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## Introduction to Content Switching

Content switching, server load balancing, intelligent switching, Layer 4 switching, session switching, application switching. Like any maturing technology, no one name has been accepted to encompass all that content switching covers. We will use the term *content switching* throughout this book, as it appears to be the most commonly used method by which to express this technology. However, please understand that even this might change depending on what your requirements are.

Therefore, before we begin our journey through the workings and terminology of content switching, we should first pause and understand where and how this technology evolved.

Without a doubt, the roots of content switching can be tied directly to the growth of the Internet in the late 1990s, where Ethernet and TCP/IP became the king of the corporate networks. Suddenly, network manufacturers were not focusing their research and development staff on Token Ring, ATM, or FDDI, or protocols such as IPX, SNA, or NetBIOS, but rather on how to leverage this new and growing phenomenon that was being driven by the unilateral acceptance of TCP/IP and Ethernet across the globe.

### The Evolution of Layer 2 and Layer 3 Networks

Networking had come a long way by the mid to late 1990s, and routing at Layer 3 was beginning to become an application that could be moved to the edge of

the network or to the wiring closet, enabling networks to be more easily managed by grouping smaller quantities of devices together in a single subnet. Companies, such as Wellfleet and Cisco Systems were the key players in the routing arena and had been able to leverage the development of Layer 2 switches, which in turn allowed the amalgamation of Layer 2, and Layer 3 functionality on the same device. The use of virtual LAN (VLAN) technology made it even easier for network administrators to deploy networks around their campuses with relative ease. Users within a department could be grouped together in one subnet allowing everyone local access. Security rules and policies could be implemented on a VLAN basis if required. By using VLANs, no longer were users forced to change IP address based on location but could remain within their relevant departments regardless of physical location. This type of flexibility coupled with the likes of automatic IP address allocation ensured that users had the ease and freedom to connect to the network and still retain access to their applications.

By enabling many users to connect to the network and access corporate information, new applications evolved that improved productivity and increased profitability. Then came the killer application—the Internet. This has changed the way we do business, and was the key driver behind many new technologies, including content switching.

## The Bigger, Faster Internet

The Internet has enabled anyone to have access to any information. Information about obscure and unknown facts is available to anyone who wants it. In addition, countries that have tried to control the media have found that the Internet does not discriminate; it allows anyone access to any information, anytime, anywhere. This is its biggest advantage but also can be its biggest downside, as with no regulation, it can be a mechanism that promotes and assists antisocial behavior and radical views. Be that as it may, the Internet is the most powerful tool the average person in the street has today, and we should embrace its potential.

Most importantly, however, the Internet has changed the way we look and do business today. Suddenly, companies and their products and services were accessible to billions of people 365 days a year. At first, this was seen as a surefire method to increase revenues. Creating and offering any Internet-based product or service seemed destined to make those involved millions of dollars. This, like any shaky business plan, has not been the case for some organizations. Using the

Internet as an extension to your existing business, or creating a viable business plan with sound research has enabled companies to leverage the reach and ubiquitous nature of the Internet. There are many success stories of companies that have done just that, and by maintaining cautious investment, were able to grow while offering quality products and services. The road to success, however, is also littered with those companies that blindly saw the Internet as an easy way to create business opportunities and provide obscure services and products. Those are unfortunately not with us today.

One of the other key things spawned by the Internet explosion is the use of the Web browser. Almost every computer in the world today is running a browser, typically from either Microsoft or Netscape. Most people know how to use a Web browser, and it is this that has ensured that companies are starting to use browsers as the front end to all their applications, thus minimizing training for the front-end software. Web enabling of legacy applications is happening across the globe. No more do companies have to buy, install, and maintain client software. The Web browser is now the default client software of choice. So now the Internet has penetrated internal organizations, and names such as *intranets* and *extranets* are widely used. While we often think of Web-based applications as being for online trading and surfing, we now see them being used for internal access within organizations. In most large enterprises today, the intranet is the single most important place where employees gain their information. From booking meeting rooms, to checking pay slips, filling in leave forms, getting the latest company news, downloading product or sales information, completing and submitting expenses, the possibilities to drive productivity and increase employee satisfaction are endless. And all of this is done using a Web browser.

