(intel)

Broadcast-Quality, High-Density HEVC Encoding with Intel® Xeon® Scalable Processors

The Beamr 5* HEVC encoder and Intel® Xeon® Scalable processors enable a dual-socket system to encode up to six simultaneous 4Kp60 HDR 10-bit video streams for real-time broadcast operations, compared to encoding a single stream on previous systems.[1]

Beamr 5*, a high-performance software encoder, delivers real-time HDR and SDR HEVC broadcast-quality encodings. Using the Intel® Xeon® Platinum 8180 processor, the encoder provides up to 72 percent better performance than the previous generation Intel® Xeon® processor E5-2699 v4.[2]

- Achieve up to 2x HEVC real-time encoding density[2]

- Increase video quality without loss of throughput

- Deliver complex workflows in less time, with less equipment

Executive Summary

Consumer Video-on-Demand (VoD) traffic will nearly double by 2021.[3] New services and video formats such as Cloud DVR, Ultra-High Definition (UHD), High Dynamic Range (HDR), High Efficiency Video Coding (HEVC), and immersive video experiences have become mandatory attributes of leading-edge services and key differentiators in the competition for subscribers. Connected devices are becoming more capable, with 4K UHD now available on smartphones displays and cameras.

These trends all drive up the volume of massive casual video uploads and entertainment and social video downloads. Other less visible influences are the increased complexity of video delivery due to network impacts and the thousands of encoding and delivery format permutations. The demand for services is ever increasing, with content costs rising while customer revenue is under pressure from competition and the loss of subscribers due to cord cutting.

It is essential for operators to invest in video processing infrastructures that can provide advanced services, are inherently cost effective, and have a flexible architecture that supports changing service delivery requirements. The Beamr 5 HEVC software encoder and the new Intel® Xeon® Scalable processors provide the essential tools to meet these requirements.

Game-Changing Performance

Before now, the words "performance," "HEVC," and "software encoder" were largely incompatible with each other. The new Beamr 5 HEVC software encoder, taking advantage of several key features of the new Intel Xeon Scalable processor, delivers high quality, density, performance, and flexibility in a simple to use, simple to deploy software component. On a dual-socket Intel® Xeon® Platinum 8180 processor-based system, Beamr 5 can encode six channels of 4Kp60 HDR 10-bit video at a quality level suitable for live linear and real-time distribution of premium content.

Greater performance fundamentally drives down operating and capital costs of video distribution applications. For real-time operations that require performance at the highest resolutions, frame rates, and bitrates called for by their content and service-level agreements, greater performance means less equipment is required. Fewer chassis means fewer racks, lower power usage, and reduced cooling costs, as well as reduced requirements for tech support and software licenses.

VoD applications that operate offline also benefit from increased performance. The shorter wall-clock time to complete VoD transcodes means that fewer operator shifts are needed. Conversely, more work can be accomplished in one shift, and content is delivered to customers sooner. Post-production houses particularly treasure these capabilities.

New Levels of Flexibility

Beamr 5 opens up a wide range of options for multiple-system operators, content delivery networks, and broadcasters to tailor their video distribution architectures to suit their investment plans and technical service goals. Beamr 5 enables them to deploy their media workflows across any combination of public clouds and on-premises data centers, as well as utilize the entire range of Intel® Xeon® processors from the entry-level Intel® Xeon® processor E3 v5 product family to the Intel Xeon Platinum 8180 processor.

Workflows based on Beamr 5 can start out on a public cloud for VoD file transcoding and real-time transcoding for live TV, and may be migrated to private data centers for premium, secure content. Beamr 5's flexibility and power enables operators to take advantage of current pricing trends in public cloud services today, yet retain the practical leverage to negotiate other deployment options, without being locked in to a single service provider.

Beamr 5-based workflows can be re-architected from cloud data center applications to run as edge services on Intel® Xeon® processor E3 family-based points of presence or head ends for just-in-time transcoding for last-mile delivery. The high performance of Beamr 5 directly enables workflows to be split and redeployed without the need to redesign workflows. Beamr 5 also provides attractive content flexibility. Operators can configure workflows dynamically to operate at any quality preset level, with any input resolution, select 8-bit SDR video or 10-bit HDR video, and specify one or up to four outputs from that input.

