Content Delivery Network (CDN) Federations

How SPs Can Win the Battle for Content-Hungry Consumers

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As consumers demand ever-greater amounts of high-quality content over the Internet, service providers (SPs) are finding it difficult to increase revenues while containing costs. This is due mainly to two trends: (1) over-the-top (OTT) content providers have outsourced the delivery of content to pure-play content delivery network (CDN) companies, and (2) traffic growth (with no resulting revenue benefit) is increasing network build-out and maintenance costs for SPs.

In response to these challenges, many SPs began to utilize CDNs within their own networks. The initial focus was to reduce content-transport costs and improve the quality of content delivery to their own customers. Over time, individual SPs started offering CDN services to OTT content providers as a way to earn extra income from the content flowing over their networks. While this approach has helped, results have been limited.

As demand for content continues to increase worldwide, OTTs would rather work with fewer individual companies for the delivery of their content. Given this situation, SPs are now exploring the potential of CDN federations, which the Cisco® Internet Business Solutions Group (IBSG) defines as *multi-footprint, open CDN capabilities built from resources owned and operated by autonomous members*.

CDN federations benefit SPs, content providers, and consumers:

- **SPs** can lower costs by pooling their resources
- **Content providers** can reduce business complexity by dealing with fewer companies
- **Consumers** receive better quality of service (QoS)

Given the clear benefits of this approach, Cisco is involved in a number of CDN-related initiatives to accelerate the move to CDN federations. For example, Cisco subject-matter experts have championed and are now co-chairing a CDN Interconnection working group at the Internet Engineering Task Force (IETF) dedicated to the standardization of protocols needed for establishing a CDN federation.

Most recently, Cisco has started working with several leading SPs worldwide to plan, deploy, and test an open CDN federation pilot. The main goal of this initiative is to move the SP industry from a great idea to a market reality that can deliver clear benefits to SPs, provide a

better experience for consumers, and offer media companies and OTT content providers differentiated online delivery capabilities.

This paper provides an overview of the trends and challenges facing SPs today with regard to content delivery; describes the Cisco-led CDN federation pilot and results to date; and lays out the next steps for the pilot in order to make CDN federations a reality.

Traffic Growth Is Increasing Costs

To enable content delivery to customers over the Internet, OTT content providers such as BBC, Hulu, Netflix, and YouTube have either outsourced video delivery to pure-play CDN companies, including Akamai and Limelight Networks, or have built distributed content-hosting infrastructures across the Internet. This approach allows them to cache popular video assets and stream them to end users, reducing server, hosting, bandwidth, and operating costs while providing an acceptable end-user experience. As a consequence, the market for CDN services now generates about $2 billion per year globally (20 percent annual growth).[1]

However, many SPs believe the current business models developed by OTT content providers and pure-play CDN companies do not offer a revenue-distribution mechanism that reflects the true value SPs provide in the overall content delivery value chain (from content developers to consumers). In most cases, SPs must bear the full costs of transporting the huge amounts of new content on their networks—without receiving corresponding revenues for the services they provide.

SPs Respond

In response to content traffic growth, many SPs have deployed their own CDNs. These have been used to deliver the SPs' own content as well as to deal with increased traffic from OTT content providers. Caching content in a CDN and distributing the CDN nodes deeply into the network can potentially yield significant network cost savings for SPs by offloading transit and peering connections, IP core networks, and potentially parts of their aggregation networks.[2]

For example, AT&T has reported that up to 30 percent of the traffic on its network is cacheable (e.g., OTT content).[3] This means that deploying an effective caching solution could translate into substantial network savings. While this may sound higher than expected, it's really not a surprise (for example, 20 percent of all Internet traffic during peak hours in the United States came from Netflix alone in 2010[4]).

From an OTT perspective, working with SPs rather than pure-play CDN companies allows them to deliver a better content experience to consumers since the caches are closer to end users. In addition, SPs are able to give content providers additional information from their networks about consumers' behavior and preferences, allowing them to target and serve their customers more effectively.

