PeerApp Case Study

University of California, Santa Barbara, Boosts Internet Video Quality and Reduces Bandwidth Costs

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Executive Summary

The residential Internet service (called "ResNet") at the University of California, Santa Barbara (UCSB), faced challenges similar to those of commercial Internet Service Providers (ISPs). ResNet's 7,500 student members were consuming a disproportionate amount of video. This was contributing to a greater than 100% year-over-year growth in bandwidth demand, as well as network congestion, quality-of-service problems, and complaints to the Help Desk. Ben Price, Manager of UCSB ResNet, demonstrated leadership in attacking the Internet video challenge by investing in carrier-grade video caching technology from PeerApp – the same technology used by many commercial ISPs worldwide. PeerApp's UltraBand solution has reduced UCSB's bandwidth consumption by 25% to 30% and improved the quality of the video experience for students. PeerApp UltraBand solutions are also being deployed in other universities, from China to the United States.

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The Santa Barbara campus is one of the 10 general campuses of the University of California system, with 19,796 undergraduate and 3054 graduate students.

Like every university today, UCSB has to compete for students. It must provide not only a superior education and research opportunities, but also a superior campus lifestyle. This includes delivering high-quality Internet service for the over 7,500 students who live in campus housing.

The Challenge

The UCSB Housing network provides broadband via a campus-wide residential Internet. Housing is provided multiple residence facilities for undergraduate and graduate students both on and off campus. All residence halls and apartments provide wireless Internet access. Access Points – APs – are connected to the main university communications and data center via Gigabit Ethernet. UCSB's residential ResNet in turn accesses the Internet via a 375Mbps link.

ResNet faced similar challenges to those of commercial Internet Service Providers: managing infrastructure and bandwidth costs and providing an excellent quality of experience (QoE). Like college students worldwide, ResNet's student members are voracious and sophisticated consumers of digital content, including video and social media. Like ISPs worldwide, ResNet was finding that video was consuming a disproportionate amount of its bandwidth. Already a significant budget item, bandwidth costs were growing rapidly.

"Increasingly students rely more heavily on the Internet for receiving video entertainment compared with traditional broadcast television, and this trend is growing at a rapid rate," explains UCSB ResNet manager Ben Price. "Our primary goal is to provide a very high quality of experience for the students. But we also need to control the fast growth of bandwidth required to support their Internet video habits. With bandwidth demand growing at greater than 100% year over year, our budget for bandwidth has had to increase proportionately."

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The situation began to reach a breaking point in 2006, when YouTube emerged as a dominant force in the delivery of streaming video content. For UCSB, network congestion became a huge problem during the 2007 Fall quarter.

Unprecedented growth in video consumption was causing additional problems. Demand was constantly exceeding planned capacity; this created network congestion, packet loss and delays, and complaints of poor performance, particularly at peak times.

Although the university was trying to keep pace with bandwidth demand, the usual response – reasonable efforts to add capacity – was no longer sufficient. Traffic would peak out during the four busiest hours of the evening. Packet loss and delays reduced the quality of students' Internet video experience, increasing students' complaints to the university's Help Desk.

ResNet's managers clearly had to find another solution. The need was particularly urgent given the UCSB Housing & Residential Services' mandate to provide an excellent broadband experience for its residents.

The Solution

In researching a solution, Price and his team identified two critical objectives: (1) control bandwidth costs and (2) provide students with a high-quality Internet service for video.

The first step the university took was to deploy a Deep Packet Inspection (DPI) device to control and shape peer-to-peer (P2P) traffic. DPI devices are effective at reducing traffic and bandwidth associated with certain applications, such as BitTorrent P2P. However, they do not provide the function of localizing popular content that enables improved delivery and a superior video quality experience. DPI also cannot control HTTP video services such as YouTube or ABC.com.

The university researched alternative and complementary solutions. In January 2009, it identified caching of video content as a possible solution.

