

Route-Optimized Content Delivery: Understanding the Inter-Relationship between Network Performance and Quality of Delivery

As traffic and payload demands continue to increase and change, Content Delivery Networks (CDN) in particular are the de facto mechanism in overcoming many of the challenges this growth represents. This white paper discusses the different approaches to content delivery and what constitutes a “next-generation” CDN. Additionally, it addresses how a true end-to-end solution that combines a next-generation CDN with route-optimized Internet connectivity may be the most compelling solution of all.

An Internap White Paper

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Introduction

Today's Internet traffic in many ways bears only a passing resemblance to the nature of Internet traffic of the last ten years. The demand for richer and more interactive content over the Web is increasing every day. Web-based business applications are not only exponentially more prevalent, but they carry heavy payloads, are more performance sensitive, and this content needs to be delivered to a growing number of users. Additionally, social networking and online communities have exploded in popularity over the past several years, allowing users to create their own media content and show it off to the rest of the world. Because of this unprecedented growth, bandwidth connections and demands will continue to increase. All of this is on the backdrop of an ever-growing Internet that presents almost as many problems as it solves.

The challenges to doing business effectively on the Internet have never been more complex. As a result, it is even more important to determine the right solution for your content delivery needs in order to stay competitive and relevant in this environment.

Which Content Delivery Network Is Best For You?

Responding to this growth, more than 40 new Content Delivery Network (CDN) providers have entered the content delivery space. Most employ one of several content delivery approaches. Finding an experienced provider that has the best approach given your content needs is key. With that said, there are several content delivery approaches when determining the right solution for your business needs. Let's examine some representative methods.

1. Decentralized Content Delivery (Edge Caching Approach)

Best described as a traditional decentralized delivery, the edge caching approach is used to primarily store and deliver on-demand small payloads of static images and content. It is typically used for web page intensive businesses, as well as sites utilizing small photographic files with little personalization and few needs to go back to the origin server for customized information.

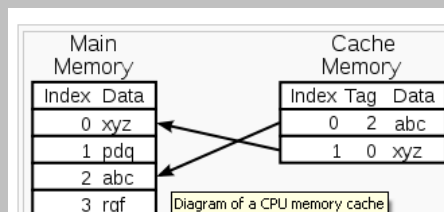
The edge caching method consists of deploying numerous edge servers globally to as many Internet Service Providers (ISPs) as possible and utilizing partnered cache servers in order to help eliminate cache misses on the edge. If the edge server hit by the end-user doesn't have the requested content, the partner edge server is then checked for that same content. If the content exists, http pipelining is used between the partnered cache servers, which can help to increase the performance in support of cache misses. Beyond that, if the content is not present on the edge server, then it must be retrieved from

What is Caching?

Caching: temporary storing of frequently accessed content in memory or on a server for the purpose of retrieving that content more quickly in the future.

