3.7 CASESTUDY Akamai Technologies: When Demand Exceeds Capacity

In 2011, the amount of Internet traffic generated by YouTube alone is greater than the amount of traffic on the entire Internet in 2000. By 2015, the digital equivalent of all the movies ever made will cross over the Internet every five minutes. In the last year, Netflix's subscriber base jumped over 50% to 16 million, most of whom are now streaming movies over the Internet, and they now account for 20% of all Internet traffic in the United States. Because of video streaming and the explosion in mobile devices demanding high-bandwidth applications, Internet traffic has increased 800% since 2006, and is predicted to expand four times by 2015. Internet video is now 40% of Internet traffic and will reach 62% by 2015, according to networking giant Cisco Systems. Mobile platform traffic from smartphones and Wi-Fi devices is growing at 60% and will soon push cell networks and the Internet to their capacities. Cisco estimates that annual global Internet traffic will hit nearly 1 zettabyte in 2015—that's 1,000 exabytes, or, in other words, 10 with 19 zeroes behind it! Experts call applications like Netflix, YouTube, and high definition streaming video services "net bombs" because they threaten the effective operation of the Internet. At some point, demand will exceed capacity, and either there will be "brownouts" where everyone's connection speed slows down or "capping" of bandwidth hogs (those 10% of Internet users who consume 60% of the Internet's capacity because of extensive video downloading).

Analysts differ on how fast Internet capacity is growing. Large telecommunication companies (AT&T, Verizon, Comcast, and Level3) argue that demand will overwhelm capacity by 2015, while other experts argue that Internet bandwidth can double every year for a very long time, and easily keep up with demand. Perhaps they're both right: Internet capacity can expand to keep up with demand if sufficient capital is invested in backbone and local networks. That's a big "if." As a result, and in order to raise capital, nearly all the large ISPs such as Comcast, Charter, Cox, and AT&T have bandwidth caps in place where heavy users of video are charged more for their Internet service. More charges based on usage are in the pipeline.

Is Internet bandwidth capacity doubling every year? The proof is in the pudding. How fast have your home or office bandwidth connections grown in the last year? Chances are, your Internet connect speed has not changed in several years. Over 1.1 million people online watched the U.S. soccer team beat Algeria in the 2010 World Cup, the largest online sports event in history. Many viewers reported dropped frames, interrupted video, and poor coordination of video and audio. On January 20, 2009, the Internet experienced an unheralded meltdown that generally escaped public notice or concern. It was the inauguration day of Barack Obama in Washington, D.C. More than 10 million people tried to watch the event on the Internet, but many were not able to view the live video feed because the Internet did not have the capacity to handle the traffic. Not only did 3 million users not receive any video, but many of the 7 million who were able to establish a connection were treated to burpy audio, freeze-frame video, and lost backgrounds. Cable and broadcast television viewers had no problem. Today you can check your bandwidth capacity by looking carefully at movies that you stream at home. On a busy Friday or Saturday night, the average Internet home viewer will experience stuttering video and sound. This is hardly the stuff of a bright future for mass audience video over the Web.

In today's broadband environment, the threshold of patience is probably much lower than even a few seconds. Increased video and audio customer expectations are bad news for anyone seeking to use the Web for delivery of high-quality multimedia content such as CD-quality music and high definition video. If you are SIRIUS/XM Radio and you want to stream online music to several million users a day, you will definitely need some help. If you are MTV and want to stream music videos to your 10 million viewers online, or Apple iTunes and want to download music or video files to your 225 million online customers, you will also need some help. Akamai is one of the Web's major helpers, and each of the preceding companies, along with most of the Web's top companies, use Akamai's services to speed the delivery of content. Akamai serves over 1 million simultaneous media streams on a typical day.

Slow-loading Web pages and Web content—from music to video—sometimes result from poor design, but more often than not, the problem stems from the underlying infrastructure of the Internet. As you have learned in this chapter, the Internet was originally developed to carry text-based e-mail messages among a relatively small group of researchers, not bandwidth-hogging graphics, sound, and video files to tens of millions of people all at once. The Internet is a collection of networks that has to pass information from one network to another. Sometimes the handoff is not smooth. Every 1,500-byte packet of information sent over the Internet must be verified by the receiving server and an acknowledgment sent to the sender. This slows down not only the distribution of content such as music, but also slows down interactive requests, such as purchases, that require the client computer to interact with an online shopping cart. Moreover, each packet may go through many different servers on its way to its final destination, multiplying by several orders of magnitude the number of acknowledgments required to move a packet from New York to San Francisco. The Internet today spends much of its time and capacity verifying packets, contributing to a problem called "latency" or delay. For this reason, a single e-mail with a 1 megabyte attached PDF file can create over 50 megabytes of Internet traffic and data storage on servers, client hard drives, and network back up drives.

Akamai (which means intelligent, clever, or "cool" in Hawaiian) Technologies was founded by Tom Leighton, an MIT professor of applied mathematics, and Daniel Lewin, an MIT grad student, with the idea of expediting Internet traffic to overcome these limitations. When Timothy Berners-Lee, founder of the World Wide Web, realized that congestion on the Internet was becoming an enormous problem, he issued a challenge to Leighton's research group to invent a better way to deliver Internet content. The result was a set of breakthrough algorithms that became the basis for Akamai. Lewin received his master's degree in electrical engineering and computer science in 1998. His master's thesis was the theoretical starting point for the company. It described storing copies of Web content such as pictures or video clips at many different locations around the Internet so that one could always retrieve a nearby copy, making Web pages load faster.

