White Paper

Content Delivery Networks

Broadpeak Builds No-Compromise CDN Benchmarking Tool

Using Intel® processors and DPDK, Broadpeak's CDN benchmarking tool simulates highly realistic video player behaviors and supports new protocol evolutions. Broadpeak leverages it to drive cache server development beyond 200 Gbps.

A content delivery network (CDN) depends on the performance of its cache servers for quality streaming video experiences. Benchmarking these servers is essential to ensuring an enjoyable video experience without stalls, lags, or pixelization. Despite the availability of proprietary and open source benchmarking tools, there existed an opportunity for a tool that can support new standards quickly and that can be installed easily on customer premises.

Need for Cache Performance Benchmarking

Streaming video is the main driver of the growth in internet data traffic now and will continue to be for the next few years. Both increased viewership and the expansion of HD (1,920 x 1,080 pixels) and UHD/4K (3,840 x 2,160 pixels) services are driving a significant impact on the internet. By 2022, video viewing will account for 82% of all internet traffic, according to a report by InterDigital/Futuresource.[1]

To maintain high performance and great customer experience, content providers and internet service providers (ISPs) are rapidly building out CDNs (see Figure 1). These CDNs rely on specialized cache servers optimized for video and image data. Caching provides fast data transfer, which reduces the latency and improves the viewing experience.

CDN caching servers are a fast-changing technology with rapid evolution of streaming protocols. To keep up with this growth and innovation, CDN software providers and their customers need to benchmark and load test their products using the latest protocols. Benchmarking CDN cache servers includes evaluating HTTP server performance and correctness with as little bias as possible. This requires players built into the benchmarking system that behave as closely as possible to real players in use by consumers. For example, when streaming videos, all players will attempt to obtain the newest video segment as soon as it becomes available. Thus, players tend to synchronize implicitly and will collectively generate pulses of traffic for the most popular channels, especially with the latest low-latency variants of streaming protocols. In addition, if the server is slightly late, players will have depleted their buffer and will react by requesting additional video content more quickly, thus increasing the load on the server. Benchmarking realistic correctness under heavy loads means emulating correctly this subtle behavior.

Test System Status Quo and Challenges

There is no shortage of benchmarking systems available for HTTP servers, but none has the optimal feature set and form factor for benchmarking cache servers in production or in the deployment in the network of an ISP or content provider.

Prominent commercial providers of network load benchmarking equipment provide versatile appliances that can support L3-L7 traffic generation for benchmarking purposes with extensions for supporting adaptive bit rate (ABR) client emulation like HTTP live streaming (HLS), or Dynamic Adaptive Streaming over HTTP (DASH).

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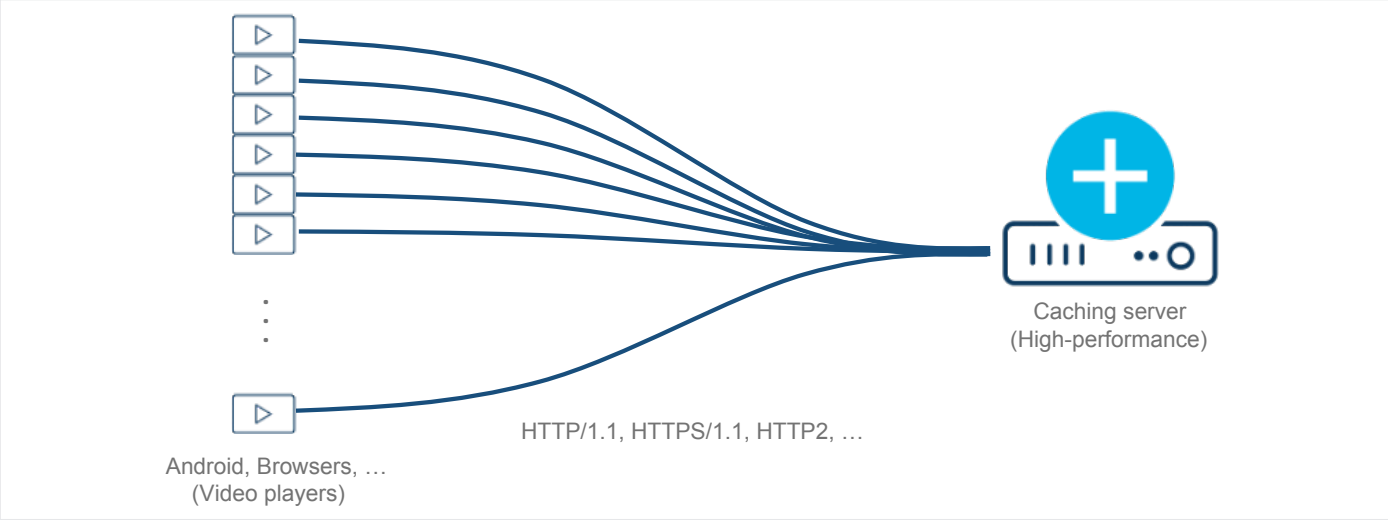

Figure 1. Caching server distributes video content to viewers who use a wide range of devices to access the content.