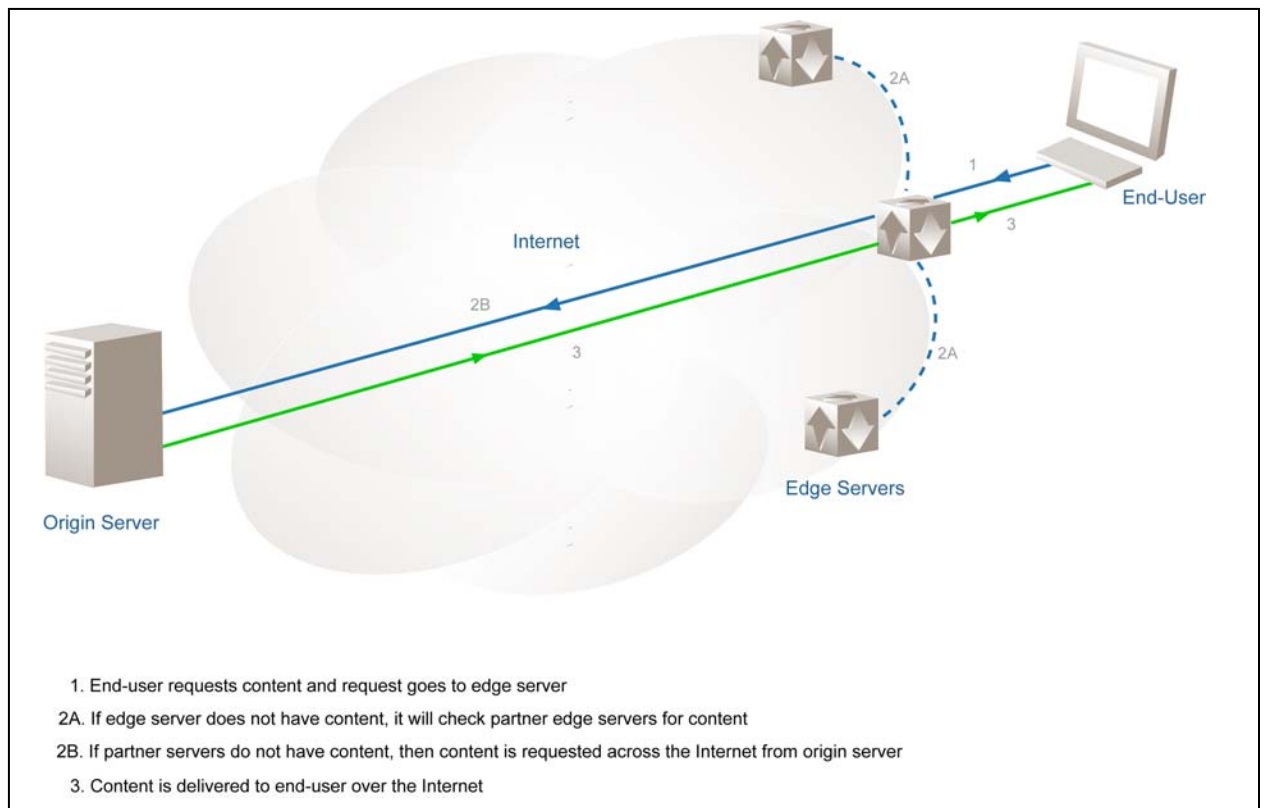
Cache Hit: occurs when the content required is found in a cache and does not require retrieval from the origin server.

Cache Miss: occurs if the cache is consulted and found not to have the content. This results in the cache retrieving the relevant content from a neighboring/partner cache or from the origin server (where the most recent edition of the content resides), so that the content retrieved as well as placed in the cache is more readily accessible on the next retrieval attempt.



the origin server, and the static content is then stored or cached for edge delivery. Subsequent requests for that content at that edge server can then be delivered from the cache. Performing path metrics techniques are used in this method to speed delivery of content from the edge server back to the origin server to resolve the ultimate cache miss.

Originally designed in the 1990s, this CDN approach was developed to overcome the limitations of end-users with dial-up connections, and the reality is small files aren't as significantly impacted performance-wise when a large pipe is available. This approach anticipates for the content to be present; but if not, then a scramble ensues to get the content while trying to ensure there is minimal impact on end-user experience. It's a well-performing model when it comes to small files and images, but less than ideal for large files that can range from 100 MB to a gigabyte+ in size, and when dynamic content or streaming is involved. This is largely due to the fact that these edge servers are relatively small and can only store a finite amount of data. With the demand for larger forms of video over the Internet, the amount of customer content that can be stored at a given edge server is relatively small. This makes it necessary for very frequent requests back to the origin server for the desired content – effectively eliminating the benefit of edge caching.



Decentralized Content Delivery Approach

An example of a CDN built on this approach is Akamai.



