White Paper

Content Delivery Networks

Broadpeak Sets New Performance Standard for Streaming with BkS450

Using 3rd Gen Intel® Xeon® Scalable Processors, Broadpeak breaks 600 Gbps throughput level with energy efficiency of up to 1 Gbps per watt; tests also showed streaming up to 330,000 simulated users with 1.6mW per user power consumption

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1. Introduction

The video streaming revolution is underway. With the decline of legacy broadcast systems[1] in favor of HTTP-based adaptive bitrate (ABR) technologies, the many launches of new OTT streaming services and platforms every year, and the change in user consumption habits, content delivery networks (CDNs) need to evolve to withstand the explosion in streaming traffic.

Video service providers need a CDN capable of delivering higher throughput with denser configurations at controllable costs, while consuming less energy. The latter has been an increasing concern due to cost of energy, to companies' own corporate social responsibility (CSR) ambitions and emerging regulation in that field. Deploying energy efficient streaming solutions has become among the top priorities of video service providers.

To meet this need, Broadpeak, working together with industry leader Intel, launched in December 2022[2] its new BkS450 software, a modern HTTP(S) engine dedicated to streaming and caching applications. BkS450 has been designed to fully exploit latest generation hardware and make use of numerous software optimizations. It aims to set new standards for performance and energy-efficiency, providing a solution with numerous benefits for the media streaming industry and the environmental issues facing the industry.

In tests detailed in this paper, the BkS450 sets two new records:

- As presented in Section 2.1, using typical benchmarking workloads[3], BKS450 achieves up to 600 Gbps of HTTPS streaming with up to 1.04 Gbps/W efficiency, using a mainstream server equipped with two Intel® Xeon® Gold 5318Y processors; throughput and power-efficiency is excellent even under high concurrency, up to one million simultaneous connections.
- As detailed in Section 2.2, BKS450 is also able to achieve power efficiency as low as 1.6mW per user on the same hardware. These results used a workload generated by hundreds of thousands of concurrent sessions from real video players.

2. New Records in Video Streaming Performance

Running on a server equipped with two Intel® Xeon® Gold 5318U Processors featuring NUMA-balanced PCIe for both networking and NVMe, Broadpeak's BkS450 video streaming software has proven that it can dramatically improve throughput performance and reduce energy consumption for video delivery.

Broadpeak has invested over the last year in a full-featured benchmarking tool, resulting from a collaboration with Intel[4]. This tool can generate various kinds of realistic, high-concurrency traffic patterns with a very high efficiency, making it easy to repeat benchmarks: this allows Broadpeak to run benchmarks during the development phase in order to deliver highly optimized and efficient software.

