VideoFlow
seeing is believing

High Quality Video
Low Bandwidth Overhead

By Adi Rozenberg, CTO

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Chapter 1. Introduction

In today's world, IP (packet transport) networks are becoming the new highway for video streaming. Streaming video over IP deployments is becoming more mature and is being used more by operators, broadcasters and content network distributors who benefit greatly from IP's fast, easy accessibility to network making deployments making adding new services simple and rapid. However, this new capability brings several complexities and inherent challenges.

IP networks were originally designed to handle data transfer where the criterion for success is complete delivery and not necessarily timely delivery. When transmitting data, IP networks can handle uneven deliveries. Even occasional packet drops can be tolerated by data delivery applications because these applications are built to handle late arrivals and protocols exist (e.g. TCP) to resend the missed packets.

Video on the other hand requires all packets to be delivered regularly and reliably, as video buffers must be fed consistently. MPEG decoders do not handle missing data well, which leads to problems for those sending the video and for end-users who do not experience the quality they expect. There is an increased awareness of the problems that packet loss and network jitter can cause when using any type of IP network. It is a reality and the resulting drop in the quality of experience for the viewer cannot be ignored any longer.

Initially, installations tended to over provision bandwidth in order to ensure good service and consistent video quality, but this can be expensive. Since economic pressures affect everyone, it is essential to reduce costs while still increasing services provided. Cost-effective solutions are a challenge that needs to be met by network equipment manufacturers and network operators.

This paper describes the current solutions available to handle the impact of packet loss and network jitter on video streams over IP. It also shows how VideoFlow can provide an economical solution to this challenge enabling all types of content distributors to save money while giving viewers maximum quality of experience.

Chapter 2. The Problem

Packet loss has multiple causes.

- Congestion and packet drop due to oversubscription of the channel or exceeding equipment buffers, bandwidth thresholds, or packet-handling capabilities.
- Statistical nature of the internet as the network is shared with other applications and users that may obstruct each other traffic from time to time.
- Reorder errors as some receivers cannot reorder packets.
- Duplicate packets, as some receivers cannot handle duplicates
- Core network issues including link failures, route convergence, reroute and multiple paths.
- Environmental effects which are commonly found in copper lines.

The impact of these effects is also interesting.

Congestion and packet dropping tend to generate bursts of loss, but the duration can be either very short or very long. For example, congestion and packet drop occur if traffic exceeds allowable buffer limits. Reducing the probability of congestion and packet drop requires either adding more bandwidth and higher end equipment or reducing the traffic bandwidth to provide sufficient margin for eliminating short-time transients exceeding the allowable buffers limits. This type of solution is expensive both to the network operator and to the content distributor, since it involves higher capital expenses for both bandwidth and equipment. This additional bandwidth cannot be used for other applications because that may cause packet loss. The typical bandwidth provisioning is 20-30% of the original stream. For example, a distributor needs to secure 12-13Mbit of bandwidth for a 10Mbit stream.

The inherent nature of the Internet tends to generate occasional jitter and other delay variations that prevent packets from reaching their prospective destination on time. These delays may cause packets to lose their place in the receiving buffer and therefore considered lost. Most network operators are not able to provide assurance that packet will not be delayed or “lost” even if the stream is running via a special VPN tunnel. This is because the network (or link) is shared with other services or applications that require different bandwidth from time to time. The traditional solution to reduce the occurrences of this issue is similar to the one described for

congestion and packet drop, which is bandwidth over-provisioning to allow the service to run with “wider” shoulders.

Packet duplication and miss order errors are less frequent. The “lost” or ”duplicated” packet arrives late to the destination and is treated as an out-of-sequence event. It is possible to reduce the number of these events by changing the network design to prevent path switching. However, this solution may not be compatible with some network infrastructures. The common solution to handle this type of event is to use RTP streaming, which is a well-established industry standard supported by most broadcasters and network equipment manufacturers.

Core network events tend to be the longest events. Each event may take 50-100ms depending on the network configuration and equipment. These events cannot be entirely eliminated, but it is possible to reduce the impact by changing the network design to enable deep buffering capabilities to absorb the impact of jitter or delay variation events. The buffer should be able to handle a minimum of a 100ms drop in traffic and shield the receiver from such drop.

Environmental effects like electrical impulse noise tend to cause uncorrelated short burst errors in the order of 1-20ms. The usual approach to reduce this effect is to increase protection at the physical layer. This is normally done indirectly through allowing larger noise margin and other parameters at the cost of less effective channel throughput.

Chapter 3. The VideoFlow Solution

The VideoFlow innovative digital video protection (DVP) product line provides a sophisticated packet recovery solution that offers 100% protection against packet loss using a robust algorithm that does not require the participation of the original transmitter and receivers, offloading the original sender for better scalability. VideoFlow uses the state-of-the-art VideoFlow patent-pending, error correction (VFEC), a unique on-demand packet recovery technique. VideoFlow patented packet recovery has multiple layers of protection techniques, all with a single goal – recover lost packets at minimum bandwidth overhead.

