

EFFICIENT AND PROFITABLE CONTENT DELIVERY FOR NETWORK SERVICE PROVIDERS

Juniper Networks Media Flow Solution:
Enabling Reduced Costs and Increased Revenue
for Fixed and Mobile Network Service Providers

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Executive Summary

Service providers are striving to deliver the already massive and rapidly growing volumes of online video with efficiency and quality. In addition to these efforts, providers are seeking ways to control both OpEx and CapEx while creating new revenue opportunities.

Recognizing these needs, Juniper is delivering Juniper Networks® Media Flow Solution, a content delivery, distribution, and caching system that is purpose built to address the service provider's need for a new media network. Media Flow Solution enables operators to create an open and flexible media infrastructure that supports the efficient delivery of video and Web content services at lower cost and with a high quality end user experience.

Introduction

The market has experienced exponential growth in online video traffic over the past few years, often doubling every six months.¹ Subscriber wireline and wireless networks cannot be built fast enough to accommodate the insatiable demand for content from any and all sources. End users, news organizations, and social networks, among many others, generate immeasurable content daily. Users want to view the vast wealth of media rich content anywhere, anytime, and on any IP-enabled device, and their expectation is to have a TV-like viewing experience. Moreover, consumption patterns are unpredictable.

The market for IP video, in particular, is growing due to the growth of Internet content, as well as viewer demand for personalization and flexibility. There is also an emerging trend to deliver content simultaneously to a large audience across three screens (PCs, TVs, and mobile devices). The technical implication of this volume growth and content diversity is that networks must efficiently handle multiple data formats, protocols, streaming bit rates, and device types. They must also adapt to the change in traffic patterns, especially across three screens, without reprovisioning. The potential business impact is that continuous network investments can easily outstrip revenues.

Current Deployments

Service providers are naturally looking for technologies that can help them meet the challenges outlined above and improve the economics of delivering rich media content. One such approach is the deployment of content delivery and caching solutions within the service provider's network. By leveraging content delivery and caching technology, service providers can improve the efficiency of the network, and potentially open up new business models.

However, the challenges service providers are facing, as described above, pose unique problems that traditional content caching solutions cannot solve. Traditional solutions are simply not designed for the service provider network—specifically because they do not adequately address issues of latency, scalability, and flexibility.

- **Latency**—General-purpose file system storage devices lack content awareness and are inefficient for handling rich content. For example, disk I/O throughput times and the inherent indirection and file fragmentation encountered with regular file systems increase latency.
- **Session scaling**—General-purpose OS schedulers/kernels are not optimized for handling large numbers of concurrent sessions and meeting bandwidth demands.
- **Flexibility**—General-purpose caching systems lack multiprotocol and multimedia support.

To truly change the economics of content delivery, service providers require a new approach—one designed for the new media network. Furthermore, the current content delivery model is quickly becoming obsolete. Many providers run multiple networks, with each network delivering content to the same customers on different end devices. For example, providers might have an unmanaged network that is delivering over-the-top (OTT) traffic to customers with best-effort delivery. They might also peer with content delivery network (CDN) providers to distribute their content globally.

This multi-network content delivery model is expensive and difficult to scale as traffic demands continue to increase. Consequently, service providers are looking for new ways to distribute their content to multiple devices at scale and with reduced costs.

¹ Source: IDC

The Juniper Networks Solution

Juniper Networks Media Flow Solution can support virtually all types of Internet streaming video and other rich media content on a single converged, managed, and efficient content delivery infrastructure. The solution combines media intelligence, storage organization, multitier caching, and network optimization with high-performance storage systems. The result is lower latency, reduced bandwidth consumption, and massive scaling, which in combination offer superior viewing quality of online media and lower operational costs.