## The Drive for Richer Content

As the Internet has evolved, PCs have increased in speed and processing power. Bandwidth to the average user has increased significantly and the ability to provide new and exciting services over the Internet has been enabled. Aside from the services mentioned in the previous paragraph, new and emerging technologies such as e-learning, e-conferencing, streaming media and Voice over IP (VoIP) will and are being delivered over the Internet. No longer do we want text-based Web sites; interactive games and multimedia applications are the

requirement of today. Digital TV, downloadable music in whatever form will be the norm. Most radio stations are available over the Internet, and one could argue that it will be only a matter of time before free-to-air television becomes available. With the public hooked on the Digital Age, we will require richer, more powerful content, not less.

Companies are starting to exploit and leverage the Multimedia Age by broadcasting company updates and product launches over the Internet. All of this has led to dependence on the infrastructure similar to the way we are dependent on the mature voice networks of today. While convergence is happening between voice, data, and video, we will need to see a huge increase in the quality of service over the Internet before we can effectively use its reach for business-critical voice traffic as well.

As we travel through the 21<sup>st</sup> century, we can only assume that the Internet will bring more content, more information, more applications, and above all, more fun to us, the users.

## Solving the Problems with Content Switching

Nearly every company in business today has some form of online presence, be it internal, external, or both. Regardless of how a company does business, having information available to its customers, partners, and employees is crucial to its success. The issue facing these organizations is that the infrastructure underpinning this requirement has often been deployed with little thought to the growth and the success of online commerce. The server, switching, and routing infrastructure is not geared for content networking as a whole. We need to move away from the traditional Layer 2 and Layer 3 deployments and increase network and server performance, and manage and control content much more effectively in order to provide the business performance required by today's competitive organizations. Content switching is the technology that enables this.

### **Overview of Content Switching**

In the old days, bandwidth was king—performance issues were solved by increasing bandwidth. However, as more information is flowing at faster speeds, servers are swamped with data and are not able to respond with critical information in a timely fashion.

The problem in the data arena is, how do we differentiate between “Spam” and valuable content, critical applications and noncritical, faster and slower servers, and local or remote sites? The archetypal Layer 2 and Layer 3 approach has no concept of content, merely an address to send the data. For example, consider your postal address. Imagine if you could get the mail sorted before it arrived in your post box—no junk mail, no offers for unlimited credit, or health care, or “you have won \$100,000—all you need to do is return this within 7 days and you will be eligible for a free pencil holder” mail—only mail you truly need.

Unfortunately, there is minimal intelligence in a Layer 2 and Layer 3 switch but plenty of processing power, so throughput of a 100 million packets per second is great but this would fill your post box faster than you could open the letters. Enter content switching.

“For checking accounts please key 1, for savings accounts please key 2, for all other services please key 3...”

This is basic content switching—streamlining requests matching what is needed to the correct destination. The ability to make intelligent decisions based on traditional Layer 2 and Layer 3 criteria as well as looking deeper into the packet to determine what the user is actually trying to access. To achieve this, the switch needs to inspect the packet in real time and determine what is being requested. The level of inspection varies depending on configuration and application requirement.

In most cases, this would be application specific based on TCP/UDP port such as FTP, HTTP, SMTP, and so forth. This allows content for those specific applications to be sent to the correct server or group of servers. This has the benefit of matching content or applications to specific servers and eradicates the need to have all content for a specific site mirrored across all servers. Security can be better managed on a per-service or per-application basis rather than a per-server basis.

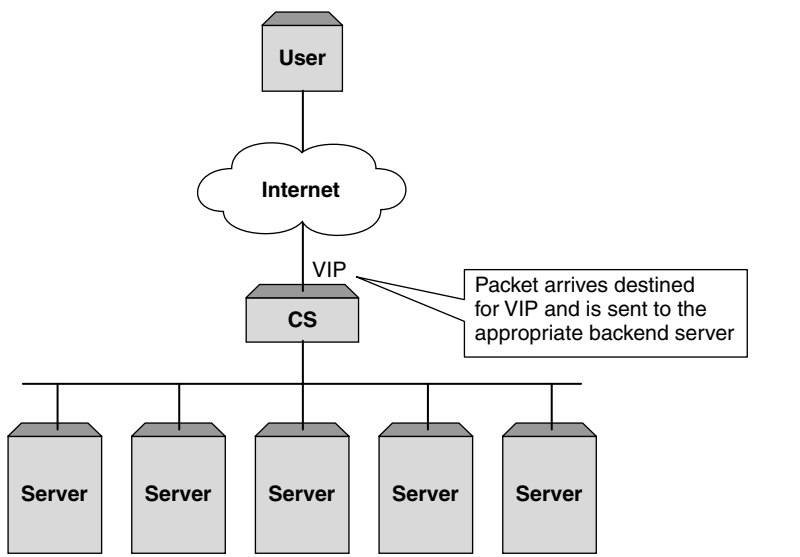
In addition to looking at the Layer 4 information, content switching allows for more granular inspection at Layer 7. Instead of sending all HTTP traffic to a set of servers, requests sent to *www.abc.com* can get sent to a designated set of servers, while those being sent to *www.xyz.com* can be sent to a different set. This provides more specific load balancing than just a TCP/UDP port and allows for virtual hosting. Content switching also has the ability to send specific Uniform Resource Locators (URLs), file types, Uniform Resource Indicators