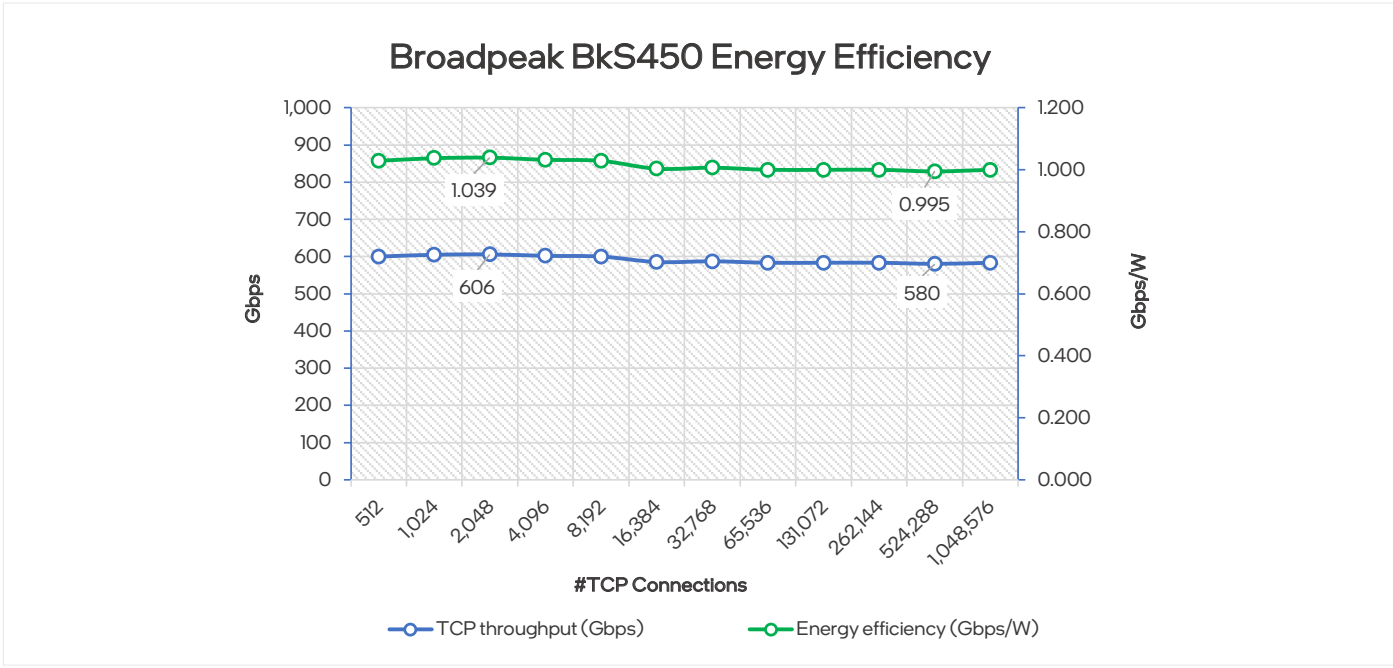

Figure 1. Raw throughput and power-efficiency performance of Broadpeak BkS450.

2.1. Throughput and Energy-Efficiency Performance

Typical raw HTTPS workloads were reproduced for the evaluation[3]. Usually, tests are based on 10,000 to 50,000 concurrent sessions; however, Broadpeak's benchmarking tool measured up to 1 million concurrent TCP connections (see Figure 1) - demonstrating that BkS450 software is tested for realistic, high-concurrency traffic patterns.

On a server consuming 583 watts (W), the raw network throughput (and resulting power-efficiency) is sustained from 512 TCP connections up to 1 million TCP connections, achieving 600 Gbps (1.04 Gbps/W) with low connection number and 580 Gbps (0.98 Gbps/W) with a challenging, high simultaneously active connection count.

In all tested TCP connection levels, BkS450 performs with low variability in throughput and energy consumption, as can be seen in the results obtained with a dual processor 24 core Intel Xeon based server.

This performance is improved by a factor of four[2] compared with Broadpeak's previous generation of streaming software running on comparable hardware.

2.2. Streaming Energy-Efficiency Per User with Real Video Players

To measure the energy-efficiency in real deployments and be closer to business needs, a new metric is introduced: the streaming server consumed power per supported user.

This metric measured in Watts (W) depicts the average contribution of one streaming session to the server power consumption. The number corresponds to the total server power consumption divided by the total number of users, i.e., the number of video clients served by that server.

Simulating real video players in high-concurrency conditions requires an efficient testing tool. Video clients supporting HTTP Live Streaming (HLS) and Dynamic Adaptive Streaming over HTTP (DASH) produce very specific workloads that can be easily mis-generated:

- Live video streaming workloads generate a large number of requests over a very small subset of objects distributed sparsely in time.
- Video clients tend to synchronize and send their requests at the exact same time, when new content is available, which produces large spikes in traffic and very skewed object popularity.

Broadpeak's versatile benchmarking tool takes these factors into account. It can run numerous concurrent HLS or DASH video clients and generate ultra-realistic traffic that emulates a production live video streaming environment.

BkS450 shows low energy consumption for a wide range of use cases (see Figure 2), ranging from typical 0.8 Mbps mobile streaming with 1.6mW per user to fixed residential 20 Mbps UHD streaming with only 19mW per user.

