Encounters

CLOSE

Cisco end-to-end solution pushes streaming and other feature-rich content closer to end users.

When you have something to say and want to make an impact, you first have to deliver the content to your audience. Sounds basic, right? Yet connecting users with information is one of the biggest issues that both enterprises and service providers face today, especially as content increases—in both value and file size—and as target audiences grow from hundreds to millions of users. Content delivery network (CDN) solutions seek to bring content to users rapidly and scalably. But not all CDNs are created equal.

In just one year, Cisco has emerged as the leader in CDN solutions due to its complete, end-to-end content delivery framework. "Cisco is the only vendor that could provide Qwest with all the components of a complete solution to build our content distribution network services," says Rod Nayfield, director of IP Innovations at Qwest Communications (qwest.com) in Denver, Colorado. "Other vendors could only provide pieces of the entire solution we needed, which would have required Qwest to purchase from multiple vendors and conduct extensive systems integration, whereas Cisco delivered an integrated solution that requires minimal development effort."

Cisco CDN 101

There are five components in the Cisco CDN solution. They include the following:

The *Cisco Content Distribution Manager* (CDM) is the central decision point. It facilitates provisioning, accounting, and billing of services provided by the content delivery network. It provides transparent HTTP redirection of user requests to the best available content engine location based on application-layer information.

At the network edge, *Cisco Content Engines* transparently cache live or prepositioned content from central content servers and serve it to users upon request.

Between the central CDM and the edge content engines, *Cisco Content Switches* select the optimal content engine when more than one engine is present. The switches intelligently load-balance traffic across content engines based on the availability of content and load on each engine.

Cisco Content Routers enhance the process of selecting the best available location for serving requested content. Content routers intercept and operate on both Domain Name System (DNS) and HTTP processing in the network to determine speed, accuracy, and reliability of optimal content placement.

Intelligent Network Services are Cisco IOS® Software features that empower CDNs to optimize requests for content services. Cisco ties its familiar IP services—such as security, quality of service (QoS), virtual private network (VPN), Layer 3 multicast, and Network-Based Application Recognition (NBAR)—to its content delivery systems to enrich the user experience.

Beginning in April 2001, Cisco announced significant software upgrades for its two major CDN solution categories: *Enterprise CDN* (ECDN) and

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Internet CDN (ICDN). The ECDN is optimized for deployment on highly controlled networks. Service providers can offer managed ECDN services, or enterprises may deploy such networks themselves. The ICDN is designed for service providers that need to distribute content such as Web-hosted e-commerce and multimedia services to millions of potential users across public infrastructures such as the Internet.

Enterprise CDN

ECDN relies upon an HTTP-based redirection technology to deliver users to the "very best" content engine (Figure 1) located within a controlled, enterprise network. ECDN is optimized for bandwidth-intensive e-learning, client and partner communications, e-commerce, training, retail point-of-sale applications, and other services typical of intranet or extranet environments.

Cisco released ECDN Version 3.0.1 software in April 2001, adding sought-after functionality to an already robust solution. Of its many new features, the latest release supports streaming native Microsoft Windows Media files, efficient multicast replication, and high-availability content routing.

Native Windows Media Streaming

Adding the ability to stream Windows Media in native format allows users to control content using VCR-like functions (stop, playback, pause, fast forward, and rewind) for Windows Media files. In previous ECDN releases, VCR functions were usable only with Motion Picture Experts Group (MPEG) and Real Networks file formats. Windows Media files were delivered via simple HTTP streaming, so users could not manipulate content flows with VCR functions.

"Cisco ECDN software also allows enterprises to integrate native video streams with third-party applications from Cisco e-learning partners, allowing companies to deploy rich e-learning solutions with complete control of content and bandwidth," says Rick Clarkson, ECDN product line manager in the Content Networking Business Unit at Cisco. "With Cisco e-learning partners, enterprises can rest assured that they're choosing enterprise-class, scalable solutions that are proven to work and will help them immediately realize the many benefits of e-learning."

Efficient Multicast Replication

"Multicast is a great way to distribute vast amounts of content," notes Clarkson, "because it uses minimal bandwidth across the backbone." With multicast, a single media stream is replicated at penultimate "branch points" before delivery to multiple content engines. However, accuracy is essential with CDNs. Cisco IOS Software has IP-layer multicast mechanisms that operate on a best-effort basis with no error check, so if packets are lost, imperfect content arrives at the content engine.