(URIs), cookies, and so forth to a certain set of servers. A request to *www.abc.com/products* could be sent to the Products servers, while *www.abc.com/technical* could be sent to those specific servers handling Technical content. This provides customers the ability to steer traffic to where they need it sent based on processing required to perform the request, or availability of content or even site availability. Without doubt, it enhances the user experience by increasing throughput and response times as servers are able to handle what they are designed for and what the network and server administrators have configured.

## The Virtual World

The basics behind content switching revolve around the ability to provide a single point to which a session is established. By using the concept of a virtual IP address (VIP) that is configured on the content switch, the user can connect to this single point and it is the content switch that determines or load balances the request to the appropriate server. Content switches are able to support hundreds of servers behind a single VIP. Figure 1–1 illustrates this concept.

This concept allows businesses to create a single entry point to their site because the VIP is associated with the domain name. It also allows the backend servers to be in a secure, nonaccessible zone from external devices. The reason



**Figure 1–1** A content switch with a single VIP and many real servers that can be used for load balancing.

why this is possible is that the content switch is the device to which the user connects, and it is the content switch that then forwards the session on to the selected server. For the duration of the session, all traffic to and from the user will traverse the content switch, and because the content switch is intelligent, the data can be manipulated. This is discussed in more detail in Chapter 5, *Basic Server Load Balancing*. It is important to understand that content switches need to sit in the data path in order to have visibility of the user sessions. They also need to have powerful processors as they need to manipulate every packet within a session that passes through the switch. With these thoughts in mind, we will now discuss the content switching market from a technical viewpoint. We should also remember that as with any technology, the goal posts shift daily, new companies emerge, existing ones disappear or are swallowed by large competitors, and market requirements constantly change. We will attempt to cover the history of content switching, the milestones, and major current and, potentially, future trends that will drive this technology forward.

## The Pioneers

The content switching market started to gain acceptance in 1997 after a relatively slow start in late 1995 and 1996. Without a doubt, 1998 and 1999 turned out to be the two years that enabled this technology to grow, and saw real players emerge and begin to take ownership of the market. All of the players were startups or new kids on the block, with no proven track record and were not associated with the giants of the networking space at the time—Cisco Systems, 3Com, Bay Networks, and Cabletron. All had seen this as a niche technology and had attempted to get a share of the market before the incumbent providers could get a foothold. No one really predicted the massive growth that took place through the late 1990s in the content switching arena, and few would have predicated the crazy days of the year 2000 when the dot.com era boomed.

It was this that allowed content networking to forge ahead and generate large amounts of revenue through sales of new technology and hugely successful Initial Public Offerings (IPOs) that enabled these new companies to challenge the incumbent networking manufacturers. We will look at the major influencers in this arena, remembering that in today's current market, mergers and acquisitions happen that change the landscape as we know it. Before we do, we should understand that the content switching market was traditionally made up of three areas:

- Software
- Appliances
- Layer 7 switches

Software was deployed on any device, and it was up to the device to load balance and redirect traffic just as another service or thread within the operating system. Appliances, on the other hand, were devices that had been optimized to run the content switching software and had been tested and bedded in by the manufacturer. They were often seen as cheaper or lower end options, with good features but performance limitations due to their PC-like nature. Layer 7 switches, however, were designed from the ground up and had silicon and dedicated processors for specific tasks. These devices were and still are seen as the top tier of the products, but do command a higher price tag as would be expected.

### **Nortel Networks (Alteon WebSystems)**

In July 2000, Nortel Networks acquired a company called Alteon WebSystems for \$7.8 billion. This company, which had 650 employees, had been founded in 1996 and was based in San Jose in Silicon Valley, California. Alteon WebSystems had been one of the first companies to market with the gigabit network interface card (NIC), and from that success started to create dedicated Layer 7 switches, or content switches as they are now known, using their expertise gained in ASIC design for the gigabit NIC.

