

Intelligent video networking

The role of video processing in next-gen personalized video delivery

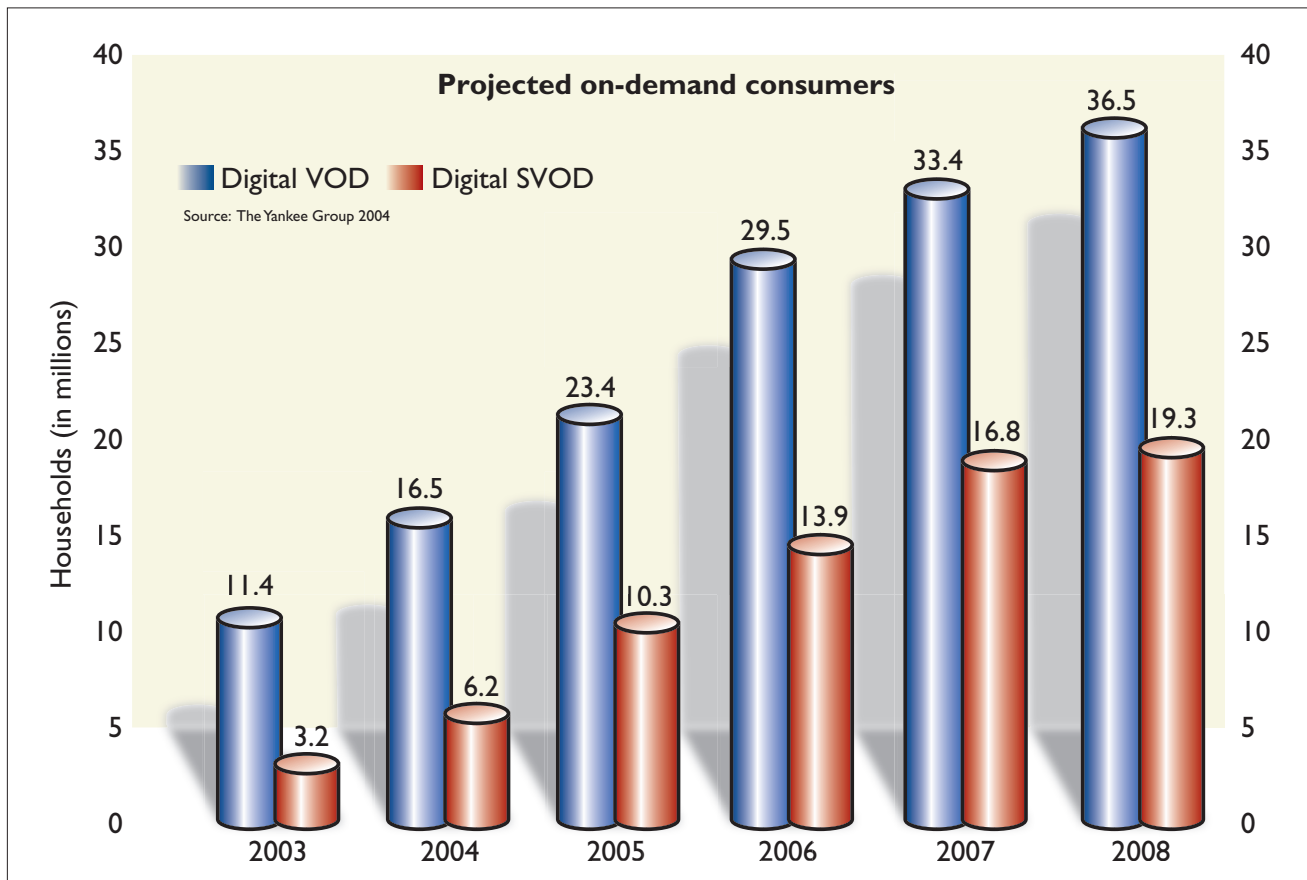


Figure 1: Projected VOD growth through Y2008.