In planning for a comprehensive assessment of a video caching solution, the UCSB team established the following criteria for success:

- Produce a minimum bandwidth of 25% of the incoming downstream traffic redirected to the cache ("In Traffic")
- Significantly improve Internet video delivery quality as measured by increased throughput data rates
- Integrate easily with current network infrastructure, including the installed DPI device

In order to support the broad video usage on campus, the solution would also need to meet the following technical requirements:

- Support for more than 30,000 concurrent HTTP session connections

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- Highly efficient HTTP video caching capability (Byte Hit Ratio, or BHR), including high-capacity storage and dynamic URL support

- "Upstream" transparency – use subscribers' IP addresses to acquire content from the Internet

- Bandwidth scalability

- Granular reporting

The university first tested a major vendor's enterprise cache solution. While proven effective in some enterprise environments, the solution did not provide the efficiency, scalability, reporting or multi-protocol support required for UCSB's demanding service-provider environment. The reason: enterprise caches are primarily designed to cache web pages, versus caching video content and large files. In addition, such solutions are not carrier-grade.

Well-known enterprise caching solutions support a minimum amount of video traffic and fail to scale to support university requirements. These solutions:

- Have inefficient HTTP video caching capacity, leading to low BHR (in part from limited storage and lack of dynamic URL support)

- Support a maximum of 12,000 concurrent HTTP session connections (whereas UCSB currently peaks at more than 30,000 sessions)

- Lack "upstream" transparency (don't use subscribers' IP addresses to acquire content from the Internet) – this creates an integration challenge with certain DPI solutions

- Lack support for P2P, such that they can't support the required number of network connections, P2P protocols, and large storage. (Not an immediate UCSB ResNet requirement as P2P traffic is currently shaped.)

- Have bandwidth-scalability limits: cannot scale beyond 200-300Mbps

- Lack granular reporting

The university ordered a PeerApp UltraBand 1000 system. The system is built on Dell hardware: PowerEdge 1950 Systems for caching engines and PowerVault MD3000i storage arrays. The system was delivered mostly preconfigured with PeerApp media caching software. University personnel performed the physical installation of the UltraBand in the ResNet Data Center. The installation required a few hours. PeerApp support personnel remotely finished the configuration in less than 30 minutes.

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The Results

The UltraBand system met all of the university's primary requirements, during the first 10 days after deployment.

- Produced 30% Cache-Out traffic. This means that 30% of the traffic as expressed in bandwidth was delivered to ResNet users from the UltraBand cache – not over the Internet. Figure 1 provides a representative description of bandwidth generation for a typical day (36-hour period) by the UltraBand.