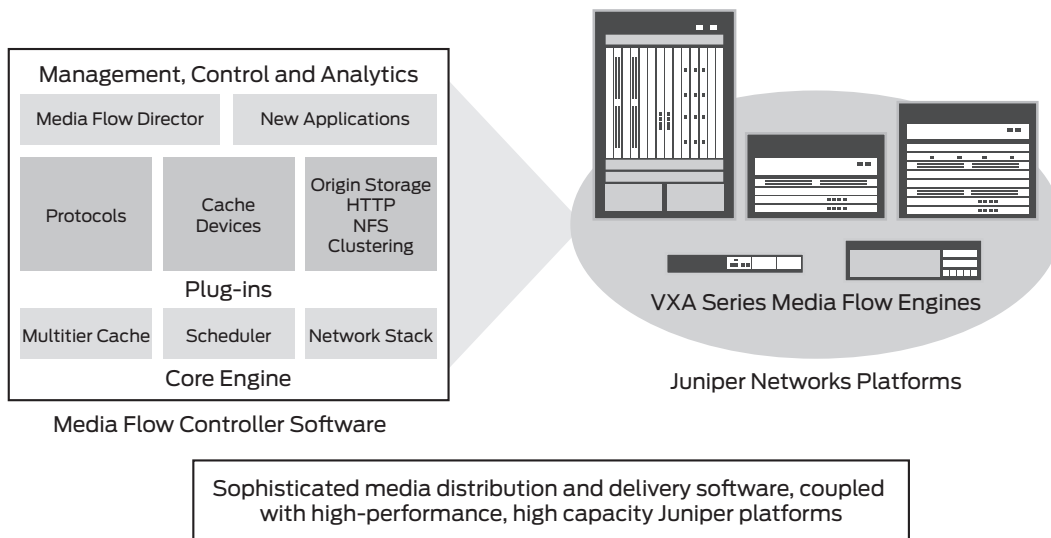


Figure 1: The Juniper Networks Media Flow Solution

In its initial phase, Media Flow Solution consists of Juniper Networks Media Flow Controller, Media Flow Manager, and the VXA Series Media Flow Engine (Figure 1).

- **Media Flow Controller** is a Juniper Networks Junos® Ready Software application and is the essential foundation of Media Flow Solution. With deep, media-aware intelligence, Media Flow Controller ties together content, storage, and networking to optimize the way content is cached, distributed, and delivered.

Within a single cache device, Media Flow Controller places objects into storage based on type, size, and popularity, and dynamically manages content based on demand. Furthermore, the Media Flow Controller can be deployed in a hierarchy to efficiently distribute content across different regions and geographies. Hot content can be cached closer to the subscriber where it can be served rapidly, while long tail content can be kept more cost-effectively deeper in the network. This enables service providers to rapidly and automatically adapt to the unpredictable and ever changing challenges of Internet content demand, while concurrently optimizing the use of network resources.

- **VXA Series Media Flow Engines** are a portfolio of purpose-built hardware appliances that optimize the performance of the Media Flow Controller software and offer flexible, onboard storage options. These carrier-grade elements are available in four configurations that include Network Equipment Building System (NEBS)-compliant form factors with content delivery performance ranging from 1 through 10 Gbps. The VXA Series offers expandable content storage options and can be flexibly configured with up to 8 TB of cache to leverage a variety of RAM, solid-state drive (SSD), Serial Advanced Technology Attachment (SATA), and Serial Attached SCSI (SAS) technologies.
- **Media Flow Manager** is a Junos Ready Software application that provides efficient, centralized management of multiple Media Flow Controllers which can be deployed throughout the service provider network. Media Flow Manager monitors system resources, and proactively maintains a record of key performance metrics.

Media Flow Manager also allows remote management and provisioning of the entire caching infrastructure, even in the most geographically distributed deployments. Interoperability with existing operations support systems (OSS) and base station subsystems (BSS) is provided by standard interfaces.

