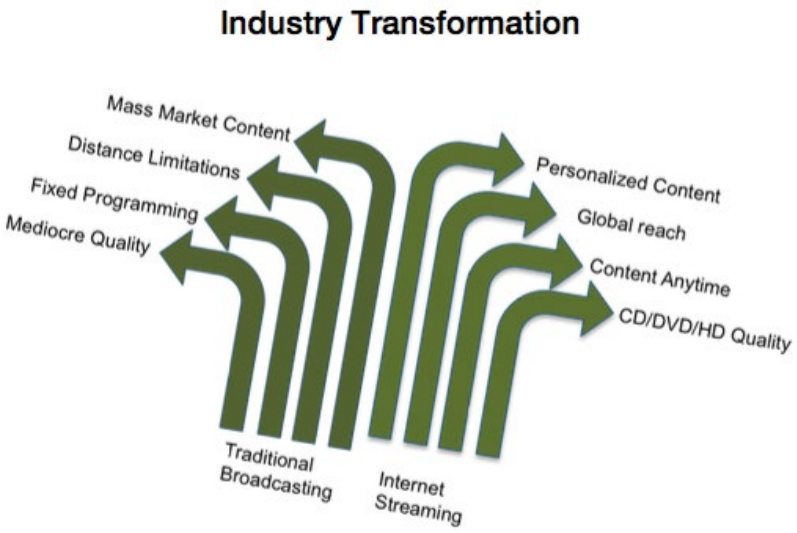
Digital Content Streaming

Cloud content streaming has become a necessity in media and entertainment. Media consumers expect streamed music and video to be available through the Internet to any internet appliance. Ubiquitous access redefines the relationships between subscribers and providers. Personalized content, where the subscriber organizes and consumes content based on their tastes, location, time of day, or even their device type, will be enabled by the Internet cloud. To remain relevant in the world of personalized content, producers must leverage technologies and services to enable subscriber-defined content. The subscriber takes full control and customizes the media to their tastes, time, location, and device type.

Digital content will be delivered asynchronously, with each subscriber having their own personalized digital streams; and while the original content may be identical, its delivery and destination appliance are unique to each subscriber ensuring no two media streams are alike. Content streaming to the mass market, whether across the air, through the Internet, or a combination thereof, will be transformed from one size fits all fixed programming, to highly personalized content.



Audio and video streamed content will be delivered from the cloud through centralized or regional data centers across optimized terrestrial or wireless technologies. Data centers are staged to offer economies of scale for content storage, search, digital rights management, and streaming delivery to millions of subscribers. The sheer volume and variety of digital content streamed through data centers allows providers to economically support personalized content. Both consumer and provider benefit from this. The consumer gets the best value for content they're most interested in, whenever and wherever they want it. The provider benefits from gaining access to lucrative social demographics attracted to these delivery modes. Moreover, the provider gains business and marketing analytic information at the consumer level with perfect knowledge of the type of content selected. The provider can use this data for targeted ad placement, cross marketing of related goods and services, and a host of new services to be developed.

The underlying technologies driving personalized content streaming are grounded in the data center. They include intelligent real-time search engines, two way interactive web front ends, rich streaming that can scale to millions of subscribers, digital rights authorization and automation management, audio and video content based storage, and racks of appliances to reliably stream rich, personalized content.

All of these components require data center class networking technologies: high speed, high availability, multi-directional, and scalable. The data center network joins these distinct technologies into a seamless consumer experience. The following solution guide will discuss the role of Data Center Switching for delivering these vital networking functions.

Rich Internet Video Streaming: The Media Industry Pace Setter

In certain demographics, video content streaming delivered via the Internet is the preferred alternative to traditional radio and satellite broadcasting. And while streaming content over the Internet has been around for over a decade, the quality and density of the content coupled with the data demands of the personalization ecosystem: business analytics, intelligent search engines, transcoding appliances and interactive programming just to name a few, has changed the entertainment industry forever.