2. Centralized Content Delivery Approach

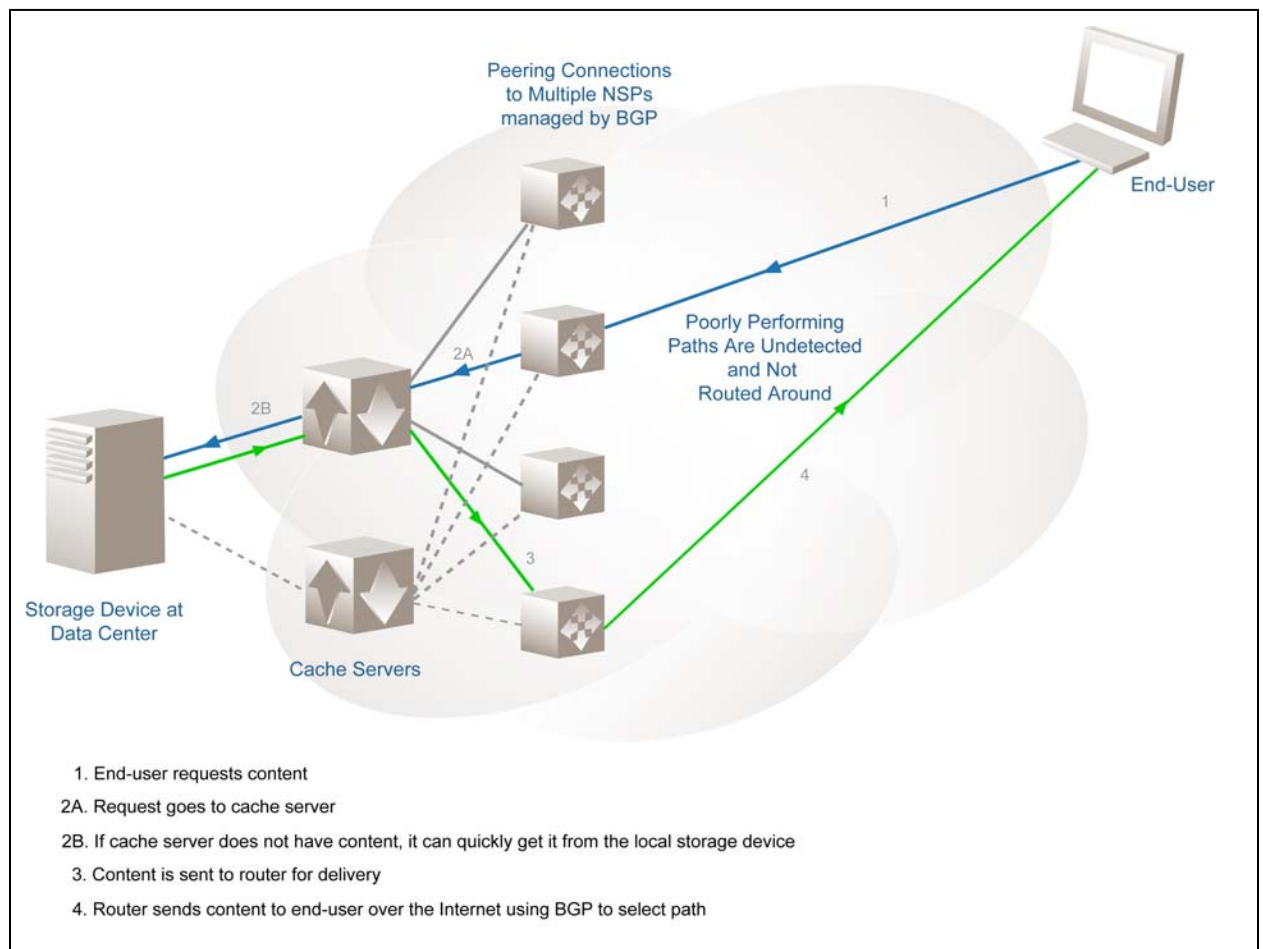
The second method of content delivery is a more centralized approach. This approach is in response to some of the ever-increasing availability of broadband connectivity around the world in the form of cable modems and DSL, and the heavily increasing demand for content with significantly larger payloads such as video streaming. Business applications where this approach is utilized include large file sizes with minimal end-user performance requirements beyond basic completion of downloads.

Unlike the edge caching approach where small clusters of servers are deployed at edge locations, this model deploys large server clusters in fewer, strategically-located data centers. A popular tactic is to store a customer's on-demand content on the network itself and then serve it up to end-users via geographically relevant data centers. At these data centers, the CDN provider peers with as many ISPs as they deem proper to get the content as close as possible to the network that the end-user is homed to. The connections to the ISPs are generally large to avoid congestion in the event of heavy demand.

With this approach, there is no caching employed as all content resides (in storage) at the data center. Therefore, the need to seek content from another source, be it a partner data center or the origin server itself, is effectively mitigated. This approach eradicates the cache miss issues of the traditional approach and thus all but eliminates the need to employ multiple methods to overcome them. The centralized approach has the added benefit of decreasing the customer's bandwidth utilization where their origin server resides as well.

The centralized content delivery approach lacks any intelligent route optimization. In other words, if the provider chosen to deliver the content is experiencing network issues (e.g. congestion, heavy packet loss or is disabled), it hinders the user experience if they are directly connected to a given end-user's provider. In this case, the end-user will be subjected to the same problems that any typical user has on the Internet. With this peer-based approach, Border Gateway Protocol (BGP) determines the path to take. BGP will not and cannot react to performance impairment intelligently, nor can it detect high latency or packet loss. Additionally, it is unable to detect regional or network-wide performance impairments. Without the ability to override the inefficiencies of BGP, this CDN approach is an improved model over the traditional edge caching model, but there is still room for improvement.