The combination of Media Flow Controller and Media Flow Engine offers a high-performance, scalable, and cost-effective solution for dynamic hierarchical caching. The solution supports a wide variety of small and large objects, and dynamically adapts to deliver content at the optimum bit rate based on available network throughput. The Media Flow Solution provides a very high number of transactions per second (up to 40,000) for small objects, while for large objects the appliance provides network throughput options that scale through 10 Gbps. This combination of high-performance, reliable, and scalable platforms with advanced content and storage-aware software is optimized for the efficient distribution and delivery of media rich online content. The Media Flow Solution is designed for service providers of all types, and can be used to improve network efficiency, reduce costs, and open up new business models and service opportunities.

Media Rich Content Flow

Initially, the Media Flow Solution will distribute and deliver media rich content from the provider to the subscriber in these simple steps (Figure 2).

1. The subscriber sends a request for a media file to a URL.
2. Domain Name System (DNS) or routing policy redirects the request to the VXA Series Media Flow Engine hosting the Media Flow Controller.
3. The Media Flow Controller requests the media content from the Web site.
4. The Media Flow Controller retrieves the media content from the Web site.
5. The Media Flow Controller serves the file to the subscriber at a suitable bit rate.
6. The Media Flow Controller places the media file in native storage on the VXA Series Media Flow Engine.

Future requests for the same content are served from the VXA Series Media Flow Engine.

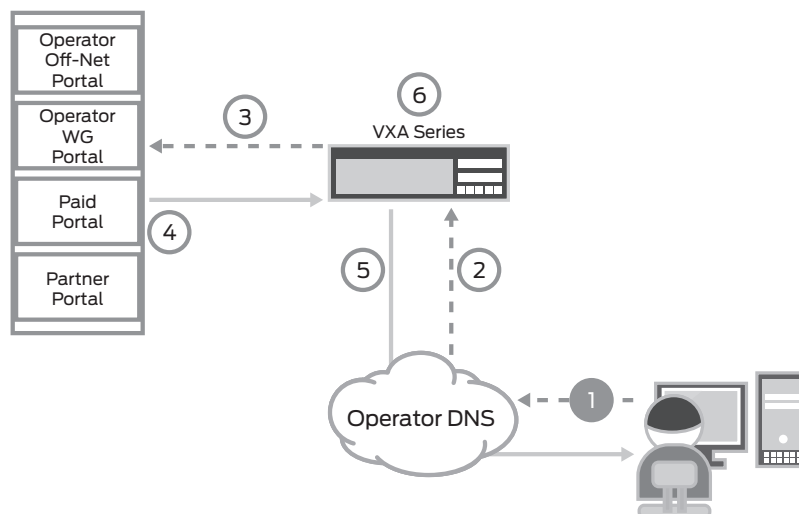


Figure 2: Media Flow Solution service flow

Media Flow Solution Deployment Models

A key challenge facing service providers is handling the exponential growth in traffic, driven in large part by video and other rich media content. Most of this content is generated off-net—also known as over the top (OTT)—and generates little, if any, revenue for the service provider. In fact, OTT traffic typically has the opposite effect, adding significant costs due to rampant Internet video bandwidth growth. Today, service providers are looking for new ways to more efficiently handle this traffic growth, either by improving the efficiency of the way the content is transported across their networks, or by exploring new business models that monetize this content—or ideally both.

Juniper Networks Media Flow Solution can be deployed to support both of these goals. Below, we will examine some specific deployment scenarios.

Over-the-Top Traffic Optimization

As noted above, the delivery of rich media content such as video over a service provider network creates a number of challenges. Because online, time-shifted videos are essentially unicast sessions, each time a user requests a video (or other piece of content), it creates additional incremental traffic on the service provider network. For a popular piece of content, this can lead to the same content being delivered multiple times (hundreds or even thousands), and if the content origin is off-net, this means that the content must traverse the entire service provider network each time it is requested. It is easy to see how this can quickly add up to a lot of bandwidth—bandwidth that has a cost for service providers in terms of network devices, bandwidth fees, and operational support.