However, these systems have two main limitations for the caching servers today. First, they are based on a proprietary appliance design, which drives up the costs and cannot be installed in customer premises as easily as software running on a COTS server. This limits their use for benchmarking a server in a customer lab or network. Second, the complexity and closed nature of these appliances makes it a challenge to quickly rollout support for the latest evolutions in the HTTP or ABR protocols to support benchmarking of evolutions as soon as they are specified.

There are a number of open source HTTP server benchmarking tools that provide a great solution for basic benchmarking of an HTTP server, including simple URL deduction and request scheduling rules. But this category of tools does not yet have the ability to reflect real end-user video player behavior. Thus, relying solely on HTTP test results can lead to unexpected performance issues when the server is deployed in a real production environment.

There is also open source web application load benchmarking software that is scriptable for added functionality. But these tools don't always support ABR traffic and require the testing organization to provide its own player software. In addition, this software is optimized for web applications generally and not CDNs specifically, so the throughput performance is in the range of 10 Gbps to 40 Gbps, which is less than needed for CDN applications that can reach up to 100 Gbps.

Lastly there is an open source sub-category of tools based on the open source Data Plane Development Kit (DPDK) libraries that have additional TCP and basic HTTP capabilities that are sufficient for basic benchmarking of web servers or traffic inspection. But these programs also suffer from a lack of player capability for real workload evaluation.

This growth in internet video and the evolution of the standards are driving a need for a new category of benchmarking tools that are portable and easily updateable and that run on commercial off-the-shelf (COTS) servers. Broadpeak, an Intel® Network Builders ecosystem partner, built its own benchmarking tool on Intel architecture servers to support its large-scale CDN development and customer deployments.

Broadpeak Builds a New Benchmarking Tool

Broadpeak has developed the benchmarking tool to support its main business of developing video delivery systems for content providers and network service providers deploying OTT/IP video services on fiber, cable, satellite, or mobile networks. The company's CDN product is for large content providers and ISPs, enabling them to deliver high quality video to a global audience.

The benchmarking tool development team set out to develop a software-based tool for benchmarking and load testing the Broadpeak CDN server. Up to now, Broadpeak has used the tool in three main use cases:

- Internal testing: The tool delivers ample performance for HTTPS/1.1 and HTTP/2 server benchmarking. The easy upgradability of the tool means it can support the latest protocols that are being developed for CDN servers. For example, the team was the first to market with support for low latency HTTP live streaming (LL-HLS) and low latency dynamic adaptive streaming over HTTP (LL-DASH). The use of COTS servers means the software can more easily be distributed to workers in a lab to remove the bottleneck of access to a limited number of dedicated shared appliances. The tool will be useful to develop the optimizations necessary to stream beyond 200 Gbps.
- Hardware partner testing: The company can also share the tool with hardware providers for evaluation of new hardware. In this application, a minimum of only two servers are needed to run the benchmarking tool. The tests can be automated and can be performed remotely.
- Customer lab testing: Lastly the tool has been used in customer labs to tune and deploy the Broadpeak CDN infrastructure. Many labs have unused servers that could be temporarily turned into test platforms using their software. The use of these available servers provided the portability that would eliminate some of the obstacles that make it much more difficult to get a high-performance tool into a customer or partner lab. In addition to standard performance tests, the tool can also be used to verify the specific customer topology and configuration.