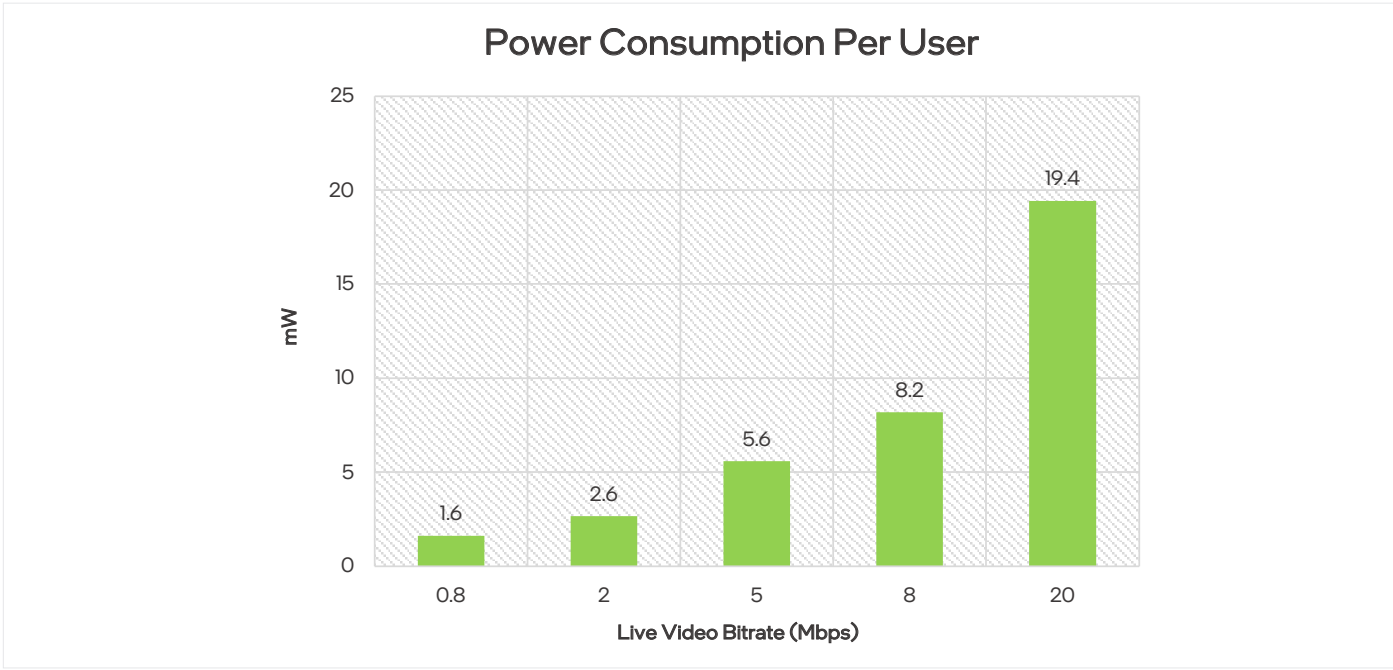

Figure 2. BkS450's average power consumption per user.

According to our tests, the BkS450 is capable of handling more than 1 million concurrent TCP connections fairly, allowing it to serve very large numbers of concurrent users without any playback issues - up to 350,000 simulated users with realistic video live workloads. Obviously, the higher the bitrate, the more throughput and the more energy per user (see Table 1). This shows that the BkS450 is the perfect complement to other efforts in the industry to reduce the impact of streaming. For instance, leveraging newer codecs with better compression ratios allows a CDN operator to reduce the bitrate per user and thus fit more users per server.

Notably, pure Gbps/W numbers disregard the optimal setup for per-user power consumption: the optimal setup is not to take the setup achieving the highest throughput, but it's to take the most efficient compression together with an efficient server that supports very high concurrency settings so as to serve as many users as possible from a single server.

Video Bit RateBitrate	0.8 Mbps	2 Mbps	5 Mbps	8 Mbps	20 Mbps
TCP Throughput	280 Gbps	435 Gbps	531 Gbps	575 Gbps	595 Gbps
Number of Concurrent Users	350 000	220 000	104 333	71 333	30 000
Power Consumption	560 W	583 W	583 W	583 W	583 W
Power Utilization Per User	1.6 mW	2.6 mW	5.6 mW	8.2 mW	19.4 mW
Energy Efficiency	0.50 Gbps/W	0.75 Gbps/W	0.91 Gbps/W	0.99 Gbps/W	1.02 Gbps/W

Table 1. BkS450's capacity and energy-consumption.

3. Technology Drivers

The design of the BkS450 makes the software genuinely unique, high performance and sustainable.

The design of the BkS450 makes efficient use of the hardware potential – including CPU capabilities and the latest operating system (OS) features. The software also has a fully redesigned and modern HTTP(S) stack, enabling it to deliver higher throughput with four times less energy consumed per gigabit than the previous generation of streaming server[2].

The following are the key Intel technological drivers behind this performance and power achievement:

3rd Gen Intel® Xeon® Scalable Processors with Intel® Data Direct I/O Technology (Intel® DDIO)

To achieve these results, the tests exploit features in Intel Xeon Scalable processor-based servers to run both the benchmarking tool (receive-heavy workload) and the HTTP caching server (send-heavy workload). Both achieve excellent performance on Intel Xeon Scalable processors thanks to the highly optimized I/O handling with hardware mechanisms such as Intel® Direct Cache Access (Intel® DCA) / Intel® Data Direct I/O Technology (Intel® DDIO) and efficient caching management for network I/O traffic.

Intel DDIO can be used to reduce the memory bandwidth and reduce latency required for a given network throughput, bypassing main memory and instead using cache directly. Workloads such as video streaming can consume significant memory bandwidth under load, and memory bandwidth savings from the network transmit path can instead be spent on additional overall CDN cache node throughput.