Service providers can improve the efficiency of this process through the deployment of the Media Flow Solution. Media Flow Solution can be deployed close to the edge of the network, where popular pieces of content can be intelligently cached and delivered. Subscriber requests can be served locally from the VXA Series, rather than having to traverse the network with each request, thus providing significant reductions in bandwidth and dramatically improving network scale and efficiency.

When deployed in this manner as an edge caching solution, Media Flow Solution can operate transparently, meaning the service provider does not necessarily need an agreement with the content provider. In this deployment model, the goal is primarily network optimization or cost reduction—and Juniper has performed analysis for customers that show a reduction in bandwidth costs by as much as 70%. This can be a powerful tool for network operators as they seek to reduce the costs of delivering OTT content.

Media Flow Solution can also be deployed in scenarios where the network operator has explicit agreements with content providers. This provides many of the same benefits in terms of network optimization and cost reduction, but it also opens the door to exciting new service opportunities for both the network provider and the content developer. We will discuss these scenarios next.

Premium Content Offerings

While network optimization and cost reductions are certainly an important goal, Media Flow Solution can also enable network service providers to more fully participate in the content delivery value system with unique and innovative services. These services can benefit the network service provider as well as those providing the content, and they offer a promising alternative to alleviate concerns about net neutrality.

As an example, with a content delivery and distribution infrastructure based on Media Flow Solution, service providers have the ability to deliver content both more efficiently (on their own network) and with a superior user experience (for subscribers). This latter ability to control both the content delivery infrastructure and the network itself is unique to network service providers, and it enables them to control quality of experience at a very exacting level.

Assured quality of experience can be very attractive to content owners who, of course, would like users to be able to consume their content with the highest level of quality possible. Traditional content delivery networks have limited ability to control quality once content leaves their edge servers (they can't influence behavior over the subscriber's access network managed by the network service provider).

With Media Flow Solution, service providers and content providers have the opportunity to work together to deliver premium, co-branded, content-based services to subscribers. These services would likely be made available on the network operators' consumer Web portal, or potentially even in the onscreen guides of Internet-connected television sets. These premium content offerings could be differentiated on quality (e.g., assured delivery HD video originating over the Internet) and would offer benefits for all involved.

Network operators can turn OTT from a loss center to a profitable service and source of differentiation, while sidestepping net neutrality concerns. Innovative services that capitalize on OTT content would also help providers retain subscribers and offset the competition from new sources of content, such as time- and place-shifted television content on the Internet.

Content providers could benefit from access to the network providers' subscriber base, enabling more cost-effective customer acquisition, while ensuring their content is delivered at a high level of quality. Content providers would also likely be able to reduce content distribution costs by working with a single partner for both network and content delivery services. And subscribers would have access to more content—content that could be delivered to any device, at any time.

CDN as a Service

Caching is a fundamental building block of all content delivery networks (CDNs), allowing content to be located closer to subscribers or viewers. Another potential ideal use case for the Media Flow Solution is for network operators to offer CDN services to their existing customers, with Media Flow Solution acting as the essential edge caching and delivery platform. In some respects, this is similar to the model discussed above in that a network operator would enter a business arrangement with an organization to cache and distribute content close to the edge. However, CDN services could be offered to different types of customers—not just content providers, but also large global enterprises that require data and applications to be distributed to many local offices.

In this model, network operators would leverage their existing relationships with enterprise customers—to whom they may already be providing network services—to extend the breadth and value of services they offer. The ability to offer CDN services in conjunction with other offerings would be a powerful combination. Service providers could offer more flexibility on price and could explore bundling CDN services with additional network-based services or options that could be specifically tailored to a customer's unique business requirements.

Control over the network as well as the content also offers significant advantages in terms of performance and response time, as in the other examples outlined above. Because network operators control the network all the way to the customer premise, they can influence the performance and reliability to a much greater extent than competitors who do not have this level of control.

Customers of such a service would benefit from improved response times and performance across multiple locations, and would also see gains from Media Flow Solution's unique quality of experience functionality. Additionally, there may be cost and flexibility advantages, enabling customers to more efficiently balance their network and content delivery services to optimally meet their needs.