The Cisco ECDN solution uses application-layer replication with Self-Organizing Distributed Architecture (SODA), which is based on TCP and checks packets to ensure complete, accurate file delivery to all content engines. However, if an e-learning provider wants to broadcast course content over a satellite network, which has a star topology, SODA replication may not be efficient. To address this issue, Cisco formed a partnership with Digital Fountain Inc. (digitalfountain.com), based in Fremont, California.

Digital Fountain already works closely with the Cisco Multicast Technology Group, so its solutions are compatible with Cisco networks. Digital Fountain offers a unique multicast solution made up of its own Fountain Server for the data center, which encodes files sent from the CDM and initiates a multicast file transfer to content engines at the edge. Cisco Content Engines contain the Digital Fountain client software that decodes, stores, and delivers original files to client devices.

The Digital Fountain solution supports reliable multicast transmission on any mul-

ticast-enabled network including satellite systems, which regularly suffer from packet loss. "Cisco's customers are looking for this capability," says Jay Goldin, director of business development and cofounder of Digital Fountain. "They need the predictable, reliable interoperation of our multicast technology within their Cisco CDNs."

To replicate perfect copies every time, Digital Fountain has a proprietary encoding algorithm that produces "Meta-Content" packets (mathematical equations about the original content). Cisco Content Engines include software that decodes Meta-

Content, so the engines don't have to receive all packets. When they have the requisite number of packets, they decode them and assemble a perfect copy of the original file. This reliable approach permits a network to drop any amount of packets; the Fountain Server continues to send Meta-Content packets to content engines until each has enough.
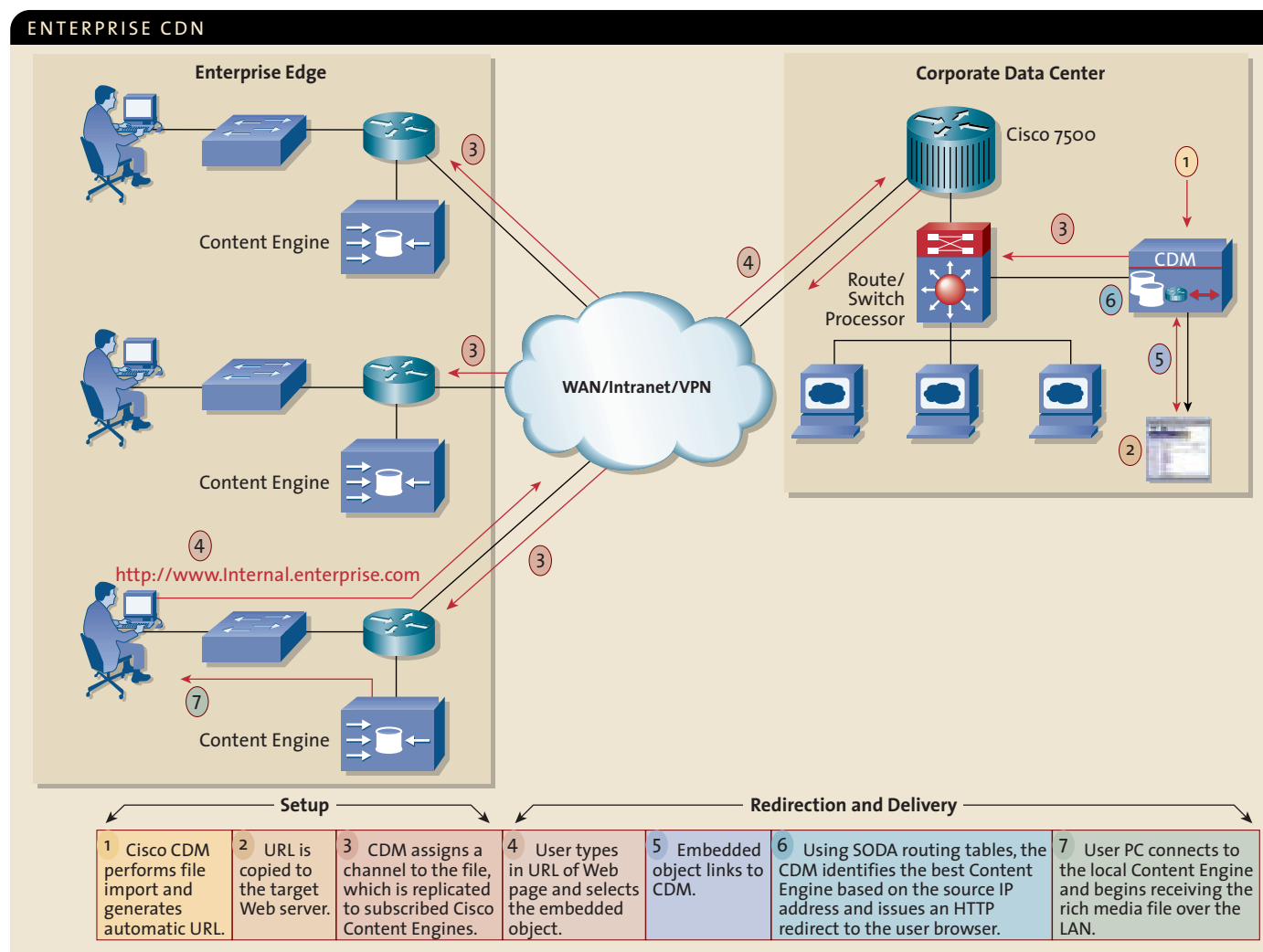
High-Availability Content Routing