The VideoFlow DVP solution is a client server model suitable for use with today's network technologies. It consists of a set of devices to handle packet loss information. The server side is the Protector; the client side is the Sentinel. One Protector can communicate with several Sentinels. The protector monitors and analyzes the video stream's health and stores error correction information for every video packet sent. Each server establishes communication with the Sentinels assigned to it, which also monitors and analyzes the video stream's health. The Sentinel report any missing packet event (single, multiple, or burst) to the Protector. In response, the Protector is using the stored information for the video packets reported missing by the Sentinel. It applies the optimum VFEC solution to recover the missing packets at lowest bandwidth overhead possible.

One of the main advantages of VideoFlow's VFEC architecture is that it requires less bandwidth overhead than other solutions. The bandwidth required by VFEC for packet recovery is proportional to the packet loss event and is optimized for finding a solution requiring the least amount of bandwidth that will guarantee packet loss correction. Therefore, the content distributors can reduce operating expenses (opex) because they no longer need to overprovision bandwidth while benefiting outstanding protection for their video streams. For example, if the content being streamed is 10Mbit, generally the content distributor would add 20-25% to the bandwidth in order to provide some protection. This means that distributors will be forced to pay for additional 2-2.5Mbit of bandwidth. Deploying the DVP will reduce the overhead bandwidth to 0.5Mbit, thereby, reducing operating expenses.

Chapter 4. The Economy of Bandwidth Saving

The key to selecting any solution is a sound business case. While the expenses saved will vary from deployment to deployment, the potential savings can be summarized as follows:

- **Reduce Network Cost by using the Internet**

  The Internet is being hailed as the next great thing in video streaming. While it does have drawbacks, such as random and unforeseen packet loss, the cost is much less than other B2B solutions. VideoFlow's packet loss protection solution enables distributors to take advantage of the Internet's benefits.

- **Reduce Opex**

  The most common solution for video streaming has been to increase the amount of bandwidth purchased to secure better protection against packet loss. This increases overhead expenses since monthly charges for bandwidth can be costly. The VideoFlow solution enables distributors to purchase less bandwidth while still providing QoE for end-users. The VideoFlow solution also enables distributors to decide what form of network to use (e.g. Internet) providing the same level of quality while lowering costs.

- **Reduce Penalties**

  Most distribution contracts today contain penalty clauses based on lost packet events. These penalties are intended to put the pressure on the network operators and content distributors to use highly expensive networks or private links to ensure higher SLA and QoE. The VideoFlow solution protects against packet loss and, therefore, reduces or even eliminates penalties without the need to use higher-cost network solutions. Distributors are able to use lower cost networks that cost a fraction of the original networks.

- **Protect Investment**

  Most distributors have already invested in state of the art equipment for streaming and receiving video. It is highly unlikely that they want to replace their current equipment with new devices. The VideoFlow solution does not require a forklift upgrade. It is reliable, flexible and integrates seamlessly with current infrastructures. It is simple to configure and easy to use In addition, it is future proof since it is designed to integrate easily with future generation technology guaranteeing scalability.

Chapter 5. Summary

It is evident that video distributors are using the Internet more and more to stream video. They became to realize that packet loss is a given and it is essential to deal with this problem in order to provide QoE expected by the viewers to ensure their revenue potential. In order to select the most efficient and cost-effective solution that will give the best result, distributors need to focus on the error characteristics rather than concentrating on complex and expansive solutions like adding network engineering or additional hardware. Several factors should be taken into consideration when selecting an error correction solution. Every network is different and each of the solutions described in this paper has its unique benefits based on the network loss profile.

VideoFlow's DVP client/server product line is simple, flexible, scalable and cost-effective. It is easy to deploy and integrate with any existing network. Designed to be future-proof, the DVP product line will just as easily integrate with next generation packet transport networks. It fits easily into existing network setup and does not require a forklift upgrade to network equipment. Network Operators and Content Delivery Networks are able to use a lower grade SLA to achieve 100% protection from packet loss. They can lower their bandwidth costs, protecting against contract penalties, enabling them to plan for moderate bandwidth upgrades according to their needs rather than oversubscribing just to protect the quality of the video stream. In addition, the high quality video experienced when using VideoFlow's solution will enable Operators and CDNs to expand their reach and acquire new customers. VideoFlow's solution is standard-compliant and protects any investment already made in equipment or services.

VideoFlow's DVP product line provides added value to network operators and content deliverers by actively protecting video against normal network behavior in order to provide viewers with the best possible quality of experience every time, everyplace and on every capable device.