Mobile Traffic Optimization

While the above use cases have primarily focused on wireline networks, the Media Flow Solution also brings many benefits to mobile operators. A key challenge that mobile operators are facing is handling the explosion of network traffic that is generated from third-generation (3G) data cards. It is estimated that 70% or more of today's network traffic is currently generated from data cards and this trend is expected to continue with the introduction of Evolved High Speed Packet Access (HSPA+) and Long Term Evolution (LTE) technologies. Currently, all of this data card traffic goes through the mobile service complex, which includes services designed for slower 2.5G data traffic and not for the higher data speeds that 3G provides. Thus, mobile operators are already challenged with congestion in their service complex, as this architecture is complex and expensive to scale. If the projections for future traffic growth are even close, this will be a growing area of concern and a major challenge for mobile operators globally.

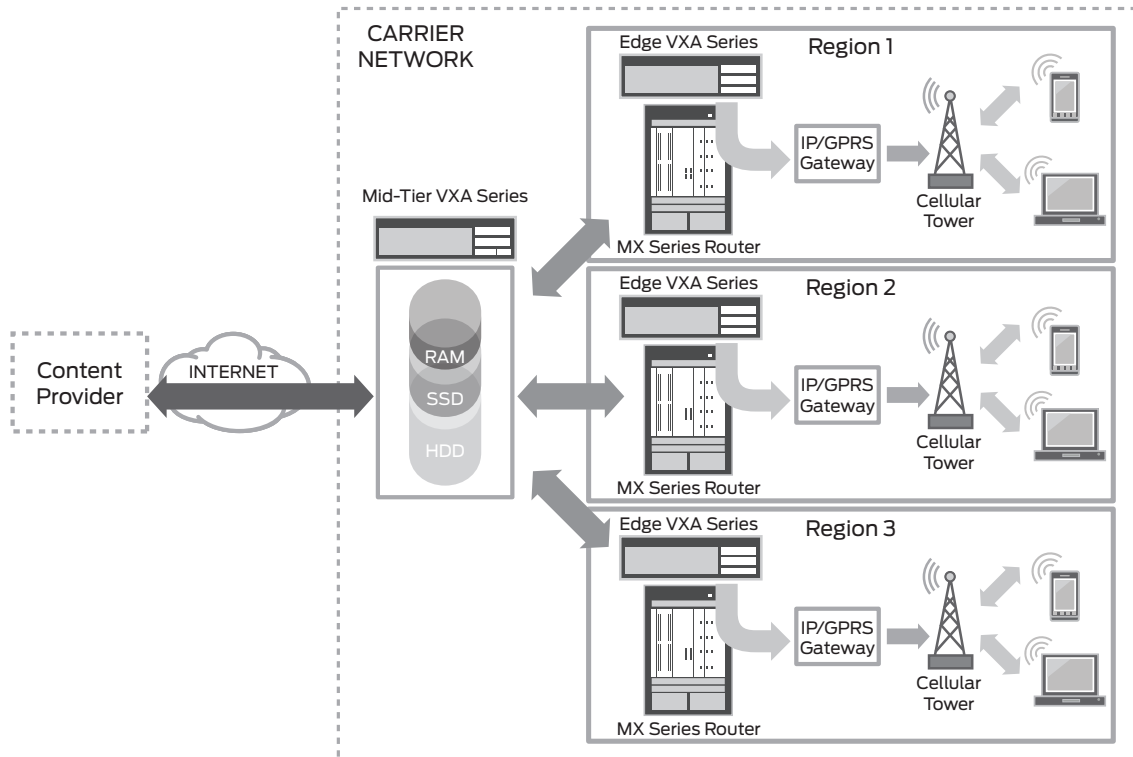


Figure 3: The Media Flow Solution in a mobile provider infrastructure

Mobile operators can address this challenge by using the VXA Series Media Flow Engine at the edge of their mobile service complex (Figure 3) to efficiently cache and deliver 3G data traffic, thus keeping it from passing through the mobile service complex and dramatically reducing or eliminating congestion due to 3G data. The VXA Series caches “hot” mobile content and serves this content closer to the subscriber, preventing traffic from entering the service complex and also improving the subscriber experience. The adaptive streaming support for a variety of smart phones and delivery using HTTP, Real-Time Streaming Protocol (RTSP), and Real-Time Messaging Protocol (RTMP) adds enhanced flexibility.