Beamr Next-Generation Video Encoding Technology

The technology at the foundation of Beamr's HEVC Encoder spans years of codec development. The combination of Beamr software and Intel® processor-based hardware delivers business benefits that position providers for the successful delivery of next-generation video, as summarized in Figure 2. As architects design in the ability to offer more demanding content formats, running the Beamr 5 4K HEVC encoder on the Intel Xeon Platinum 8180 processor improves density as much as 1.72x[2] compared to predecessor platforms. The performance that allows for greater density also accelerates encoding speed, further reducing the amount of compute resources needed to encode a given amount of content. Ongoing improvements jointly from Beamr and Intel contribute further to the ongoing value proposition of this solution.
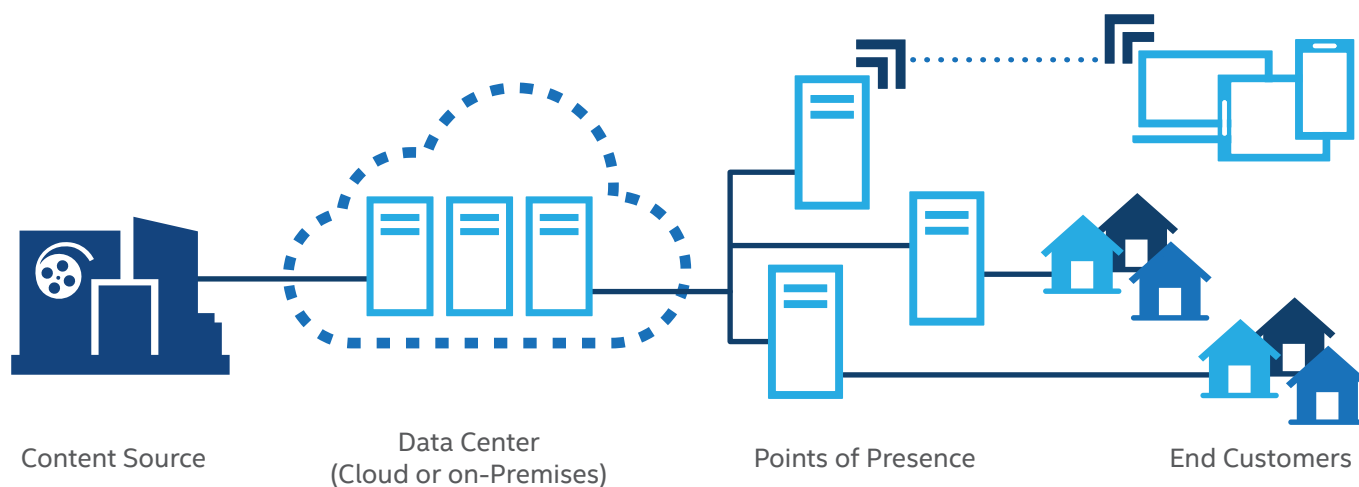

Figure 1. On-demand distribution of prerecorded video, from studio to end customer.

DENSITY	EFFICIENCY	QUALITY	FLEXIBILITY
Encode 2x as many HDR 10-bit 2160p60 streams per socket[2]	Process complex workflows in less time, with less equipment	Deploy more intensive presets without loss of throughput	Deliver multiple output resolutions and bitrates from a single input

Figure 2. Benefits of the Beamr 5* 4K HEVC encoder on Intel® Xeon® Scalable processors.

Performance

The business benefits associated with improved density, efficiency, and quality all depend on the common foundation of high performance enabled by the combination of the Beamr 5 HEVC codec and Intel Xeon Scalable processors. To quantify the performance benefit, Beamr tested its software on servers based on high-end SKUs from this generation of processors versus its predecessor; the results are shown in Figure 3.[2]
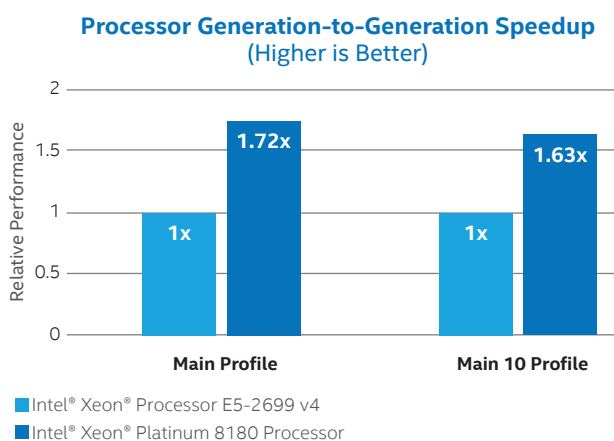
Processor Generation-to-Generation Speedup
(Higher is Better)