Centralized Content Delivery Approach

Limelight and Mirror Image are two examples of CDNs built on this approach.

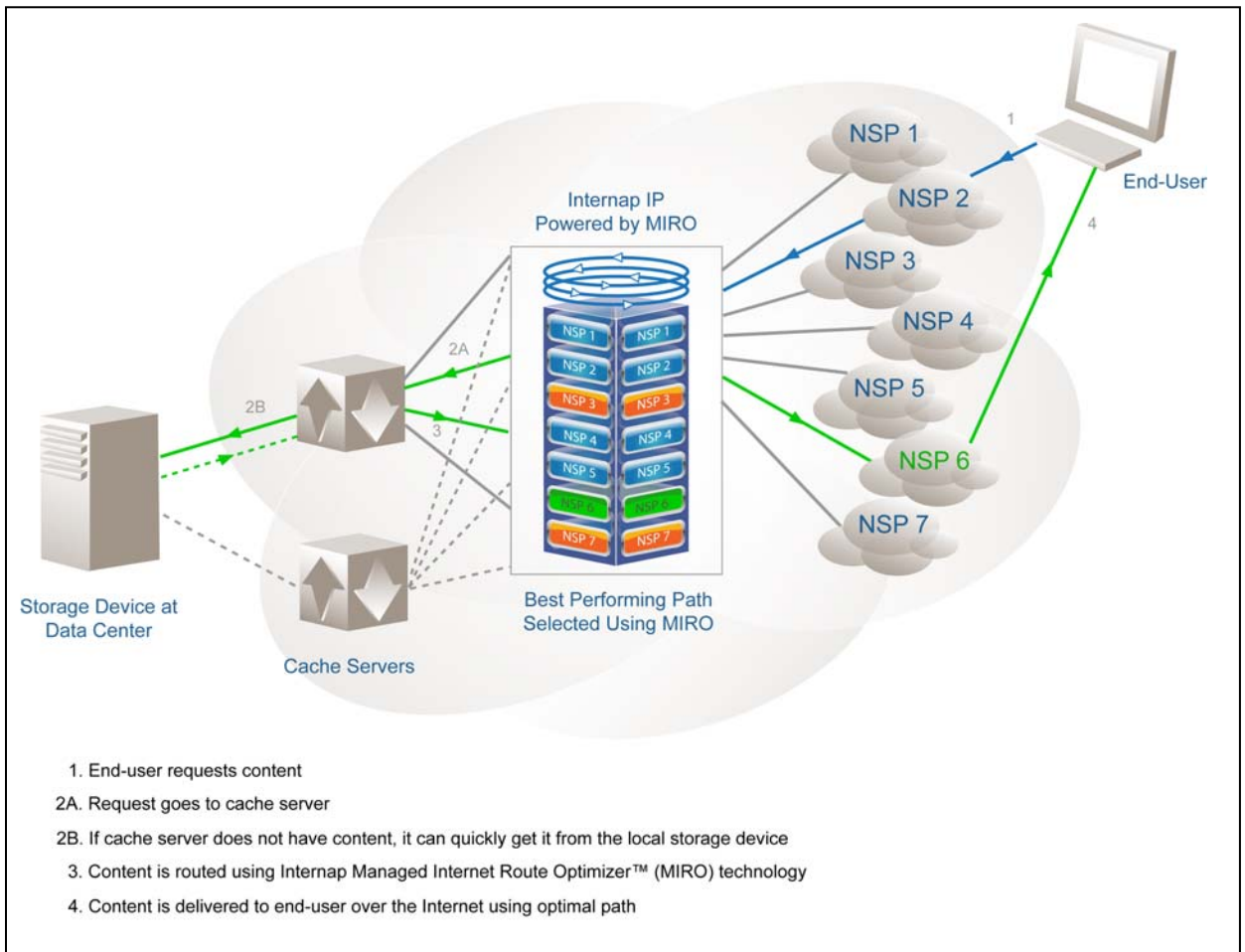
3. Optimized Hybrid Content Delivery Approach: The Next-Generation CDN