The Cisco CDM processes all content routing decisions, so what happens if it should fail? A new, high-availability solution that features the Cisco CSS 11000 Series switches and Cisco 4430 Content Router makes it possible to offload the redirection process and load-balancing decisions. Should the CDM fail, the
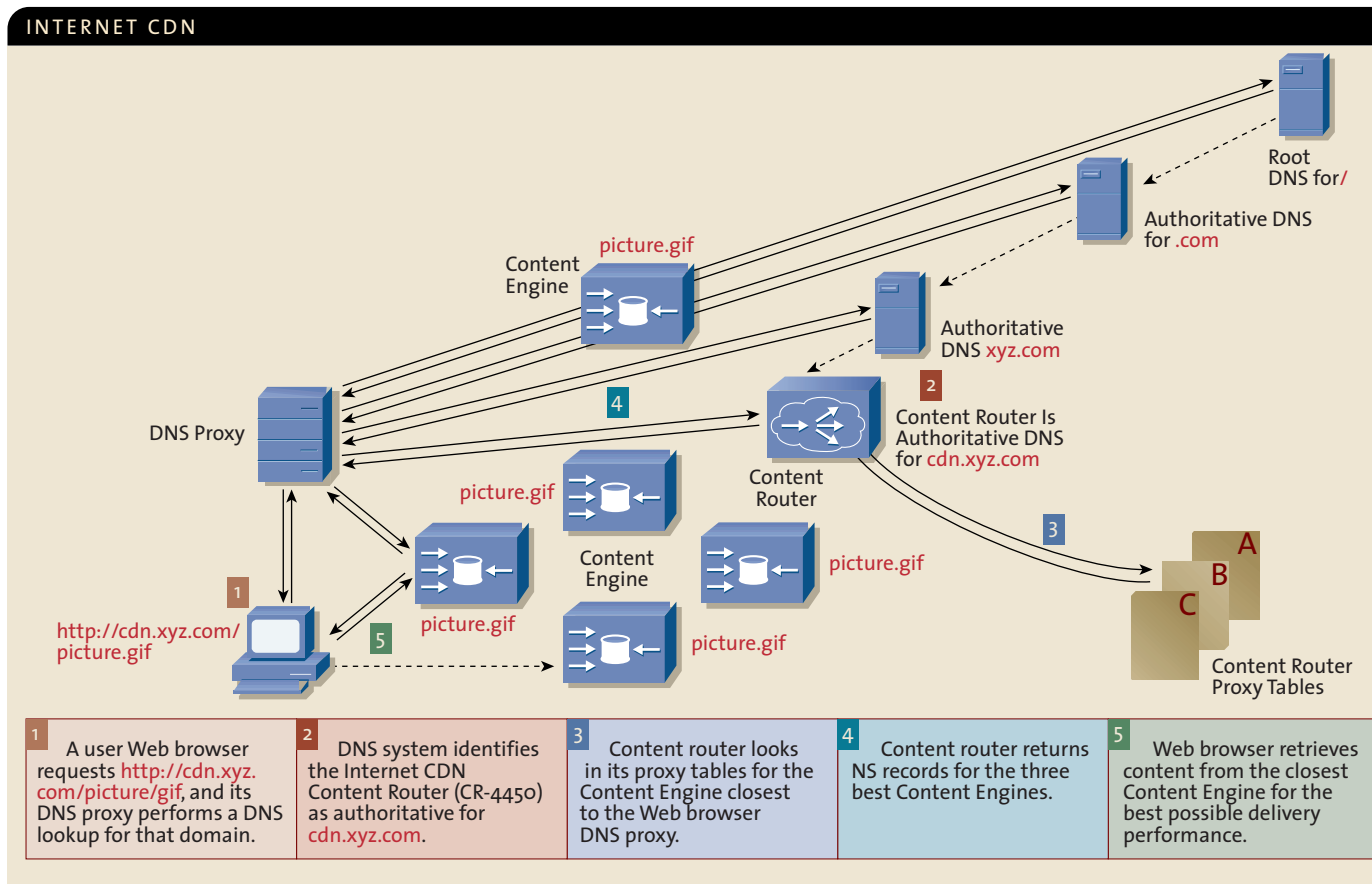
CDN can continue global routing and load balancing across multiple content switches without missing a beat. In that case, the network only loses content delivery policies until the CDM is back online—service continues to end users. "This feature not only provides higher availability, but it also increases network scalability," says Clarkson. "With dedicated devices for content routing, you achieve better overall redirection, routing, and CDN policy management."