3rd Gen Xeon Scalable processors feature up to 64 lanes of PCI Express Gen 4 per socket to enable higher I/O bandwidth per core. The server tested also utilized a balanced, efficient architecture for the I/O performance that can be used for video streaming applications. The CPU also features up to three Intel® Ultra Path Interconnect (Intel® UPI) channels that improves inter-CPU bandwidth for I/O-intensive workloads and offers an agile balance between improved throughput and energy efficiency.

Intel Xeon Scalable Processors with Intel® Crypto Acceleration

To sustain high throughput HTTPS traffic, the BkS450 software is heavily optimized to leverage all processor features and notably uses state-of-the art cryptographic implementation based on Intel® Advanced Vector Extensions 512 (Intel® AVX-512) and Vector AES extensions. To this end, the BkS450 leverages Intel cryptographic libraries such as ISA-L and IPPCP. A high efficiency crypto implementation helps to reduce the amount of processing required for a given network throughput or connection density, which helps when designing a CDN server with cost and power consumption in mind.

Profiling Capabilities

The development of the Broadpeak benchmarking tool and caching server have leveraged access to Intel® Network Builders Testbed. The development methodology is based on continuous full-scale benchmarking, integrated early in the development phase and enabled by Broadpeak's investment in benchmarking platforms and high-performance benchmarking tools.

Broadpeak has been making heavy and systematic use of profiling tools and capabilities enabled by Intel's support for LBR (Last Branch Recording, IBPS, PMON tools), Intel PMC tools, etc. The profiles obtained have been driving development and optimization work done by Broadpeak.

4. Benefits of Broadpeak's New High-Performance BkS450

New Services Delivered with Higher Energy-Efficiency and Reliability

Broadpeak BkS450 enables video service providers to deliver low-latency 4K and 8K video streaming services, VR content, and other bandwidth-intensive offerings at a reduced cost while consuming significantly less power than traditional video servers. The outstanding throughput performance obtained should also give lots of confidence to video service providers about the capability of BkS450 to sustain typical 150-300 Gbps throughputs from a single server even in presence of unexpected workload variations.

Density and Better Use of Resources

Moreover, BkS450 features a high-density design that saves crucial space in data centers. Built with a new caching software engine, BkS450 also extracts maximum performance from relatively modest and cost-effective hardware configurations, including existing CDN deployments. This innovation unlocks CDN capacity across the board while enabling better use of resources.

Immediate Energy-Efficiency Gain for Most Service Providers

Of course, technology cannot be truly sustainable if it is accessible only to the biggest tier-1 operators. If equipment is not available to most integrators, then it can be considered a futuristic solution that may have a significant impact in several years but not immediately. However, Broadpeak's BkS450 is actionable and easy to implement today at any size of point of presence (PoP).

BkS450 is based on highly optimized software running on well-configured standard servers and does not rely upon added-cost accelerators or proprietary hardware. By leveraging mainstream processors that are broadly available at a cost-effective price, the BkS450 makes high performance and energy-efficient streaming accessible to most video service providers.

3. Conclusion

Broadpeak's BkS450 addresses the critical challenge of reducing energy consumption while operating at high levels of performance. The software allows video service providers to deliver high-quality video experiences to end-viewers both rigorously and efficiently, keeping them one step ahead of a constantly evolving video streaming ecosystem.

Additionally, by being tested in realistic, high-concurrency environments, BkS450 allows providers to withstand changes to industry standards and technologies, end-user expectations, avoid over-provisioning of capacity, and avoid premature obsolescence of equipment.

Collaboration is key for technological advances, and Broadpeak's solution is successful in part because of Intel's support. By expertly combining high-performance software and hardware, Broadpeak's BkS450 demonstrates the power of software optimized for Intel Xeon Scalable processors without being dependent upon added-cost accelerators or single-source components.

New performance standards have been established with energy efficiency up to 1.04 Gbps/W and power consumption as low as 1.6mW/user for video streaming applications on mainstream servers.

Going forward, Broadpeak will continue to work together with industry partners like Intel, to push performance and efficiency higher and the performance-per-Watt envelope toward a more sustainable future for the rapidly growing media streaming market. In the near future, PCIe Gen5-supported platforms based on Intel Xeon Scalable processors will be tested. This is just the beginning of the journey.

Learn More

Broadpeak homepage

Broadpeak Advanced CDN

3rd Gen Intel® Xeon® Scalable Processors

Intel® Network Builders

[1] Digital Terrestrial TV (DTT), cable TV, IPTV, Direct-to-Home (DTH) satellite TV
[2] https://broadpeak.tv/newsroom/video-streaming-at-725-gbps-with-new-bks450/
[3] synthetic live-linear workload that randomly picks fixed-size 1MB objects with a cache 100% hit-ratio
[4] https://networkbuilders.intel.com/solutionslibrary/broadpeak-builds-no-compromise-cdn-benchmarking-tool

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