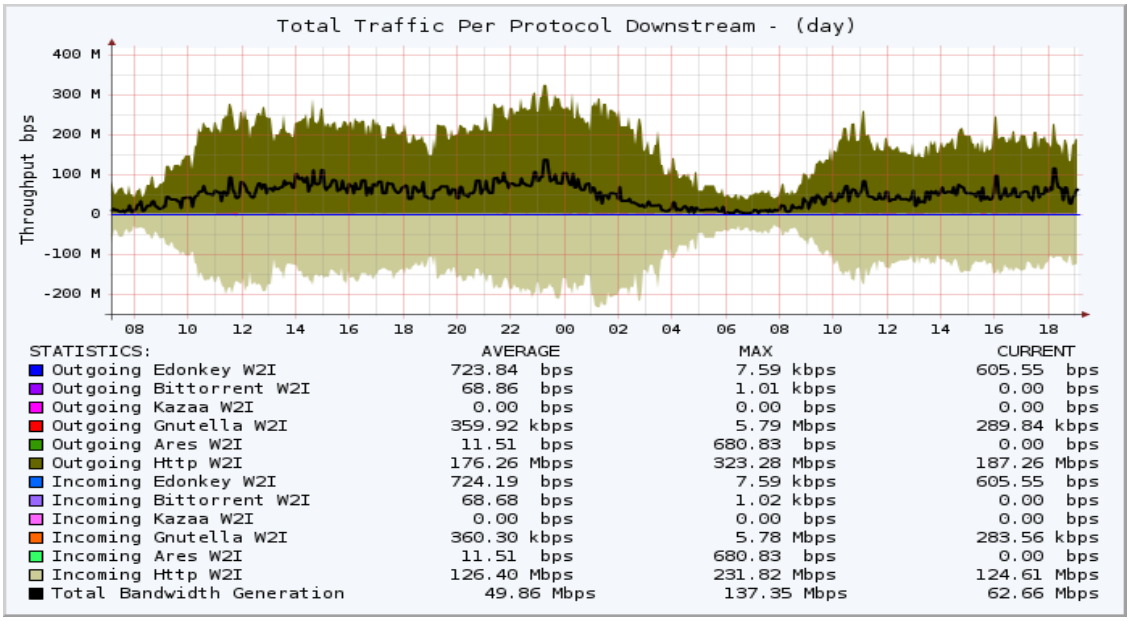

Figure 1: The UltraBand system at UCSB is generating an average of approximately 50Mbps of bandwidth (~30%), in the form of cached generated content delivered to ResNet users. At maximum or peak periods of consumption, the UltraBand is generating about 137Mbps (~43%). This graph shows that most of the content that is received and forwarded or cached by the UltraBand is HTTP – streaming of videos and downloading of files via sources such as RapidShare. Because the university uses a DPI device to shape P2P traffic, very little of that traffic makes its way to the UltraBand, reflected in the absence of any incoming P2P protocol traffic

- Accelerated the delivery of streaming video content as well as HTTP-delivered downloads by a factor of 4 to 8 times.

- UltraBand Quality of Service data revealed that the caching benefits were delivered to over 90% of ResNet users. (See Table 1.)

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Time Frame	Total IP Addresses Seen	IPs Served by Cache	Total % IPs Served by Cache
During Last 60 Minutes	3,877	1,653	42.7%
Last Day	8,285	7,018	84.7%
Since Service Started	13,062	12,238	93.4%

Table 1. The UltraBand applies a high level of intelligence to caching. As traffic passes to and through the UltraBand, the system identifies files and determines their cache-ability – whether it is worth caching for subsequent delivery. The ratio – percentage of served divided by "seen" IP addresses – reveals the degree to which the UltraBand is delivering content to the ResNet population as a whole. Today, about 94% of all ResNet users have received content from the UltraBand cache. In short: almost all ResNet users have benefitted from the UltraBand – making a strong business case for the university's investment.

Some of the key technical capabilities that the UCSB UltraBand 1000 deployment established were the following:

- Demonstrated transparent system operation: ensuring anonymity of the UltraBand 1000 within the university network, such that its IP address is not visible to students or Internet users. This also establishes that the system will never interfere with the business logic of any Internet application or service, including pay-per-click, peer ratings and conditional access provisions.

- Demonstrated complete HTTP file caching, 100% Cache-In, download speed, jump forward and backward, and HTTP QoE.

- Produced average and maximum Byte Hit Ratios of 23% and 49%, respectively. The Byte Hit Ratio (BHR) is an expression of efficiency of the cache. For example, a 49% BHR means that 49 of 100 bytes are delivered from the cache, not the Internet.

- A steadily increasing proportion of total ResNet IP addresses are recognized and served by the cache, making the caching steadily more efficient (See Table 1.)

Said Ben Price, "We were extremely impressed at how quickly the UltraBand System became fully productive – within two weeks of installation -- and the level of support PeerApp provided. In addition, the UBView reporting dashboard gives us a level of granular reporting so we now have a good sense of where traffic trends are going. As a result, we can control bandwidth allocation, fine-tune how we use caching, and examine bandwidth use anomalies. All of this has enabled us to do much smarter network planning and operations management."

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The Final Word

ResNet manager Ben Price concludes: "The UltraBand 1000 provided an immediate solution to our bandwidth-consumption and students' quality-of-experience problems. We reduced bandwidth consumption by 25% to 30%, eliminating the packet loss and video-streaming problems that were creating so many user complaints. We expect that UltraBand will continue to provide proportional bandwidth savings while ensuring an extremely high Internet video quality of experience for ResNet users."

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