Internet CDN

The Cisco ICDN solution allows service providers to build a single CDN infrastructure and logically divide it into multiple virtual CDN (VCDN) networks. With VCDN capability, enterprises can purchase

FIGURE 1: Relying on an HTTP-based redirection technology to deliver users to the very best content engine, ECDN is optimized for bandwidth-intensive e-learning, corporate training and client communications, retail point-of-sale applications, and other intranet/extranet communications.

ENTERPRISE CDN

	Setup			Redirection and Delivery		
1 Cisco CDM performs file import and generates automatic URL.	2 URL is copied to the target Web server.	3 CDM assigns a channel to the file, which is replicated to subscribed Cisco Content Engines.	4 User types in URL of Web page and selects the embedded object.	5 Embedded object links to CDM.	6 Using SODA routing tables, the CDM identifies the best Content Engine based on the source IP address and issues an HTTP redirect to the user browser.	7 User PC connects to the local Content Engine and begins receiving the rich media file over the LAN.

Root
DNS for /

Authoritative DNS
for .com

picture.gif

Content
Engine

Authoritative
DNS xyz.com

4

DNS Proxy

2

Content Router Is
Authoritative DNS
for cdn.xyz.com

picture.gif

Content
Router

3

A
B
C

Content
Engine

picture.gif

1

http://cdn.xyz.com/
picture.gif

picture.gif

5

picture.gif

Content Router
Proxy Tables

| **1** A user Web browser requests http://cdn.xyz.com/picture/gif, and its DNS proxy performs a DNS lookup for that domain. | **2** DNS system identifies the Internet CDN Content Router (CR-4450) as authoritative for cdn.xyz.com. | **3** Content router looks in its proxy tables for the Content Engine closest to the Web browser DNS proxy. | **4** Content router returns NS records for the three best Content Engines. | **5** Web browser retrieves content from the closest Content Engine for the best possible delivery performance. |

just the level of service they need from the service provider, whether by region or number of content edge devices.

"VCDNs give service providers the ability to identify their offerings on a per-customer basis," explains Greg Smith, ICDN product manager in the Content Networking Business Unit at Cisco. "By creating subsets of the entire system, service providers can put many customers on the same set of hardware, offer differentiated service levels, and bill based on usage. This model also makes CDN capabilities available to smaller organizations that can't afford full-blown systems."

ICDN uses a DNS-based redirection system to route users to an "almost best" content engine (Figure 2). The newly released Cisco ICDN Version 2.0 software supports media streaming with Real Networks and QuickTime to content engines, adding to Cisco ICDN Version 1.0 software, which served static HTTP content.

The latest release also includes key new functionality with SuperNodes and content pre-positioning and pinning. The software greatly enhances Web users' experience by providing improved performance, especially for e-commerce and services based on streaming media such as television news or radio stations.

"**Q**west CDN services allow our business customers to reduce capital and operational expenditures as they scale their Web infrastructures to meet additional demands or add rich media."

—**ROD NAYFIELD, DIRECTOR OF IP INNOVATIONS, QWEST**

The streaming feature enables on-demand and live audio or video streaming from Real

FIGURE 2: Using a DNS-based redirection system to route users to the closest available content engine, ICDN is designed for service providers that distribute e-commerce, multimedia services, and other media-rich content to millions of users across public infrastructures such as the Internet.