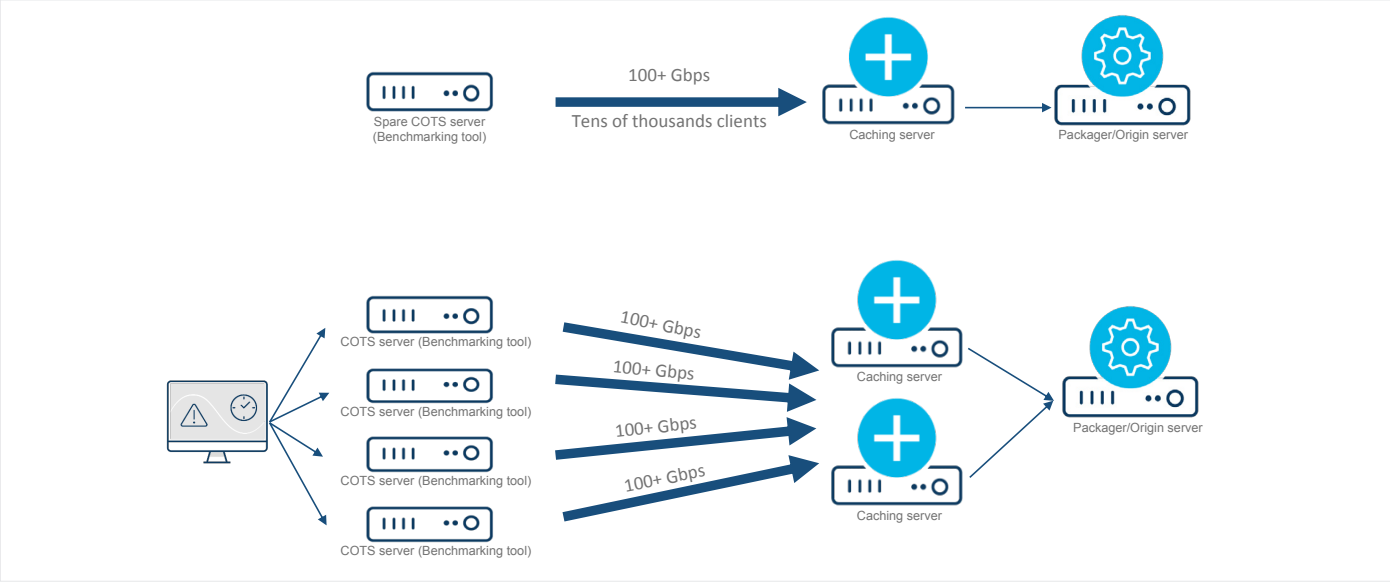

Figure 2. CDN server benchmarking topology.

Test Tool Architecture and Development

Being pure software, the tool can run on any spare server, allowing cost-effective benchmarking and avoiding the need to invest in dedicated hardware for temporary needs. A single instance of the benchmarking tool running on a COTS server can support tens of thousands of concurrent clients and more than 100 Gbps of throughput.[2] The tool can also be run in a distributed setting to benefit from the processing power of multiple COTS servers to benchmark high-capacity servers or more complete systems.

The software was designed using Seastar, an open source framework for high performance server applications. Seastar is designed for I/O-intensive applications and can leverage DPDK for improved networking performance. The combination of DPDK and Seastar is ideal for this network I/O intensive benchmarking application.

The Broadpeak tool integrates a full-featured HTTP stack, with full protocol conformance, that is bound to DPDK libraries for avoiding overhead related to CPU context switches. The CDN cache servers being tested are network I/O intensive and the use of DPDK provides more performance and more benchmarking capabilities for a given server.

The benchmark tool borrows code from Chromium to offer highly realistic support HTTP/1.1, HTTPS/1.1, HTTP/2 and HTTP/3. In addition, it has a broad feature set to match real browser-based client and players such as comprehensive compression support, browser-like connection pooling, and scheduling. This allows the tool to better reflect the impact real clients would have on the system.

