



Application Note: Providing High-Quality Video over IP

Introduction

Video-on-demand. Streaming video. IPTV. These high-profile video services over IP promise to deliver the next wave of revenue for network service providers. IP video completes the vaunted “Quad Play” – broadband data, voice, wireless, and video – enabling service providers to integrate and bundle distinct new offerings to attract additional subscribers and retain existing ones.

Challenge

Delivering high-quality video over IP requires offering the same or better quality of experience (QoE) than what broadcast and cable TV subscribers have been receiving for many years. When TCP/IP was invented in 1973, delivering high quality video in volume was not a top design goal. As such, traditional packet networks were architected to optimally route and forward traditional “data” services like file transfer, email, and then web browsing. Voce over IP (VoIP) came next.

The low-latency requirement of continuous “streaming” traffic like VoIP has been more or less met. However, in addition to consistently low latency, video also requires extremely high throughput compared to voice – usually multiple megabits per video channel vs. 64 kbps for voice. The unique low latency with very high throughput requirements of video pose a severe challenge to today’s networks, whose basic packet forwarding architectures have remained unchanged for over thirty years.

What impacts the quality of video traffic? In two words, it is “packet loss”; witnessed as pixilation, jitter, and freeze-frame. Any of these visible quality flaws can cause viewers to quickly consider other video service alternatives. The primary cause of packet loss is network congestion, often caused by surges in subscriber demand. Consider, for example, that a network has enough capacity to support up to 5 TV programs (channels) to a particular user. When a sixth program is requested, routers have no choice but to apply some traffic management/congestion avoidance techniques such as Weighted Random Early Discard (WRED), which by definition discards packets randomly across all existing streams. This random packet discard then visibly damages the quality of all 6 video streams, and users quickly start looking for an alternative service. Consider Figure 1, which shows how packet-based networking equipment attempts to control video over UDP.

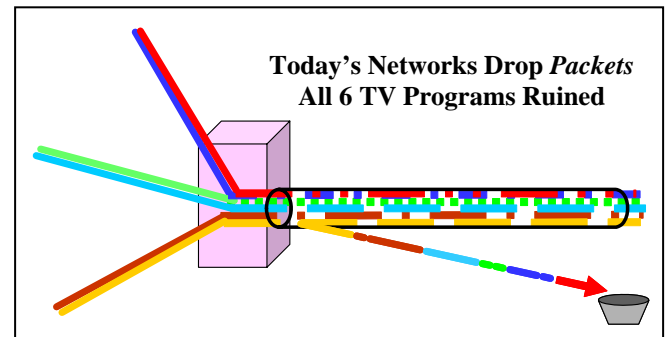


Figure 1. Traditional Packet Rate Control

Solution: Intelligent Flow Management

The simplest, crude solution to address network congestion is to massively over-provision network links and router ports – a cost-prohibitive proposal. Even more challenging is determining the required peak network capacity for video, which can vary dramatically based on the content itself, the target audience, and how it is delivered (unicast, multicast, streaming, or on-demand).

Anagran solves the IP video challenge with an effective, economical solution: **intelligent flow management**, which includes an inherent in-band video call admission control (CAC) function as well as **behavioral** traffic management.

In-Band Video Call Admission Control (CAC)

The Anagran FR-1000 maintains vital flow statistics on all flows and closely watches incoming video streams to proactively control misbehaving packet rates. Flow-based CAC is performed on any streaming flows that violate their required rates to ensure proper service levels for all streams. An example of flow-based CAC for UDP based video flows is shown below in Figure 2.

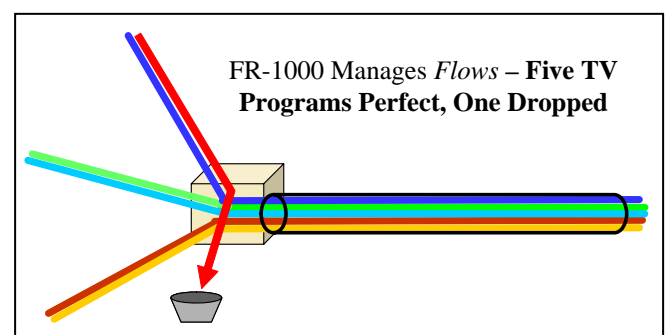


Figure 2. Flow-Based Call Admission Control

The FR-1000 constantly measures bandwidth utilization at the outgoing port and feeds that information back to the ingress side where the decision to admit or reject a new video flow is made. If enough bandwidth is available to support a new video stream, then it is admitted. On the other hand, if a new video stream will damage existing streams' quality due to inadequate network resources, then that video stream is rejected, and the requesting subscriber may see a friendly "please try later" message. Thus, congestion is eliminated, fairness is effectively invoked and existing videos run at their desired quality; all without the latency and scalability limitations of out-of-band signaling schemes or extra special-purpose "resource management" servers and processes.