The route-optimized hybrid approach is a blend of the two previous models. It incorporates large geographically distributed caches and a small number of large content storage locations. It differs from the other approaches in that its large, geographically-distributed caches are strategically located at “route-optimized” locations throughout the provider’s network. By integrating route optimization technology within the CDN, this approach overcomes the issues that arise when the content is being delivered by a poorly performing network. This technology continually analyzes the traffic situation on every major Internet backbone and then dynamically detects the best route for the content to take. Advanced analytics are used to probe and benchmark all known points on the Internet through each bandwidth carrier and continuously adjust the routes that the content uses to reach the end-user. Similarly, these same analytics allow for the adjustment of additional locations in which popular content is cached, so that popular files may end up on many servers, as opposed to less popular or larger sized files that may only exist on a handful of servers. It also directs the end-user to the most appropriate data center for streaming or downloading content based on capacity and



availability, improving delivery performance at the source by avoiding overload at one location (thus eliminating stuttering videos or plain stops in the stream).

Internap is the only company to provide this next-generation approach. By leveraging its patented route optimization technology, Managed Internet Route Optimizer™ (MIRO), Internap navigates content around network congestion, poorly performing links and disabled providers ensuring the best possible end-user experience.



Internap Next-Generation Content Delivery Approach

Businesses looking to employ web-based applications that have a high performance or end-user experience sensitivity, such as rich media content, large file transfers, on-demand and live streaming, and unique content for personalization would all benefit from the route-optimized centralized content delivery approach.

Beyond the CDN: An End-to-End Solution

In this white paper we've discussed the general types of CDNs as well as their merits and strengths. However, all CDNs by their design have inherent limitations as a stand-alone business solution. There are many instances where applications require more than just a CDN.



For instance, CDNs fall short when it comes to optimization for Voice over IP (VoIP). Online chat support and personalized or customized end-user content also benefit very little from content delivery due to their uniqueness, as well as monetized transactions because of their interaction with back office systems. Because the Internet has become the avenue for a broad array of business-critical applications, companies today require solutions that ensure the optimization of applications through improved network performance and control.

The reality is that most businesses use a combination of vendors for their CDN and Internet connectivity. But it is important to note that just as CDNs vary in their efficacy, so do ISPs. If your business relies on content delivery, as well as interactive applications or unique transactions, it is essential to not only have a strong CDN provider, but a stable, consistent, high-performing Internet connection. If you do not have both, it can result in poor performance for the end-user, and in turn, decreased customer loyalty or even the loss of your customer.

The answer to this challenge can be found with Internap. This end-to-end solution utilizes the same patented route optimization technology described in the optimized hybrid content delivery approach, but over the Internet connection as well – improving performance and reliability for literally any type of web-based application. By routing over redundant, high-speed connections to all major Internet backbones, this service provides highly-reliable robust delivery of your content, applications and communications throughout the world. Because it is picking the best route to deliver the payload headed towards the end-user, usually the larger quantity of data in the exchange, Internap's route optimization technology assures strong performance of all applications – many of which CDNs cannot improve at all. Additionally, due to the Internap IP network design, in most cases the return path for your end-users responses are seen as “on-net”, thereby assuring high performance across the best performing Tier 1 ISP at the time towards your applications.

Internap's approach takes your applications beyond the ISP and beyond the CDN. It gives your business the ability to utilize the most complete solution in the industry, and partners you with a forward-looking company whose set of products and solutions scale effectively with today and tomorrow's Internet. This unique combination of flexibility, performance, advanced technology and legendary Network Operations Center will assure your business can focus on product development and customer acquisition instead of overcoming the challenges of dealing with multiple vendors and the wiles of the Internet. It is hard to imagine a more complete solution.

Closing

With today's growing Internet content delivery usage, it is even more important to determine what type of content delivery approach is best for your business needs. From small, non-dynamic files to web-based applications that have a high performance or end-user experience sensitivity, there is an approach to meet your needs. The Internap next-generation approach provides no equal. Its CDN approach not only provides for the ever-increasing availability of broadband connectivity around the world and the heavily increasing demand for content with significantly larger payloads, but leverages patented route optimization technology to navigate content around network congestion, poorly performing links and disabled providers – ensuring the best possible end-user experience. The combination of a route-optimized CDN and industry-leading IP connectivity, along with a world-class Network Operations Center combine for an unparalleled and unmatched end-to-end solution that can power every aspect of your web-based business.