As a result, SPs are beginning to sell content delivery services to third-party video providers (e.g., local broadcasters going online). This allows them to generate revenue and reduce their network costs. Using their on-net caches, SPs are in a favorable position to support a better user experience than pure CDN players can offer. Additionally, SPs are able to correlate multiple layers of information—from the application to the network. This enables them to

provide richer, more meaningful reports to media broadcasters about the actual end-user experience. This is critical information for media companies because they can use it to improve the content they deliver to consumers.

Despite these benefits, SPs are discovering that selling CDN capabilities solely based on their own network footprints is difficult. Imagine a content provider having to negotiate separate contracts with dozens or even hundreds of SPs to reach consumers who may be located around the world and/or attached to many fixed and mobile networks. For simplicity and manageability, content providers would much rather deal with fewer companies for their content delivery. This scenario also puts SPs in head-to-head competition with pure-play CDNs such as Akamai and Limelight Networks, a battle that could prove costly.

Another method used by some SPs to deal with the increase in traffic is to intercept, store, and serve content deemed as cacheable without cooperation from the originating content providers—an approach known as "transparent caching" (TPC). While TPC can help reduce network costs, it does not address the revenue side of the equation for SPs. Additionally, the significant challenges associated with deployment of TPC limit its applicability, including legal obstacles associated with storing of third-party content, the burden of traffic identification, and ever-changing obfuscation techniques used by content providers.

A Better Approach: CDN Federations

Several leading SPs are pursuing the concept of CDN federations as a better way to manage and benefit from the dramatic increase in traffic on their networks.

The objectives of CDN federations are to:

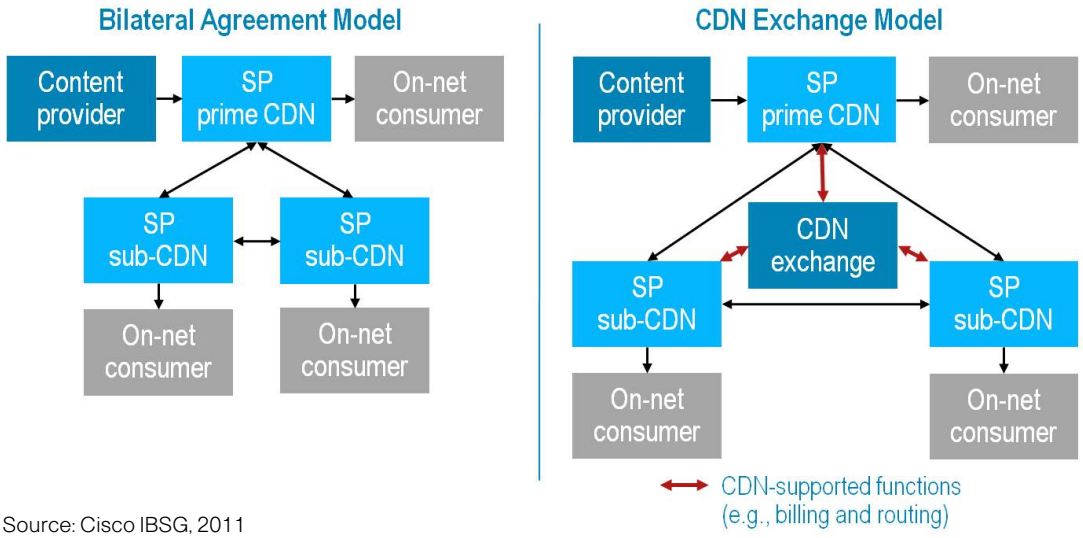
- Enable content providers to offer a better experience to their end users and have better control over their content distribution
- Allow individual CDN federation members to sell delivery services across the Internet that reach consumers worldwide
- Simplify business and technical arrangements with content providers
- Extend on-net differentiators such as quality and scale across multiple network footprints
- Provide a new interconnection model between OTTs and SPs that offers caches closer to end users to improve the content experience for consumers
- Reduce local network transport costs
- Provide a platform for value-added and SP retail services
- Combine and take better advantage of SP investments to meet next-generation video delivery requirements

CDN federation deployment approaches (see Figure 1) being considered include:

- **Bilateral model—**every member directly interconnects and interworks with every other member
- **Exchange-based model—**every member interconnects with a centralized hub that performs some of the interworking functions on behalf of all members

While both models are distinct, it is possible that some aspects of CDN interworking may be performed through direct member interconnections, while other aspects may be realized by interconnecting to a CDN exchange.

