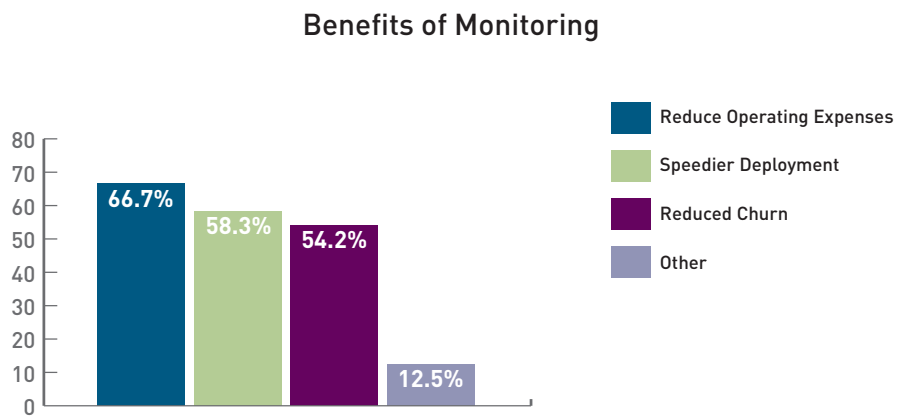

Figure 3 Key Business Benefits of Monitoring

Availability of timely and accurate video service quality information can radically improve bottom line business metrics. The data above, gathered from cable operators, outlines the top business benefits of video monitoring.

Reduce Operating Expenses
Maintaining and managing a video service offering is a key expense that needs to be controlled. Support calls generally cost a minimum of $30 per call while truck rolls can run upwards of $800 per instance. Support costs for video services have been steadily growing and poor video quality is a key reason for this as per the chart below.

These costs need to be controlled if operators are to deliver profitable video services.

Reduced Churn
Lost customers are a key metric to measure IP video service success and unfortunately, poor video service quality is a key driver of churn. The high cost of new customer acquisition makes losing customers even more painful. Because of negative impacts on churn, it is extremely important to deliver high quality video and measure this quality to ensure ongoing video performance.

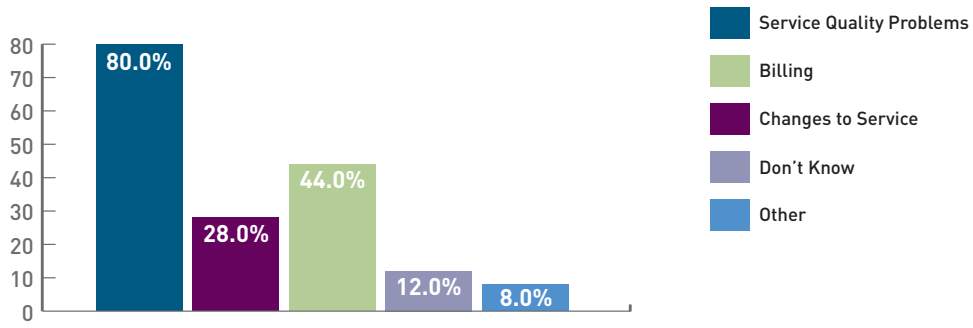

Figure 4 Key Reasons for High Support Call Volumes

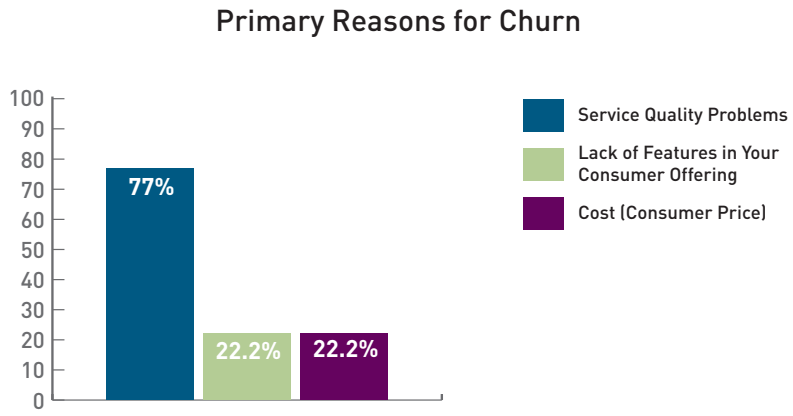

Figure 5 Primary Reasons for Customer Churn

Without the right monitoring tools, the following may be a typical scenario:

- Customer calls complaining of poor video quality
- In response, service providers send a truck, make a test, and determine video is good. In an effort to ensure the customer is satisfied, the set-top box is replaced and tested by the manufacturer
- Same customer calls a few days later with the same issue
- Due to frustration, customer moves to competitive digital video service

Such a scenario represents a lost revenue stream of nearly $100 per month. What's worse is customer acquisition costs, often upwards of $250 per customer, need to be expended to replace this lost revenue stream. All these factors quickly escalate total cost of rolling out a poor quality video service and rationalize video monitoring solutions.

When you consider costs of not monitoring outlined above, the investment in monitoring technology is generally a very smart choice.

Speedier Deployments

Because high quality video is of central importance to IP video services, and the adverse affects of poor quality, operators need to ensure service performance before customers are turned up. On the other hand, extreme pressure exists to turn up large numbers of video customers to meet overall business objectives. Deploying monitoring tools, which validate video quality, speeds deployments and is key to faster service monetization.

Common Objections to Monitoring

Monitoring is Too Costly

True, deploying monitoring solutions requires capital investment in hardware and software components along with training and other upfront operations costs. Despite this, based on current deployments, monitoring solutions generally cost less than $1 per IPTV subscriber and based on these figures, a return on capital investment of 2 to 5 months depending on deployment and architecture. When you consider costs of not monitoring outlined above, the investment in monitoring technology is generally a very smart choice.

Network Repair-only solutions are sufficient

Packet loss recovery approaches like forward error correction (FEC) and packet re-transmission techniques such as reliable UDP (RUDP) can overcome a large percentage of packet loss in some network scenarios. These solutions can be helpful in mitigating impact to video quality from packet loss in network elements. These approaches, however, are not sufficient as their "static" nature (they are tuned for specific cases) often only protects against pre-determined loss probabilities; there are theoretical and practical limitations to their effectiveness. In addition, being a real-time service, video cannot often "wait" for retransmission to occur and service quality can suffer with delays and overhead resulting from retransmission.

Impairments come from other places besides the IP network making FEC and retransmit approaches insufficient to recover from all problems.

Furthermore, FEC and RUDP are network-centric solutions designed to recover from packet loss. Impairments come from other places besides IP network making these FEC and retransmit approaches insufficient to recover from all problems. As packet loss is only one source of video quality issues (others include poor source quality, encoder/transcoder artifacts, ad-insertion issues, and a host of other content-related artifacts and issues), video quality problems still exist even if these approaches are deployed. Moreover, ensuring quality in each network demarcation (headend, VSO, CPE, etc) is essential to

daily operations activities including troubleshooting and diagnosis and requires monitoring devices specially designed for the specific challenges of each of these demarcations.

While such repair-only solutions can help make video delivery more robust, operators will still require monitoring tools to understand and improve the quality of their video service.

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Overhead

A general misconception about monitoring solutions is that they add extra processing, bandwidth, reliability and complexity overhead to IP video systems. Because the vast majority of monitoring activity is “passive,” where streams are “tapped” and a copy of the streams is analyzed, monitoring does not impact the video performance. While there are some “active” monitoring approaches (which involve setting up connections to servers to simulate end-users and test performance) these are generally for temporary troubleshooting and diagnosis.

SUMMARY/CONCLUSIONS

For years, network and service monitoring tools have been providing operations engineers with invaluable information for troubleshooting, diagnosis and problem resolution. With the introduction of new high bandwidth, real-time video services that stress IP network infrastructure, monitoring solutions become even more critical. High end-user expectations for video quality—especially for HD—combined with the negative business impacts of delivering a poor quality service, are driving demand for higher quality and new video-focused monitoring solutions.

Ensuring high quality video is a critical component of any successful IP-based video offering. Based on proven ability to affect bottom line business metrics (such as lower churn, lower operations costs and faster growth), monitoring solutions bring significant value to IP video services. Monitoring is an essential activity, that time-and-time again more than justifies its return on investment, drastically improving IP video service offerings, and enabling rapid growth in overarching business and service objectives.

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