In addition, by combining Media Flow Solution with the Juniper Networks Traffic Direct Solution, content can be ingested directly from the Internet source, bypassing the service complex altogether. Also, stream quality to users may be adapted to optimize spectrum utilization, allowing consistent delivery even during oversubscription events. For example, 20% oversubscription will cause edge cache to serve a low bit rate file to all users without causing jitter or buffering.

VXA Series Media Flow Engine Network Placement Options

The placement of Media Flow Solution components depends on network size and topology, as well as on the end goals desired (Figure 4).

- **Edge**—Deployments where content is placed close to subscribers. This placement minimizes online transit traffic across the backbone, expediting content delivery to end users and improving their quality of experience.
- **Mid-tier**—Deployments where the caching server is placed near high traffic exchange points. This placement offloads session termination traffic from the origin server and increases bandwidth.
- **Origin**—Deployments where content and cache are colocated to maximize efficiency of video distribution in the backbone. By caching at the origin, repeat requests need only hit the locally cached content and thus, do not need to reach the origin server. As such, content delivery is greatly accelerated, as is the ability to scale the performance of network storage file servers and Web servers. With this server consolidation, CapEx is also reduced.

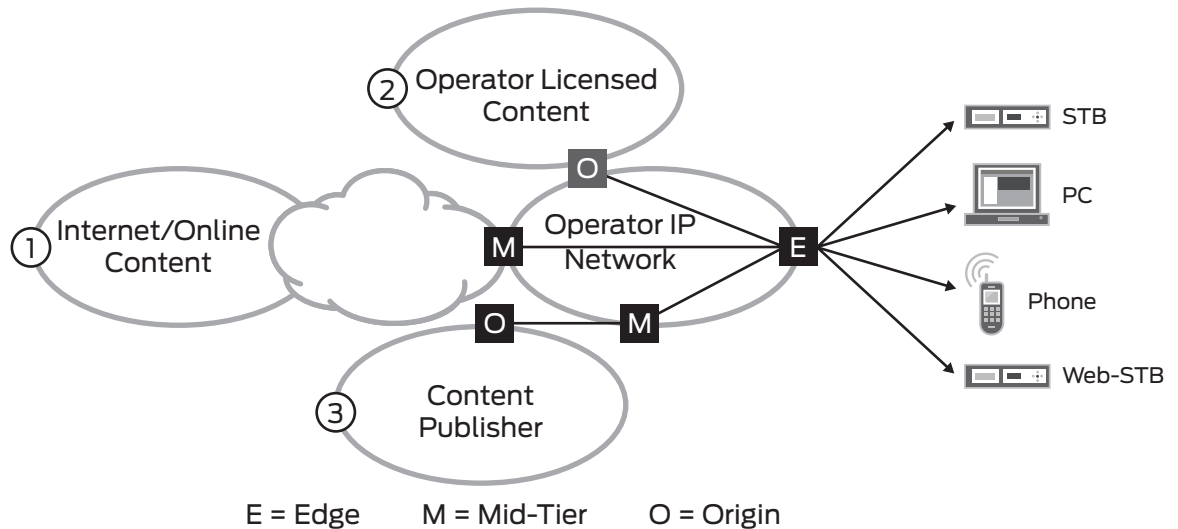


Figure 4: VXA Series Media Flow Engine network placement options

The Juniper Networks Advantage

Media infrastructure and delivery technologies play a major role in defining the quality of experience for consumers of online video, and they also contribute greatly to the incurred OpEx and CapEx in delivering these services. Juniper Networks Media Flow Solution delivers online video with a TV-like experience to increase customer satisfaction and loyalty and to improve the provider's bottom line.