Figure 1. CDN Federation Models: Bilateral (Left) and Exchange-based (Right).



Source: Cisco IBSG, 2011

Cisco IBSG believes CDN federations will enable SPs to gain market share in the business-to-business-to-consumer (B2B2C) services market and grow revenues from new delivery services, while building a foundation for significant, long-term network cost savings.

Cisco's Open CDN Federation Pilot

To accelerate the development of CDN federations, given the clear benefits of this approach, Cisco IBSG is working with several leading SPs and content providers worldwide to implement a long-term, large-scale, multi-phased initiative to plan, deploy, and test an open CDN federation pilot. The main goal is to move the SP industry from a great idea to a market reality that can deliver clear benefits to SPs, provide a better experience for consumers, and offer media companies and OTT content providers differentiated online delivery capabilities.

Cisco is collaborating with participating SPs and content providers in three areas:

1. **Business assessment.** Identify the roles and responsibilities for each stakeholder, as well as the associated and supporting use cases, business models, business cases, and processes.
2. **Technical assessment.** Assess the CDN interconnection architecture, capabilities, approaches, and operational procedures, as well as identify a technical roadmap for production deployment. This includes interconnection capabilities for request routing, content distribution, and accounting/reporting.
3. **Lab trial.** Test and validate the concept of an open CDN federation through the worldwide interconnection of participating CDNs and content sources in a lab environment.

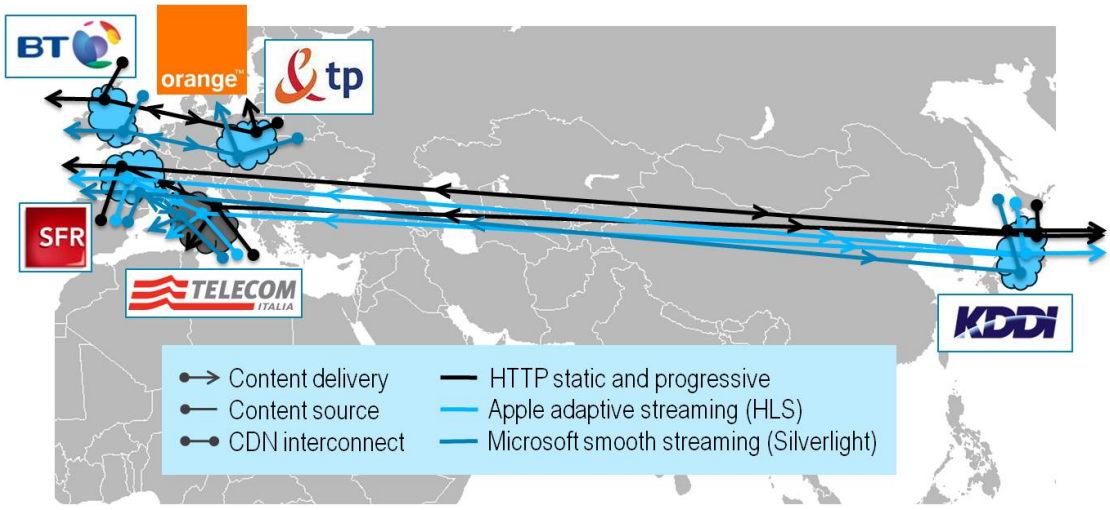
A common theme spanning all of these components is Cisco's goal of creating CDN federations using an open and standards-based approach.[5] Cisco believes this is the best way to ensure the success of CDN federations in delivering the strongest possible benefits for SPs, content providers, and, most important, consumers. To this end, Cisco and the pilot members are making the results of the pilot available to the industry's standards bodies, including the IETF, which includes a CDN Interconnection (CDNI) working group co-chaired by subject-matter experts from Comcast and Cisco.