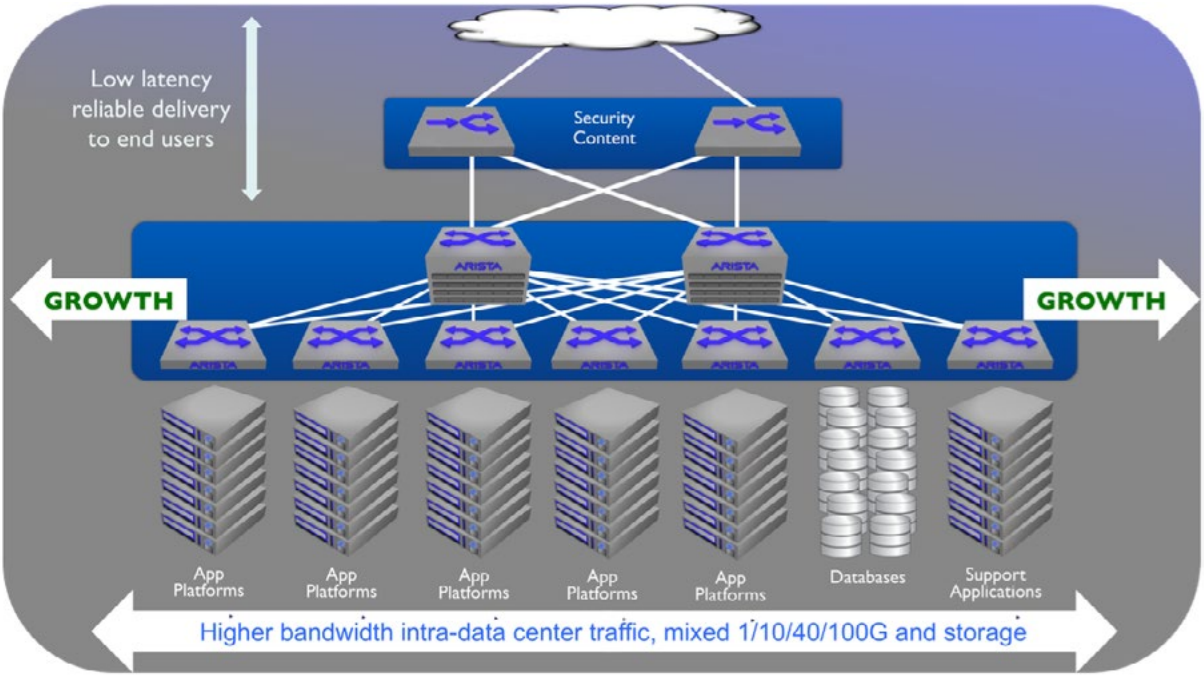
This new way to order and deliver content, based on custom searches and highly personalized music or video libraries is the new mainstream. Highly personalized music and video streaming is converging, with personalized entertainment libraries situated in the cloud and accessible by any Internet appliance. Subscribers can choose from a variety of cloud-based entertainment, be it purchased, rented, or streamed on demand. This custom content generation is data driven: only implicit human interaction is required.

This level of automation requires ultra fast networking between search engines, content libraries (NAS based storage) and streaming, royalty, advertising, and messaging appliances.

The data center network is the main technology integrator, interconnecting search, media streaming, and messaging systems with centralized content repositories. Moreover the data center network is the main technology enabler for delivering millions of unicast streams to the subscriber community. This requires a highly scalable, reliable, ultra fast, and automated, data center class-switching infrastructure. Arista Networks recommends platforms that deliver 10G, 40G and 100Gbps switching technologies to meet these requirements.

Data Center Networking Challenges and Design Recommendations

The evolving world of content streaming offers both challenges and opportunities for content providers and their data center networks. While intelligent search technologies offer true personalization, searches must occur in real time, across millions of subscribers and with hundreds of search attributes per subscriber. The near geometric product of these search attributes (one hundred plus search variables times millions of subscribers) requires significant processing across servers, databases and storage files running flawlessly in an east/westbound network traffic orientation (server to server, server to storage, storage to storage).