Advantages and benefits of the Media Flow Solution:

- No change to the network architecture or design
- No change to the router operation or end user configuration
- Protects resources and contains costs
- Reduces traffic across the network
- Improves responsiveness and flexibility
- Ensures quality of experience
- Supports differentiated services and business models
- Increases revenue potential for online media (on-net and off-net)

Multitier Caching

The Juniper solution minimizes latency by using a cache hierarchy for content storage where the placement of objects is based on dynamic load characteristics. Detailed analytics and statistics are used to automatically place objects within the tier's storage media based on popularity. The Media Flow Controller's storage intelligence addresses variable workloads of traffic, ensuring fast response times for end users and providing optimized caching and delivery of objects of different sizes.

Quality of Experience

Two unique and innovative technologies, SmoothFlow™ and AssuredFlow™, are key features of the Media Flow Controller and dramatically improve the end user's quality of experience.

SmoothFlow, based on adaptive streaming, provides a smooth viewing experience by dynamically detecting the available bandwidth and seamlessly varying the bit rate of the media being delivered. It allows viewers to enjoy media continuously without any buffering interruption.

AssuredFlow guarantees bit rates to clients based on their needs or service-level agreements (SLAs) by ensuring sufficient output bandwidth for clients who need higher bit-rate media. This functionality can enable delivery of tiered services for additional revenue.

Scalability

General-purpose Web servers and caching proxies do not scale well for media workloads. One key issue is that they rely on the underlying OS scheduler for processing, as well as on network and disk I/O. For time sensitive media workloads, this implementation works only if the systems are significantly underutilized. As the system scales to more sessions and aggregate bandwidth, the bandwidth required by each session can no longer be assured. Furthermore, the OS scheduling primitives (threads and processes) add significant switching overhead, resulting in inadequate CPU scaling.

By way of contrast, the Media Flow Solution is optimized for scale. The Media Flow Controller is built on a highly scalable asynchronous task model that allows it to handle a large number of connections with low CPU overhead. This optimized protocol stack incorporates scaling (bandwidth and sessions), along with rate management and capacity-based admission control.

- The Media Flow Controller utilizes a unique rate-based model to dispatch tasks, which allows it to manage delivery rates specific to each connection as an inherent feature of the platform.