CDN Federation Pilot Work to Date

Participants in the just-completed first phase of Cisco's open CDN federation pilot were BT, KDDI, SFT, Telecom Italia, and Orange Group through its affiliate Telekomunikacja Polska (TPSA). From a technical standpoint, Cisco and its SP partners have successfully created a laboratory-based CDN federation validated through distributed testing that covered:

- The base functionality required from a CDN federation over the meshes of participating SPs' interconnected CDNs (see Figure 2)
- Multiple streaming protocols supported by the federation, including static and progressive HTTP, Apple adaptive streaming, and smooth streaming Microsoft Silverlight
- Various CDN topologies, including one upstream CDN to one downstream CDN, one upstream CDN to multiple downstream CDNs, multiple upstream CDNs to one downstream CDN, and one CDN to one CDN to one CDN (i.e., cascaded CDNs)
- Dynamic content acquisition across CDNs
- Purging of content across CDNs
- Inter-CDN redirection and acquisition latencies
- Exchange of logging and reporting information across CDNs, both in a bilateral manner as well as through a log mediation function in a prototype CDN exchange

Figure 2. CDN Meshing in the First Phase of the Cisco CDN Federation Pilot.



Source: Cisco IBSG, 2011

Cisco IBSG and its SP partners have analyzed content provider use cases, business requirements, and pain points with regard to current non-federated content delivery models to understand how to improve upon the current value chain. The group has also assessed economic models of the various CDN federation approaches to determine the roles and responsibilities of prime versus sub-CDNs.

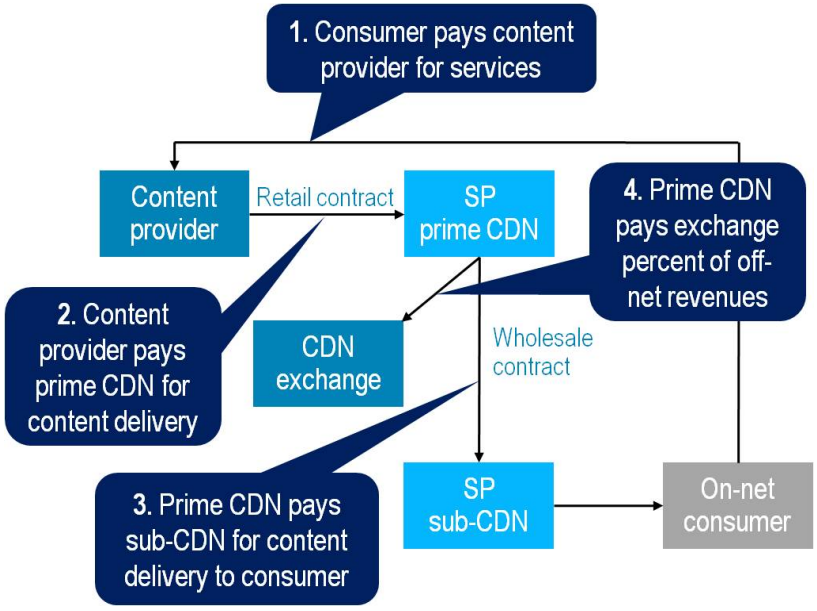
Highlights from this work include:

- The role of prime and sub-CDNs can vary based on which entity receives the contract with a particular customer. For example, a single SP can be both the prime CDN for a contract with content provider A and a sub-CDN for delivery of content on behalf of another SP who is the prime CDN for content provider B. Each participant will have a mix of prime and sub-CDN roles across contracts.
- In order to reduce off-net delivery incentives for prime CDNs, the pricing of wholesale CDN services must be clearly articulated with the additional value that the sub-CDN delivers (e.g., quality of experience, reporting, scalability).
- Performing service-level agreement (SLA) measurements and delivery performance monitoring of both prime and sub-CDNs is critical to the creation of retail contracts.
- Global analytics and traffic reconciliation are key to providing multiple views to various parties in the value chain (e.g., content providers, prime CDNs, and sub-CDNs). This becomes even more important with the massive deployment of available bit-rate (ABR) technologies for streaming, which makes end-to-end reporting more complex.
- CDN exchanges must be provided by a neutral party.
- Additional value-added services can be delivered using pure bit-delivery. Additionally, these services can be proposed by a third-party provider or by the CDN federation itself (most likely by the prime CDN).
- Not all sub-CDNs will support the complete portfolio of services from the beginning, so a mechanism to maintain an inventory of capabilities is important to support expectations from content providers.
- A CDN federation architecture must be developed with openness in mind, since participants will come to the table with their own legacy CDN architectures and network technologies.
- Most likely, multiple CDN federations will exist to serve a variety of international and country-specific needs.
- Service fulfillment and assurance could become a burden for CDN federations, so network technologies and functions that simplify and help automate operation processes such as discovery and dynamic content acquisition will be key success factors.
- CDN interconnections with large “do-it-yourself” user-generated video properties could be offered as an alternative to paid peering and cache co-location arrangements. Deep caching within SPs’ networks will help reduce unit network transport costs.

Cisco IBSG believes that employing CDN federations to deliver next-generation content distribution services will result in significant growth of the overall content delivery market. This will increase service revenues for CDN federation participants, including SPs, content

providers, and pure-play CDNs. In fact, studies show that moving to a CDN federation model will double the size of the content delivery market from $6 billion to $12 billion by 2015.[6]

Figure 3. Potential Money Flow within a CDN Federation.



Source: Cisco IBSG, 2011

This is because the CDN federation approach enables content providers to deliver greater amounts of premium and higher-quality content over fixed and mobile networks to consumers, thereby stimulating the development of and demand for innovative, video-rich applications. Also, content providers that currently support "do-it-yourself" CDNs will be able to utilize the large-scale, robust infrastructures of CDN federations that will result from the collective strength of the participating SPs. Figure 3 shows the likely money flows with the CDN federation model.

Moving Forward

While much progress has already been made, considerable work must still be accomplished before functional CDN federations become a reality. Soon, Cisco will start phase two of its open CDN federation pilot initiative. This phase will include more SPs as well as other players from the content delivery value chain, such as content providers, so that the broader content delivery ecosystem is represented. The goals of this phase are to:

- Expand the technical capabilities of the CDN federation to better match the requirements of content providers
- Validate the concept of an in-country domestic CDN federation model
- Investigate interactions with mobile video distribution services
- Further develop operational process requirements among CDN federation members
- Experiment with richer CDN exchange functionality

Conclusion

CDN federations are gaining momentum as a way for SPs to generate revenues and lower costs from the ever-increasing traffic on their networks. Already, Cisco's work with leading SPs has validated the key concepts and fundamentals required to make CDN federations a reality. As this work progresses, CDN federations will soon become a viable approach for SPs to achieve the appropriate business benefits for their critical contribution to the content delivery value chain.

For more information about CDN federations or the Cisco CDN federation initiative, please contact:

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Endnotes

1. Source: Cisco Visual Networking Index, 2011.
2. "Internet transit" describes the service of allowing network traffic to cross or "transit" through an SP network to allow connectivity between two networks that are not directly connected. Early in the Internet's development, the assumption was made that larger, tier-1 SPs would provide paid transit services for smaller, tier-2 carriers. As time passed, the interconnection framework of the Internet changed so that tier-2 SPs connected with each other through "peering" arrangements. This was to avoid paying IP transit fees to tier-1 operators. Today, both forms of interconnection agreements (transit and peering) exist.
3. Source: AT&T, 2011.
4. Source: "Global Internet Phenomena Spotlight: Netflix Rising," Sandvine, 2011.
5. A mix of Cisco and non-Cisco networking equipment is being used to meet the objective of creating an open standards-based CDN federation initiative.
6. Sources: Frost & Sullivan; Akamai; Limelight Networks; Cisco's Virtual Networking Index; Cisco IBSG (all 2011).

More Information

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