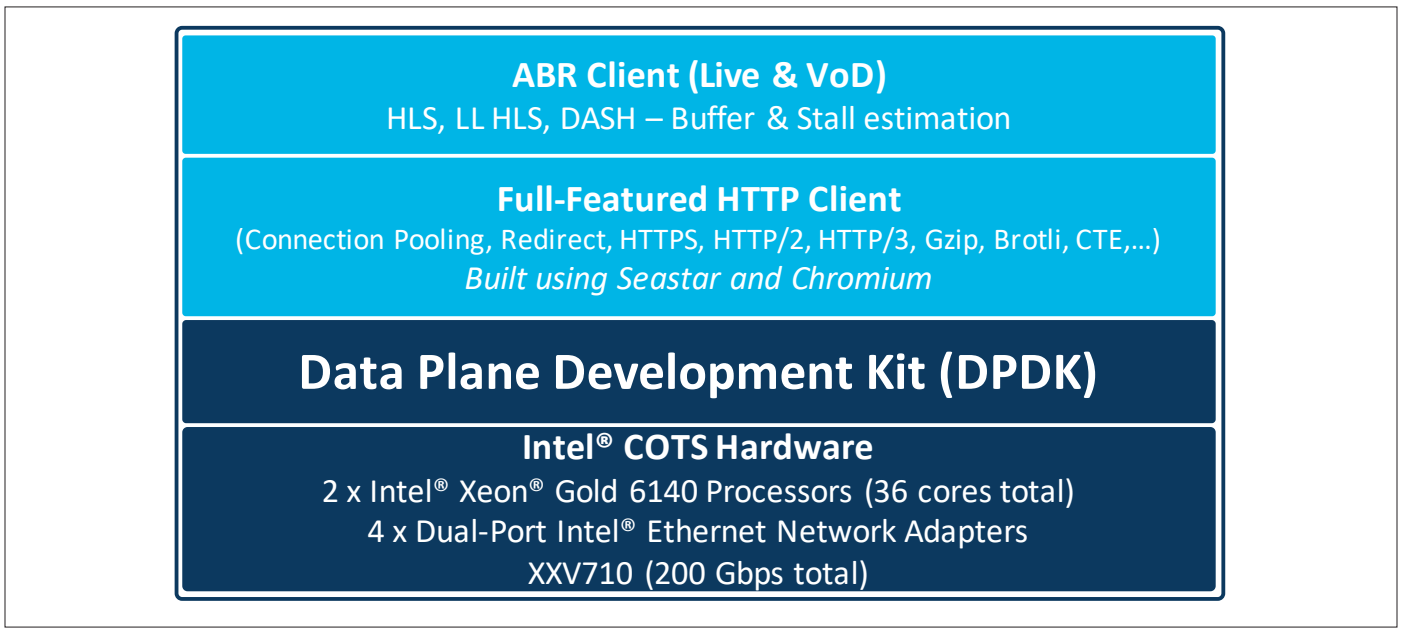

Figure 3. Broadpeak benchmark system technology stack.

The full-featured HTTP stack is combined with ABR clients that behave very similarly to browser-based players based on player simulators such as Dash.JS or Shaka. The player computes video-related metrics such as buffer-levels, stalls, and others in order to better report the impact of performance issues on quality of experience.

Intel Development Environment

The tool was developed using the Intel Network Builders' Secure DevCloud, which provides access to powerful servers based on Intel® Xeon® Scalable and Intel Xeon D processors for edge compute and NFV application development. Broadpeak had access to a server based on dual 18-core Intel Xeon Gold 6140 processors operating at 2.3 GHz. When using the server at a customer premises Broadpeak has run the software on servers based on dual Intel Xeon Gold 5218 processors, each with 16 cores running at 2.3 GHz. This shows the flexibility of the tool to operate in a wide range of COTS environments.

The Secure DevCloud service also provided Broadpeak with debugging and back end systems as well as high-bandwidth security-enhanced connectivity. The Intel lab team was available to Broadpeak for onboarding, trouble shooting, testing, and optimization.

The Secure DevCloud configuration used four dual-port 25 GbE Intel® Ethernet Converged Network Adapters XXV710, supporting 200 Gbps throughput per server. Broadpeak used that bandwidth to improve the scaling of the benchmarking tool from 20 Gbps to 170 Gbps by improving the software code to remove unnecessary locks, implement zero-copy optimizations, and reduce context switching through refining the implementation of DPDK.[3] To drive these optimizations, the team benefited from the bare metal access to the server with support for last branch record (LBR), a unique feature for Intel architecture processors that allows performance profiling.

Conclusion

Broadpeak's CDN cache server benchmarking tool allows the company to benchmark its CDN server software will operate at high levels of performance with support for the latest HTTP protocols. To differentiate the tool from other options on the market, Broadpeak worked to incorporate correctness and realism. To accomplish this, and get great performance, Broadpeak built its tool using advanced techniques and open source tools including Seastar and DPDK.

With the rapid expected growth of streaming video, the standards and technologies will continue to evolve. With this flexible benchmark tool, Broadpeak can stay one step ahead, offering a more robust and efficient CDN product to its customers, while delivering the best video experience to the end-consumers.

Learn More

Broadpeak video CDN services

For more information on Broadpeak's CDN cache server benchmarking tool, contact yann.begassat@broadpeak.tv

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Seastar

Notices & Disclaimers

[1] https://www.streamingmedia.com/Articles/ReadArticle.aspx?ArticleID=144177

[2] Testing conducted by Broadpeak in October 2020. Server configuration included dual Intel® Xeon® Gold 6140 processors (microcode 0x2006906) with Intel® Hyper-Threading Technology turned on. BIOS version was SE5C620.86B.02.01.0011.032620200659. System memory was 196 GB DDR storage. Network connectivity was provided by four dual-port Intel® Ethernet Converged Network Adapters XXV710. OS was Ubuntu 20.04 LTS and application was DPDK (19.06). CDN stack used consists of Broadpeak Origin Server (BkS350) and Streaming Server (Bks400). The benchmarking tool was running as bare-metal.

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