Officially launched in August 1998, Akamai's products include Digital Asset Solutions such as Akamai HD Network, which enables Web sites to deliver an online HD experience, Dynamic Site Solutions, which speed up the delivery of rich interactive content, and Application Performance Solutions, a suite of services that allows corporations to maximize their Web performance. Akamai's products allow customers to move their Web content closer to end users so a user in New York City, for instance, will be served L.L.Bean pages from the New York Metro area Akamai servers, while users of the L.L.Bean site in San Francisco will be served pages from Akamai servers in San Francisco. According to Akamai, 85% of the world's Internet users are within a single network "hop" of an Akamai server. Akamai has a wide range of large corporate and government clients: 1 out of every 3 global Fortune 500 companies, 90 of the top 100 online U.S. retailers, all branches of the U.S. military, all of the top Internet portals, all the major U.S. sports leagues, and so on. Akamai has over 95,000 computer servers on nearly 1,900 networks in 71 countries around the world. In 2011, Akamai delivers between 15% and 30% of all Web traffic, and hundreds of billions of daily Internet interactions. Other competitors in the content delivery network (CDN) industry include Blue Coat, Limelight, Savvis, and Mirror Image Internet.

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Accomplishing this seemingly simple task requires that Akamai monitor the entire Internet, locating potential sluggish areas and devising faster routes for information to travel. Frequently used portions of a client's Web site, or large video or audio files that would be difficult to send to users quickly, are stored on Akamai's 95,000 servers around the world. When a user requests a song or a video file, his or her request is redirected to an Akamai server nearby and the content served from this local server. Akamai's servers are placed in Tier 1 backbone

supplier networks, large ISPs, universities, and other networks. Akamai's software determines which server is optimum for the user and then transmits the "Akamaized" content locally. Web sites that are "Akamaized" can be delivered anywhere from 4 to 10 times as fast as non-Akamaized content. Akamai has developed a number of other business services based on its Internet savvy, including content targeting of advertising based on user location and zip code, content security, business intelligence, disaster recovery, on-demand bandwidth, and computing capacity during spikes in Internet traffic in partnership with IBM, storage, global traffic management, and streaming services. Akamai also offers a product line called Advertising Decision Solutions, which provides companies with intelligence generated by the Internet's most accurate and comprehensive knowledge base of Internet network activity. Akamai's massive server deployment and relationships with networks throughout the world enable optimal collection of geography and bandwidth-sensing information. As a result, Akamai provides a highly accurate knowledge base with worldwide coverage. Customers integrate a simple program into their Web server or application server. This program communicates with the Akamai database to retrieve the very latest information. The Akamai network of servers is constantly mapping the Internet, and at the same time, each company's software is in continual communication with the Akamai network. The result: data is always current. Advertisers can deliver ads based on country, region, city, market area, area code, county, zip code, connection type, and speed. You can see several interesting visualizations of the Internet that log basic real-time Web activity by visiting the Akamai Web site and clicking on "Data Visualizations."

As impressive as Akamai's operation has become, it is not nearly enough to cope with the next 10 years of Internet growth, which is expected to be over 100% a year. It's unclear that government authorities in the United States or elsewhere are aware of the serious imbalance between the demand for Internet services and capacity. The Obama administration has pledged to double broadband wireless Internet capacity in the next 10 years. Even if successful, the effort would be totally inadequate because Internet mobile traffic is expected to quadruple in four years. Private industry will not be able to meet Internet demands either unless it can successfully charge customers for the bandwidth they use rather than charge a flat fee for all users regardless of how much capacity they use. Proponents of "net neutrality" oppose industry demands to charge for usage, and the FTC is resisting efforts by industry to charge for usage. The proponents of net neutrality include some heavy hitters like Google, Microsoft, AOL, and Yahoo, all of whom want their customers to think the Internet is "free" no matter what is clicked on. The last thing Google wants is for users to hesitate when thinking about viewing a YouTube video because they might have to pay for the experience. In an ominous sign of the disconnect between Washington and industry, Verizon halted a $23 billion build-out of its fiber-optic network to homes (FiOS) for fear they would not be able to recover their costs unless they could charge customers for the amount of bandwidth they use. Without charging for Internet use based on bandwidth consumed by customers, Internet capacity will be overwhelmed by demand in the foreseeable future despite the efforts of firms like Akamai.

SOURCES: "Facts & Figures," Akamai.com, August 23, 2011; "The State of the Internet, 1st Quarter 2011 Report," by Akamai Technologies, Inc., July 26, 2011; "Cisco Visual Networking Index, 2010-2015," Cisco Systems, Inc., June 1, 2011; "Internet Data Caps Cometh," by Holman Jenkins, Wall Street Journal, May 11, 2011; "Wider Streets for Internet Traffic," by Anne Eisenberg, New York Times, October 9, 2010; "Google TV, Apple TV, and Roku's Biggest Enemy: A Lack of Internet Bandwidth," by Steven Vaughan-Nichols, zdnet.com, October 8, 2010; "Obama Pledges to Increase Internet Capacity," by Stephanie Kirschgassener, FT.com, June 29, 2010; "ESPN3.com's World Cup Coverage: A Bit Choppy, But There," Appscout.com, June 11, 2010.