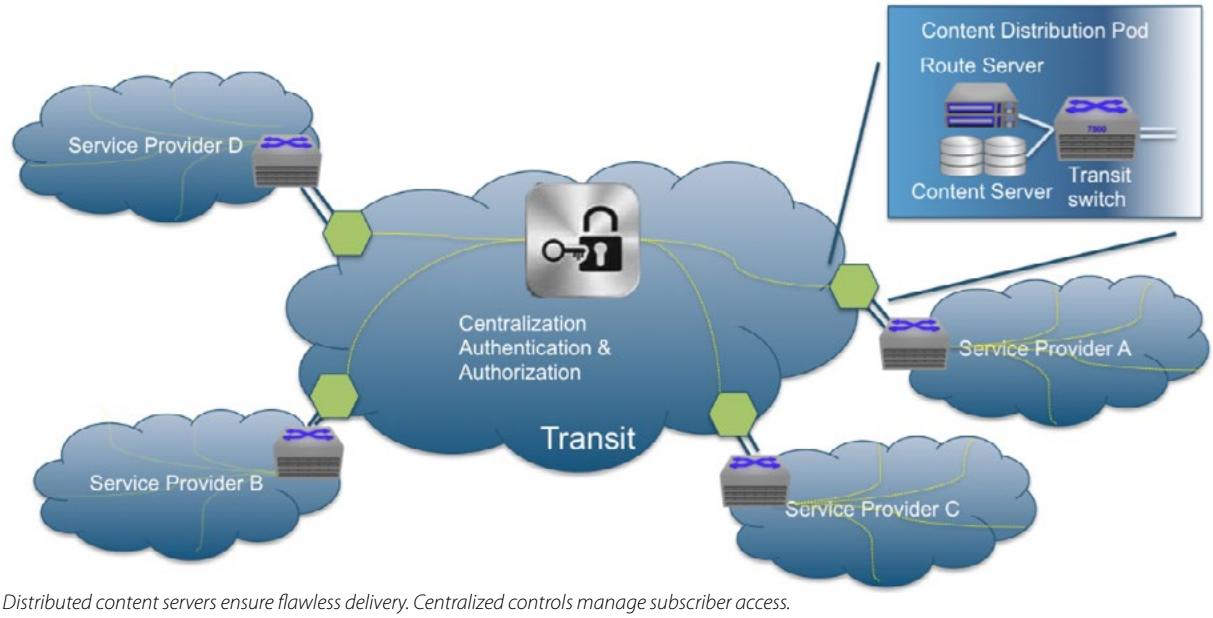
Furthermore, streaming for each user, across millions of subscribers, requires an equal number of digital files being processed and forwarded across the network, in a north/southbound traffic direction (server to subscriber, subscriber to server). This drives multi-directional traffic flows; with the need for every network switching node being able to handle traffic bursts to avoid content disruption. To effectively address these requirements, providers must consider high speed networking technologies, with lower latency node-to-node switching, and ample network traffic buffering to level out occasional congestion and avoid service disruption and data loss.

A significant challenge to scaling content distribution is ensuring its flawless delivery across the Internet. While MPEG compression mechanisms deliver impressive error correction and jitter mitigation services, it's unavoidable that subpar connections or saturated links will adversely impact video streams and degrade the customer's experience. Telemetry, embedded in content applications, provides information to content providers of network degradation. The data has revealed patterns of network deficiencies giving providers new insights to the weaknesses of centralized content distribution models.

Regardless of claims by services providers, what's become clear is that transit performance and reliability are affected more by business rather than technical factors. Putting it bluntly, business arrangements with transit providers helps ensure the quality of service needed for flawless multimedia entertainment. Therefore, the challenge is to develop an economical distribution system that

both delivers high quality services to customers while minimizing the economic overhead from transit providers.

One successful model is to create multiple service points for distributing content to service provider customers. Co-locating a content "jukebox" server to major providers transit points helps ensure a relatively short, reliable and good performing network to deliver flawless content. Managing distributed content it not time critical so there's no special networking requirements for the backhaul. Subscriber authentication and content authorization is also not time critical nor bandwidth intensive. Business costs are minimized to the major content providers that provide access to virtually the entire subscriber base. Finally, the specifications for the content distribution pod are more simplified, making them more economical to build and deploy in quantity.



Distributed content servers ensure flawless delivery. Centralized controls manage subscriber access.

From a networking perspective, the primary requirements of content distribution clusters are: bandwidth, low latency, no data loss, and route table optimization for peering to transit providers. Networking platforms supporting these capabilities, plus automation, monitoring and extensibility services are a perfect fit for a content distribution application. Low latency, high bandwidth 40G and 100G interfaces are a requirement so content servers using 40G network adapters can aggregate thousands of content streams to 100G peering connections. Networking packet buffering provides an advantage, helping ensure lossless content delivery during moments of transit congestion.

While internet sized routing tables were thought to be a requirement, the fact that over eighty percent of content is delivered over a handful of transit providers links means route optimization is more important. In fact, measuring transit latency and merging that data with content next hops is more important to optimize throughput and minimize latency. Publicly available routing stacks like Bird or Quagga provide route summarization features along with the ability to manipulate metrics based on user defined criteria. Standards based monitoring services like SFlow provide latency telemetry to help rank order transit links. Combining latency and route summary information is accomplished programmatically. Likewise, the programming of the hardware routing table (routing FIB) is accomplished using standard APIs. The end result is a content network transport that is latency aware, more economical and provides better price performance than traditional routers.