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The video service provider market promises to be an increasingly competitive environment. Consumers are reaping the benefits of this competition, taking advantage of the growing number of services and products offered by video service providers and electronic manufacturers alike. However, these expanding choices have also created certain expectations among consumers. Now, they are demanding even more offerings, and they won't hesitate to change providers if those

services aren't delivered quickly, as evidenced by the high degree of subscriber churn seen in the industry today.

For the operators, video delivery services still represent the core of their business—and the key to their competitive survival. Despite growing success with high-speed data services and the promise of the IP telephony market, digital and on-demand video have proven to be effective tools for attracting and retaining customers. The recent success of personal video recorders (PVRs) has shown that customers are receptive to, if not eager for, the freedom that personalized video applications provide.

Clearly, these types of personalized

video services will continue to be an effective competitive tool for video service providers and cable operators. Their continued development and deployment, however, is not without challenge.

The challenge of competitive evolution

In response to the increasing consumer demands and multiple competitive offerings, cable operators have continually upgraded their networks to deliver compelling new services.

In recent years, these upgrades have included a rapid deployment of digital ser-

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vices, along with the equally rapid transition of existing systems to high bandwidth capacities and bi-directional digital return capabilities. This combination—new efficient digital video systems and expanded bandwidth capacity—produced a formidable architecture upon which new services could be deployed to satisfy the increasingly demanding customer base.

This new architecture, however, has already shown signs of stress. As operators continue to roll out new services such as video-on-demand (VOD), high definition TV (HDTV), and digital off-airs, they are constantly challenged to find enough bandwidth to support them. The problem only promises to get worse, as demand for digital on-demand services is expected to climb dramatically over the next several years (see Figure 1). Investor and analyst pressures have all but eliminated the option for additional upgrades. As a result, operators need to find more effective ways to manage the resources they have already deployed.

While many systems successfully deployed VOD services, the state of existing video delivery technologies made expanding those services a constant challenge.

The scalability required to support personalized services (as opposed to broadcast services) has challenged all facets of the cable network. Lack of effective back-office systems and resource managers have forced personalized services such as VOD to be deployed through static point-to-point connections, requiring dedicated over-provisioned channels to deliver a predetermined amount of video to an undetermined amount of demand. Operators realized that traditional video-specific interfaces (such as ASI and DHEI) were woefully inadequate to meet the bandwidth, scalability and long-haul requirements for distribution of the on-demand services. Headend and network video processing products, having been designed around live broadcast video specifications, lacked the density, scalability, and economics required to address a growing number of personalized services.

Throughout the deployment of new digital services, operators have identified and begun to address many areas of opportunity. Working closely with the ven-

dor community, operators have applied new enhancements and standards to all areas of the digital systems, with the goal of increasing the efficiency of their bandwidth-limited systems and to enable the continual growth of new digital services—video, high-speed data, and telephony. By combining these services, cable operators have discovered that they can not only increase customer satisfaction, but also dramatically simplify the operation of the network.

IP video delivery—a glass half full

One of the most important standards adopted by the video operators was the Internet Protocol (IP), which was critical for the migration to triple play (video, voice and data) services.

The proliferation of IP technology and the use of high-speed Ethernet switching mechanisms to transport video have had a positive ripple effect on modern digital video delivery systems. IP solutions, used predominantly in data networking, are simple to configure, highly affordable and widely available. Technologies such as IP and Ethernet provide standards-based methods for transporting video at tens of gigabits per second, making them key enablers for simultaneous distribution of large numbers of streams. Networking vendors continue to evolve their Ethernet switching and routing devices, providing increasingly scalable solutions with extremely high throughput at very low costs.

Thanks to all these benefits, cable operators have accepted Gigabit Ethernet as their transport standard for digital video, and they have upgraded their systems to support this technology at a record pace. Today, all newly manufactured digital transport, server I/O, and modulators are networked devices supporting IP and Ethernet.

While Gigabit Ethernet has proven invaluable for scalable on-demand systems, it offers many enhancements to broadcast digital video services as well. Managing services and resources over the Gigabit Ethernet network has also been an area of great interest, with the focus on providing dynamic bandwidth monitoring and efficient use of available resources. As the push for IP technologies continues, there

have even been proposals for architectures that could transport video services over the DOCSIS broadband infrastructure, expanding the IP network all the way into the home and creating a complete, end-to-end IP network.