Intelligent Flow Discard™ for TCP

More often than not, web-based video applications run over TCP. Anagran's Intelligent Flow Discard™ (IFD) technology proactively alleviates any packet loss that could cause TCP streams to fall into TCP slow stop/slow start, which damages video download speed and quality. IFD also inhibits a severe TCP congestion condition called "TCP congestive collapse" where many of the TCP streams are momentarily halted due to excessive re-transmission requests and TCP rate throttling. Packet loss and TCP congestive collapse are the main reasons why so many networks are massively over-provisioned. In contrast to this cost-prohibitive "buy and pray" approach, IFD meters each video flow as it arrives and prevents harmful packet loss and congestive collapse, resulting in extremely efficient bandwidth utilization. Studies¹ have shown that adding IFD to a network can instantly increase bandwidth utilization by 3X or more, while at the same time reducing latency.

IFD enables fine-tuned control of TCP traffic, with select individual flows throttled first per their Quality of Service (QoS) requirements. It provides an extremely cost-effective and powerful mechanism to mitigate much of the over-provisioning (over spending) commonly used to avoid network congestion problems in the first place. Network users receive their expected user experience while total cost of ownership for the network is dramatically reduced.

Dynamic, Behavioral Control of Video Quality

Anagran Behavioral Traffic Control™ (BTC) classifies and optimally manages traffic, including video, by observing its behavior over time. For every flow, the FR-1000 maintains flow state information which is used to classify the traffic. As traffic is instantly classified, appropriate actions per policies are applied.

For video, BTC can detect anomalies between the *expected* behavior and the *actual* observed behavior for any given video flow. If any anomalies are detected, BTC can take any number of policy-based actions including re-marking DSCP to allow higher priority or lower priority downstream, or changing the path to force all video traffic to a certain port that is linked to a higher QoS enabled network, for example. Figure 3 shows how BTC works:

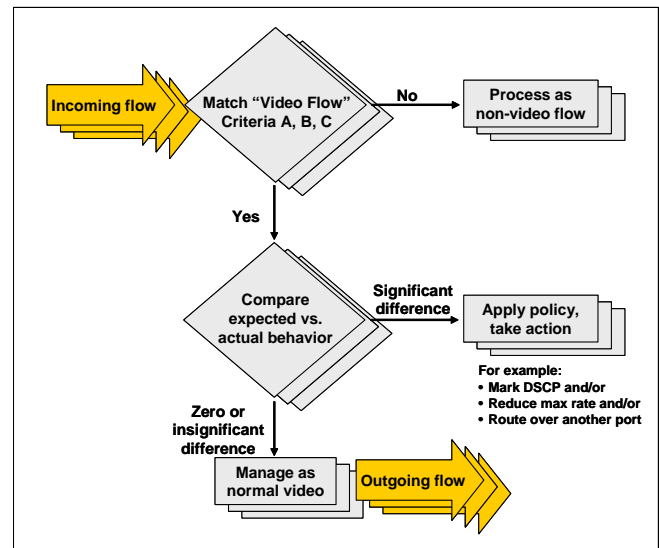


Figure 3: Dynamic Detection with BTC

With BTC, dynamic flow detection, classification, grooming, and packet forwarding by policy allows the FR-1000 to provide real-time diagnostics for all flavors of video traffic, and to optimally move video streams from source to destination anywhere in the network based on established policies per each network video service. IPTV can match broadcast and HDTV quality, VoD streams can download without delay and with high QoE, and multicast video streams can move from concept to revenue-producing reality.

Conclusion

Anagran IFD™ provides the proactive, intelligent metering required for video to successfully complete the fourth element of Quad Play network services. Behavioral Traffic Control™ allows all varieties of video services to meet users' quality demands, even as network load and behavior fluctuates, while peacefully co-existing with all other traffic types.

Anagran's intelligent flow management with IFD and BTC delivers the next wave of Quad Play services including IPTV, video-on-demand, and live streaming video with unmatched ease and efficiency. Finally, real-time and on-demand video services can scale over a converged IP network, and at a small fraction of the established operating and capital expense.

¹ Lawrence Roberts, "Router Techniques for Controlling TCP Overload," May 2006