Network Operation Considerations

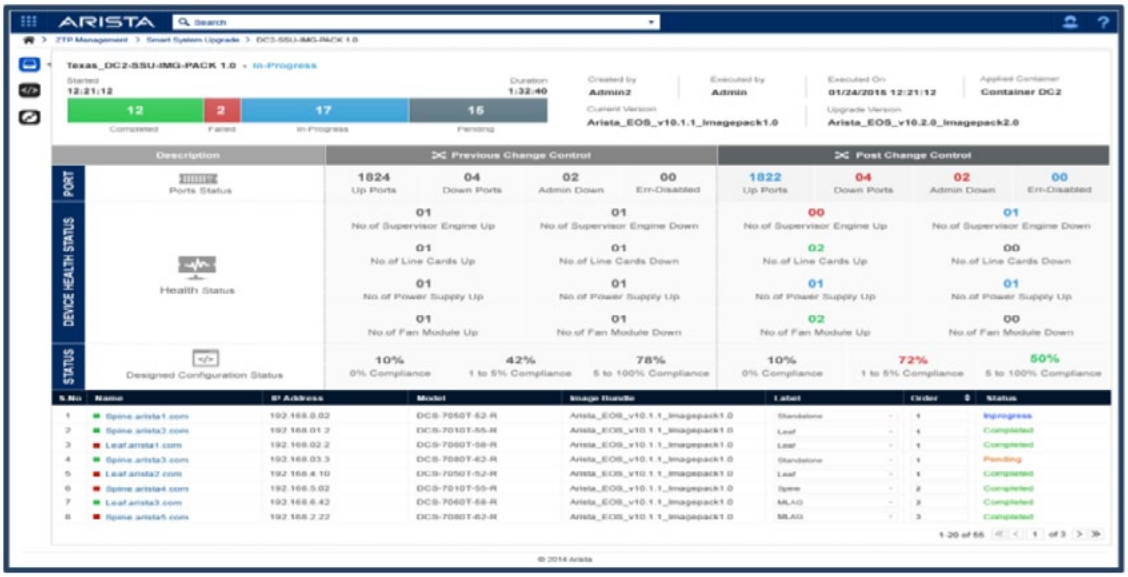
Today's consumers have high expectations for faultless quality and continuity of service. They expect zero downtime and digital quality equal to over the air (OTA) HDTV. To meet these expectations, data center managers must monitor network performance data, outage conditions, honor service level guarantees and have the ability to add more networking, storage and compute capacity as new subscribers are added. They have to roll in new subscription services without impacting those that are running, and be able

to make software upgrades and perform maintenance non-disruptively.

These operational requirements must be considered when evaluating a networking vendor. Switches must offer active/active load sharing: that is, balance traffic across redundant links, especially when there is growing streaming demand. Switches must handle upgrades non-disruptively avoiding service outages. Moreover, well- designed switches will log performance and throughput information for analyzing problems before they occur.

Network architectures now deliver high availability and more bandwidth using active/active load sharing.

The good news is that some of these features are available as part of standard multipath routing and bridging services. Multi-Chassis LaG (MLAG) and Equal Cost Multipath Routing (ECMP) provide layer two and three traffic load sharing services that avoid network layer single points of failure. In the event of failure, only in flight traffic is lost which in worse cases amounts to a couple of hundred milliseconds of lost data. Using these features as a foundation, its possible to aggregate software features to provide loss free maintenance and upgrade services to content publishers. Combining ECMP with maintenance mode commands or route filters allows administrators to gracefully remove platforms from service without losing a single packet! Peered MLAG switches can be upgraded by seamlessly moving traffic away from the device under maintenance. With Arista's Smart System Upgrade feature, its even possible to perform a full system upgrade while the device is still in production. Arista's EOS provides easy to use APIs so system maintenance can be automated using tools such as Ansible, Chef or Puppet. Alternatively, Arista's CloudVision provisioning and change management framework provides turnkey automation for auto provisioning, replacement and change management. These capabilities are mission critical for providers tasked with reliably delivering content to its subscriber base.



CloudVision simplifies and automates provisioning configuration and change management

Data Center Compatibility

Digital media content providers should plan how to rack, cable, cool, manage and optimize the infrastructure required to host high bandwidth, high availability digital streaming services. Fortunately, there's much in common in requirements for content streaming, compute, analytics and network-attached storage. Administrators can therefore choose a common data center network architecture, allowing them to streamline best practices and lower acquisition, installation and management costs. Moreover, content providers may find it more economical to outsource the infrastructure to a service provider or lease cloud services.