However, while the adoption of IP technology has been a very important step in the realization of the fully efficient video system, it's still only part of the overall picture. Digital video processing techniques will continue to play a significant role in the modern efficient video distribution system. These techniques are the key to enabling new revenue sources, new consumer devices, and services that cannot be matched by competitors.

Continual improvements in digital video processing technology will lead to lower deployment costs, better use of existing bandwidth, multiple options for all-digital strategies, better video quality, and a more satisfying viewing experience for discerning consumers. However, existing technologies aren't enough to make this vision a reality. What's required is a new generation of video processing technologies that complement the IP and high-speed data switching infrastructure, creating a complete, competitive video services delivery solution.

Completing the picture

To truly meet the needs of the digital video services market, next-generation video processing technologies must satisfy a number of demands: they must be able to take full advantage of the high-speed, high-performance IP infrastructure; they must be highly adaptable to support the different types of video services that operators will deploy; and they must be able to process all video services indiscriminately.

Unfortunately, today's video processing solutions fall far short of this mark. With their high costs, low stream densities and lack of scalability, current solutions can only be applied to video services on a highly selective basis. Solutions such as statistical multiplexing, digital splicing/insertion and encryption—common in the broadcast digital services world—are nowhere to be found in the on-demand personalized video market, not because they aren't important, but because they

are just not practical with existing solutions.

Simply put, the ideal video processing solutions must provide the flexibility to apply any function to any video service delivered to any customer at any time. They need to offer lower costs, higher densities and greater scalability to meet the specific demands of operators at any point in the growth cycle of new digital services.

These solutions will be vitally important to the ultimate success of the next generation of video services, playing a crucial role as more services are shifted from traditional linear networks to personalized on-demand delivery.

On-demand video processing

Statistical multiplexing—which played an invaluable role in the deployment of current broadcast digital systems as well as the introduction of new digital services such as HDTV—will play an equally important role in the on-demand environment.

The application of statistical multiplexing will allow better utilization of the growing on-demand spectrum, providing as much as 40 percent greater bandwidth efficiency. In North America, the on-demand architecture is designed to support 10 constant bit rate video services per modulated QAM channel; with statistical multiplexing, that number would grow to between 14 and 16 services per channel, allowing operators to reduce their investments in QAM modulators and video transport equipment. Statistical multiplexing will also allow cable operators to efficiently handle peak usage times without having to over-provision the service.

Statistical multiplexing can also be used to deliver a higher-quality on-demand service than today's standard encoding rates by applying the technology to CBR content encoded at a higher rate than today's VOD content sources. While the same number of VOD streams is supported on each channel, the video quality would match that of the higher encoding rates.

As high-definition services are introduced to the on-demand environment, statistical multiplexing will also play a critical

role in managing the additional bandwidth requirements, perhaps allowing for HD service deployment in an otherwise bandwidth-restricted system.

Clearly, with its numerous essential benefits, statistical multiplexing is a video processing technology that needs to catch up to the demands of the next generation of high-density personalized video services.

Digital ad insertion

As with today's digital broadcast solutions, video processors are essential for digital-into-digital advertising insertion.

As services become more personalized, targeted advertising opportunities will become abundant. While there has been a limited need for ad insertion in today's primarily movie-on-demand services, free on-demand and time-shifted programming will provide operators with many more ad

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avails which can be used for targeted advertising. Ad insertion opens up tremendous revenue opportunities because it offers advertisers the ultimate granularity for reaching their target customers.

Network insertion of this targeted advertising gives operators the best alternative in their quest to build open, vendor-independent solutions—but only if these solutions can be delivered at a density and price point suitable for the on-demand environment. Unfortunately, today's solutions do not adequately meet these requirements.

Supporting new compression types

The application of MPEG-2 processing techniques such as statistical multiplexing and digital program insertion will also be important steps in

furthering the competitiveness of personalized video services. However, the deployment of next-generation video services will also require new, more challenging video processing capabilities.