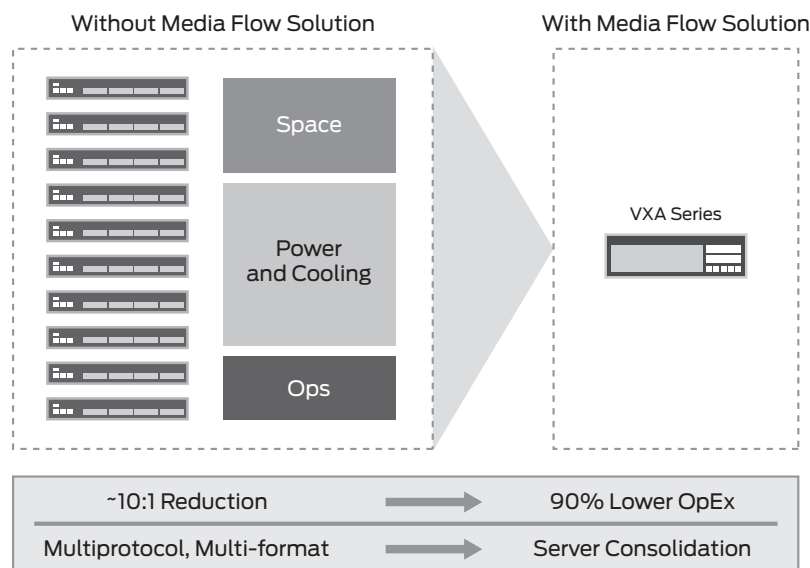


Figure 5: Reducing costs via equipment consolidation

- Managing interrupt timers and per-connection rates require sophisticated algorithms. The Media Flow Controller protocol stack interfaces with other Media Flow Controller components to ensure that the required rate for each connection is met. Based on the required rate of existing sessions, it also enforces session admission control to ensure that there is no over commitment
- The Media Flow Controller protocol stack provides a highly scalable interface to the origin storage device (for example, using HTTP). Connections to origin servers are managed asynchronously with minimal resource consumption. Failures or slowdown of origin connections do not impact delivery from the local caches.
- The Media Flow Controller scalable solution offers up to 10x reduction in media delivery infrastructure such as hardware, rack space, power, and cooling. The Media Flow Controller, hosted on the purpose-built VXA Series Media Flow Engine, can deliver up to 1,000 percent improvement in media delivery throughput compared to a single general-purpose x86 server that supports one gigabit per second of media flows.

Multimedia and Multiprotocol Support

Flexible support for multiple formats and protocols obviates the need for provisioning servers per media type. Media Flow Controller delivers streaming content to any device via HTTP. It also supports Microsoft Silverlight and Adobe Flash. For communication with the origin server, HTTP, Network File System (NFS), and FTP (push) are supported.

The multiprotocol and multimedia capabilities, coupled with the high-performance Media Flow Engine, allow for server consolidation that results in reduced administrative costs when implementing and managing a purpose-built, content rich delivery appliance versus custom open source solutions, and it can drive up to a 10:1 reduction in OpEx.

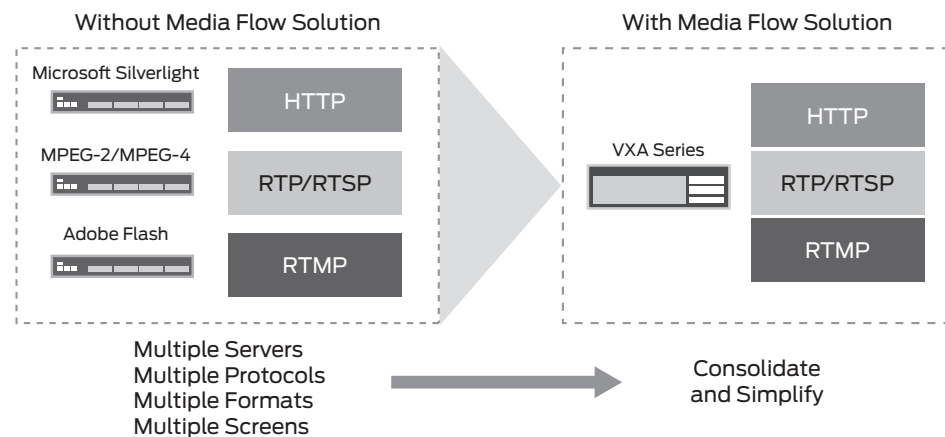


Figure 6: Reducing costs via protocol consolidation

Conclusion

Juniper Networks Media Flow Solution, which consists of Media Flow Controller, Media Flow Manager, and the VXA Series Media Flow Engine, enables network operators to more efficiently deliver and distribute content, and also enables a broad set of content delivery business models. Media Flow Solution provides the foundation for a “new media network”—an optimized network that helps protect resources, contain costs, and monetize online media traffic.

The key features of this solution—efficiently caching objects of all sizes, multiprotocol delivery (HTTP, RTSP, RTMP), and multiple format support packaged in a highly scalable form factor—make Media Flow Solution ideal for supporting three-screen media delivery in fixed and mobile networks.

This solution further validates Juniper’s commitment and technologies that promote greater efficiency, reliability, performance, and scale, as well as enabling network operators to develop innovative new services.

About Juniper Networks

Juniper Networks, Inc. is the leader in high-performance networking. Juniper offers a high-performance network infrastructure that creates a responsive and trusted environment for accelerating the deployment of services and applications over a single network. This fuels high-performance businesses. Additional information can be found at www.juniper.net.

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