Networks Version 8.0 servers or on-demand streaming from native QuickTime servers. It provides metered delivery and a full set of streaming functionality including (for on-demand playback) VCR-like fast-forward, rewind, and pause controls.

The ICDN Version 2.0 software is designed for bursty IP networks such as the Internet that may not have consistent quality-of-service (QoS) controls. It configures all content engines into an efficient tree structure to minimize bandwidth consumption on the backbone.

A SuperNode is a Cisco CSS 11000 Series Content Services Switch that performs load balancing and next-click failover to two or more content engines within the

The Content Alliance

Initiated by Cisco in August 2000, the Content Alliance was formed to foster interoperability among CDNs and accelerate the evolution of content networking services. As a self-governing organization, the Content Alliance is open to any technology vendor, service provider, or content provider interested in supporting the development of open standards and protocols to advance content networking and deliver key technologies in emerging content networking-related areas.

The Content Alliance's initial efforts have focused on content peering, which enables separately administered CDNs of multiple providers to work in cooperation. With content peering, a Web site owner can work with its preferred hosting service provider, but benefit from the reach of multiple combined peered networks. Formed by the Content Alliance, the Content Distribution Internetworking (CDI) Working Group (formerly called the Content Peering Working Group) has proposed several draft technical standards to the Internet Engineering Task Force (IETF), with the aim of helping to define specifications for peering needs such as authorizing the use of content between networks, content request-routing, and sharing logging or billing information for charge settlement. Among the Internet-Drafts being considered by the IETF are "Content Internetworking Scenarios" (ietf.org/internet-drafts/draft-day-cdnp-scenarios-03.txt) and "Distribution Peering Requirements for Content Distribution Internetworking" (ietf.org/internet-drafts/draft-amini-cdi-distribution-reqs-00.txt).

In addition to Cisco, charter members of the Content Alliance include, among several other vendors, America Online, Cable & Wireless, Digital Island, EMC, Genuity, PSINet, StorageNetworks, and Sun Microsystems. More than 100 service providers, technology providers, and content providers have joined. For more information on the Content Alliance—including a list of members, IETF standards progress, and how to join—visit the URL content-peering.org.

same point of presence (POP). It offers service providers the capacity and reliability they need in their Internet data centers.

Cisco ICDN Version 2.0 software is supported in the Cisco CSS 11150 and CSS 11800 platforms. Where a CSS is dedicated to a SuperNode, the CDM takes over configuration of virtual IP addresses, load balancing, and other settings. Next-click failover reroutes users to a secondary content engine in case the primary one fails during a session. Users won't notice the change, assures Smith.

Content pre-positioning and pinning is a true push technology. Until now, the first requestor had to wait for the network to pull content from central servers into an edge device. Now service providers can proactively stage content, because Cisco ICDN Version 2.0 enables them to reserve space on content engines, download content before it's requested (pre-positioning), and tell it how long to stay (pinning) before being purged.

"The first requestor suffers no delay, especially for large files," says Smith. "Pulled caches can lose content because it ages, but pinning ensures that content is always available."

World's First ICDN Service
Cisco Powered Network provider Qwest Communications launched a portfolio of CDN services in April 2001 deployed across the same all-Cisco CDN infrastructure. Qwest offers three services across its Intelligent Content Environment (ICE) based on complete Cisco ICDN and Cisco ECDN solutions. The Qwest ICE services are available at the customer premises or throughout its 16 nationwide, state-of-the-art Web hosting and managed services facilities called CyberCenters.

"It's an outsourced management play," says Nayfield of Qwest. "Offering content services is a logical next step in the existing Qwest service portfolio. Qwest CDN services allow our business customers to reduce capital and operational expenditures as they scale their Web infrastructures to meet additional demands or add rich media. That's critical in today's rapidly changing economy, because it allows our customers to offer larger, more complex, feature-rich Web solutions while conserving precious capital." ▲▲

FURTHER READING

For more information on the Cisco solutions and partner programs mentioned in this article, visit the following URLs:

- ICDN solutions:
  cisco.com/warp/public/779/servpro/services/webhosting/content_networking/
- EDCN solutions:
  cisco.com/warp/public/779/largeent/learn/technologies/content_networking/
- Cisco e-learning partners:
  cisco.com/go/elearning
- Cisco Powered Network program:
  cisco.com/cpn