Alteon WebSystems has continued to lead the content switching market in features, performance, and reliability, and has added additional security, caching, and content routing products to their portfolio. Nortel Networks has managed to ensure that the products are integrated with the existing product range and continue to build on the success of this early pioneer.

### **Cisco Systems (ArrowPoint)**

With Cisco losing market share to the startups in this area through 1998, 1999, and 2000, it was inevitable that an acquisition would take place. In May 2000, Cisco acquired ArrowPoint, one of the main players in this arena, for \$5.8 billion. Based in Boston, Massachusetts, ArrowPoint had developed a chassis-based solution to enhance their existing Layer 7 content switches that allowed

them to penetrate large ISP and hosting environments. ArrowPoint was seen as one of the visionaries of this area with features such as flash crowd and hot content support.

Prior to this, however, Cisco had a product called Local Director, which had also been obtained through an acquisition. Since then, Cisco has acquired another content switching company, Netiverse, and OEM security products to ensure that they offer an end-to-end solution in content switching products. As we write this book, Cisco is bringing all their content networking products to a common operating system, or at least a common look and feel.

### **F5 Networks**

Established in 1996, F5 managed to catch the market at the right time and, with good marketing has been able to not only survive, but also side step the acquisition trend. Having been an appliance-based company, they have managed to form relationships with some of the larger companies, and it is this that has probably kept them as a major player in content networking. Development of a new switching platform has seen them embrace the Layer 7 switching market, and they now offer an appliance and dedicated switch in their portfolio. Investment from Nokia has ensured that F5 will be able to compete effectively for some time to come.

### **Foundry Networks**

Founded in 1996, Foundry Networks' major success has been in the high-end Layer 2 and Layer 3 space competing with core routing technology. By using this as a base, Foundry has been able to offer comprehensive content switching. Their products are true Layer 7 switches and make use of the powerful Layer 2 and Layer 3 design. These products might not be as feature rich as some of the competitive offerings, but content switching is not their core business; it is one of their businesses, and development time needs to be centered on routing and content switching. Like F5, Foundry has also managed to side step the acquisition trend.

As can be seen, these companies are fairly young in networking terms, most having started in 1996, but have made huge advancements in cementing this technology into today's communications infrastructure. There are many players in the content switching market offering software, appliances, and Layer 7

switches, and all have added and contributed to this exciting marketplace. However, it would be almost impossible to cover each in this chapter, so we have only focused on these four manufacturers who are typically seen as the early pioneers in content switching and are still regarded as market leaders today.

## Current Market Landscape

We feel it is important to discuss the current market and the history, but as we write this book, the technology market is changing due to many influences, from economic to behavioral to technology and consumer demands. It is important to understand that this can and will influence the way in which content networking is deployed, developed, and accepted, and going into great depth would be a task that could and probably would be superseded very quickly. We would rather discuss the underlying concepts and issues that will not change due to the fact that they are directly associated with protocols and communications in general. However, we have dedicated a few lines on market trends.

### **Market Trends**

With high-speed network access being easily available and affordable to the average person and to small business, content and online communications will continue to grow. It is this growth, coupled with the changes in the wireless world, that will ensure that content is king. Users demand quality, and they also change their habits, likes, and dislikes quickly; therefore, being able to provide the latest, feature-rich content to the consumer will be key. The major issue to the content providers is how to deliver this content quickly and intelligently. Content switching will become an integral player in allowing this to happen. In addition, companies are moving to unified messaging where voice, data, and video merge. Ensuring quality of service across the Internet and intranet will be a massive task that will require the intelligence of content switching to differentiate the traffic streams and sessions. Regardless of the application, content switching will play a key role in the networks of the future.

## Summary

Content networking is a technology that is here to stay. It will slowly become ingrained into networking products just like spanning tree and routing protocols

have in Layer 2 and Layer 3 devices. While skills are not as widespread as needed, education and a desire by the content manufacturers to simplify and automate these processes will ensure that penetration into the marketplace is a given. With the early pioneers and the new players all still competing for market and mind share, we will not see a slowdown in this area for some time to come. We believe that content networking is an exciting technology to work with, and hope that this book goes some way to not only educating you but also providing you with the ability to enhance the way you and your company do business.