2015 is an inflection point for higher density, bandwidth and performance in Ethernet switching. 10/40Gbps Ethernet is now being joined by 25/50Gbps and 100Gbps in densities and packaging that's both technically and economically compelling for new services. This abundance of bandwidth, density and connection options supports compute, storage analytics and content distribution applications that are orders of magnitude greater than previously imaginable. Increased network capacity and density directly translates to improved power, cooling and space savings. These present opportunities to revise and economize existing wiring, racking, power, and cooling designs.

Recent advancements in 25/50Gb Ethernet server connections complements economical 10GBASE-T copper networking. Intel based X86 servers are now offering 10GBASE-T LAN on the motherboard (LOM) with optional 25Gb, 40Gb and 50Gb SFP+ connections delivering enhanced performance for content delivery systems. Customers can opt to use existing twisted pair cabling system to connect these servers to top of rack high density, power efficient 10GBASE-T switches or use conventional SFP+ twinax to double, quadruple or even quintuple bandwidth for critical content delivery services. Arista offers industry-leading switches for these applications.

The bottom line is that new data centers must provide rich performance options for bandwidth hungry content delivery and data analytics applications without raising established norms for power, cooling and wiring layouts. High-speed switching technologies have matured to the point in which they are now backwards compatible with existing data center infrastructures.

The Arista Networking Solution

From a data center network perspective, many of these next generation, personalized, content streaming requirements are similar to other industries that have high performance computing requirements. These other industries include:

- Oil and gas exploration
- High frequency stock trading
- Bio-science gene research and mapping
- Movie rendering
- Crash test analysis

These other industries also have large search requirements including millions of content rich files that are stored, analyzed and processed, sophisticated web applications which generate and display custom search results, time to market and real time delivery systems, and integration with customer tracking, billing and royalty payment systems. Arista Networks is well established in all these markets. Arista has leveraged this expertise with industry leaders in personalized digital content streaming. Customers who use Arista have the industry leading, best price/performance and the most extensible data center networking systems. This is the optimal combination for the rapidly growing digital streaming market.

Arista has developed a complete line of 10, 40, 25, 50 and 100Gbps Ethernet switches, offering a wide variety of connectivity and switching performance options. These switches have been designed for the modern data center, where there is a high traffic volume between servers and storage nodes (east to west), driven by search and distributed compute applications and also high bandwidth south to north traffic between content servers streaming from the cloud to the consumer.

To facilitate deployment and ensure investment protection, Arista switches utilize common data center media to deliver 10Gb through 100Gb networking connections. The same Cat6 cable can be used for 1G to 10G connections. Likewise, the same twinax, multi or single mode fiber optic cable can support speeds from 10G through 100G. Combine this flexibility with the power and space

efficiency of Arista switches to support virtually any manner of content delivery, analytics or web services.

Arista Solutions for Digital Streaming

- The modular 7500E series is optimally suited for content delivery, analytics and web service applications owing to its interface diversity, density and deep packet buffers that ensure traffic delivery even in the most bursty or congested instances.
- 1152 line rate 10G or 25G ports, 288 40G ports or 96 100G ports at Layer 2 and Layer 3 using MLAG or ECMP for scalability
- Virtual Output Queuing and ultra deep buffers ensuring reliable packet delivery even in congested environments
- Deep buffers in the 7280 1U switch emulates those of the modular platform, providing 150MB of packet buffering per 10G interface and up to 1.5GB per 100G interface.
- N+1 redundancy for all system components
- The 7050X is recommended for dense 10/40G rack deployments and is occasionally implemented in smaller spine environments
- Non blocking L2/L3 performance, low power, redundant power and cooling
- Deep buffer architecture avoids traffic loss from congestion and speed changes

Conclusion

Streaming content to any device, anywhere, is the new reality. Delivering that content faultlessly is the expectation. To achieve five-nines goal, stability, failover, capacity on demand, and the ability to perform upgrades is critical to the digital streaming provider. Arista has designed these capabilities into its EOS and its switching product line. Providers can design resilient leaf/spine topologies with no single point of failure, where all interfaces are used for distributing and load balancing network traffic. Where software switch upgrades (SSU) can be made by diverting traffic to alternate devices without impacting streaming or search services. Much of this functionality is inherent in Arista's hardware and the Extensible Operating System (EOS) that is common to the entire product line.

Digital streaming providers can reliably deploy and scale their search, streaming, billing, advertisement, and storage content across the Arista 7000 family of high performance Data Center switches. Arista has qualified sales engineers, well trained in the media and entertainment market, which can consult with data center architects to help build or upgrade their infrastructure to state of the art, personalized digital streaming solutions.

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