As the bandwidth requirements of on-demand, HD and new linear programming services continue to grow, they will eventually force operators to recapture bandwidth through all-digital system conversions and the adoption of advanced codecs such as MPEG-4 AVC and SMPTE VC-9.

Migration strategies such as all-digital conversions and advanced codec support pose a considerable challenge for operators, who must account for the numerous legacy consumer devices deployed in today's systems—millions of MPEG-2 digital set-tops and tens of millions of analog televisions. Advanced video processing applications such as dense digital decoding, dense modulation and video transcoding (advanced codec ↔ MPEG-2 conversion) can all play an important role in these conversions.

These processing techniques will allow operators to push bandwidth-efficient digital services in any video format far into the IP-enabled networks, converting to the proper video format (analog or MPEG-2) to support the appropriate consumer device. The benefits of such solutions are tremendous, because they will offer the ability to perform all necessary video processing functions such as ad insertion, video switching, video transport and emergency alert systems (EAS) support in the digital domain—regardless of the eventual delivery format.

Video distribution and storage using advanced video formats also provides tremendous savings in digital transport and storage solutions, even if the end clients are not capable of supporting an advanced video codec. In migrating to video-over-IP and video-over-DOCSIS, advanced processing techniques allow the same content to be shared among many client devices. PCs, set-tops and digital TVs can all share the same content as an intelligent video processor makes the appropriate format and transport conversions to meet the needs of the client device.

Video quality

While on-demand and personalized TV viewing offer the consumer an enticing video experience, they must be delivered at a quality level that is consistent with all other existing services.

Video processing is the key to enhancing video quality and improving user satisfaction. For instance, in an on-demand environment, video-processing techniques can be used to enhance the viewing experience through optimization of the trick play functions. Special buffering techniques and message exchanges between video streaming servers and video multiplexers allows for faster and smoother transitions between trick play functions.

By communicating with the video server appliances, video processors can be made aware of transitions between play and trick modes and can therefore substantially reduce or eliminate the latency associated with these operations, as well as offer the ability to move to an on-demand switched video environment.

Advanced video processing will also play a significant role in managing quality video multiplexes. Through short- and long-term analysis of video usage and video characteristics, intelligent video management can provide information and produce suggestions on how to build optimized video multiplexes. The video content of such multiplexes would be a mix of variably complex video streams, resulting in optimal quality for each video stream while taking full advantage of available bandwidth. Initially, such information would likely be developed and

implemented off-line. However, as the flexibility and control of these systems increases, the information could be used to dynamically address the real-time delivery of high-quality, optimized video.

While video quality management can be implemented in a variety of forms, it

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may be best served within a high-density video processing solution. This high-density solution can offer a solid foundation for such functionality, as it is well positioned within the network to observe all video streams simultaneously and to act on the creation of the final optimized multiplexes. The importance of maintaining high-quality multiplexes in dynamic video environments (such as on-demand) will be essential to customer acceptance of, and satisfaction with, these new, advanced services.

Winning the race

As the video service market heats up and consumer expectations continue to grow, existing providers must work harder to offer new and enticing video services to reduce customer defections. In order to remain competitive, they need an efficient, high-performance delivery system

coupled with a high-quality digital video processing solution that can help them deliver the types of advanced, personalized services their customers are demanding.

The implementation of a high-speed IP infrastructure has been a step in the right direction. However, it alone cannot satisfy the demands of the emerging personalized services delivery environment. Given the current state of video processing technologies, the realization of a true, next-generation video delivery system remains a promise only half-fulfilled.

What's required is a new class of video processing solution that can match the density, scalability and performance capabilities of the IP infrastructure by delivering personalized video services over the last mile and into viewers' homes.

Such a combination—a robust infrastructure that transports high-density video streams at tens of gigabits per second, coupled with an intelligent video processing solution that reduces the cost and complexity of delivering personalized services on-demand—would produce a true next-generation video distribution environment. By addressing both today's broadcast services and the personalized, all-digital services of the future, such a solution would ease the transition for operators and consumers alike, allowing the gradual adoption of next-generation technologies at a pace that best meets the users' needs.

Best of all, such a solution would deliver the tools video service providers need to compete—and win—in the new all-digital environment. ■