■ Intel® Xeon® Processor E5-2699 v4
■ Intel® Xeon® Platinum 8180 Processor

Figure 3. Beamr 5* 4K HEVC encoder increased performance with the Intel® Xeon® Platinum 8180 processor.[2]

Beamr 5 achieves its high performance primarily by focusing on two aspects of encoding: two-level motion estimation and micro-level parallelization. Incoming frames are extensively analyzed by the encoder, which determines the complexity of the scene, calculates the rough motion vectors, and estimates the bit demand of the encoded frame. The estimates guide the second stage of the encoder and allow those activities to focus on the meaningful aspects of each frame to refine the previous estimates. By partitioning the encoding process, unproductive calculations can be avoided.

Beamr 5 builds on software engineering lessons learned from earlier generations of real-time software encoders, which led to the design of a micro-level parallelization technology that stages portions of the encoding tasks in a controlled manner, staggering their execution such that each micro task starts when its data becomes available, still in the cache, so as not to waste power and CPU cycles writing out and then fetching the data from memory. Careful design of the micro tasks assures that they can execute efficiently across the whole frame, in an even manner so that all cores are kept uniformly busy and none are left waiting unnecessarily for their next task.

The Beamr encoder does not rely on the OS to manage these critical execution threads. It controls their execution based on availability of pipelined data. These techniques allow the encoder to deliver outstanding quality while utilizing all the available cores efficiently. For example, Beamr was able to encode six (6) 4Kp60 10-bit channels on a dual-socket system based on Intel Xeon Platinum 8180 processors.[1] In that process, the Beamr 5 encoder loaded every one of 108 (from 112 available) threads at 90 percent or higher utilization, demonstrating the effectiveness of the task parallelization.

Intel® Xeon® Scalable Processor Performance Advantage

Built using 14-nanometer process technology, Intel Xeon Scalable processors represent the most significant set of platform improvements in a decade. A completely redesigned architecture delivers more throughput per execution core.[4] Hardware parallelism is significantly increased, with 28 cores per socket in the newer processor compared to 22 in the baseline platform used in this testing, which contributes to a 1.72x increase in encode density,[2] allowing this new processor to deliver more video processing than predecessors at lower power consumption per channel.

Performance contributors of the Intel Xeon Scalable processors include the following:

• **High core count** with efficient thread management maximizes utilization of CPU cycles for production.

• **More and faster memory channels** (six versus four in the previous generation)[4] significantly increase the memory throughput that is one of the main performance factors for video workloads.

• **A large, low-latency L1/L2 cache hierarchy** improves the efficiency of on-die data handling, supporting memory-intensive video workloads.

• **Support for high-speed memory** (DDR4-2666, compared to DDR4-2400 in the predecessor platform under test) increases data throughput.[4]

• **Mesh interconnect between cores** enables fewer hops and lower latency data movement between cores and sockets, compared to predecessor ring topologies.

While the performance results discussed here use the Intel Xeon Platinum 8180 processor, Intel Xeon Scalable processors with the same-generation architecture are available in a range of feature configurations, including low-power SKUs that are suitable for blade form factors. Processor core counts range from four (4) to 28 per socket.

Transcoding Considerations

The applications described in this brief accept input video at a relatively high bitrate from the backbone and then transcode it for delivery to viewers, as illustrated in Figure 4. Such applications need to integrate multiple components, among them a video decoder and the video encoder. The video encoder is the critical component in the system, because it consumes the most CPU cycles, and this brief is focused on the Beamr 5 HEVC Video Encoder. Other video processing elements to consider include the following:

• Beamr 5 software HEVC decoder capable of handling HEVC inputs up to 120 Mbps

• Beamr 4 software AVC encoder capable of encoding AVC HDR and SDR video up to 4K

• Beamr 4 software AVC decoder capable of handling AVC inputs up to 120 Mbps

With these elements, it is possible to build responsive transcoding solutions to execute on Intel Xeon Scalable processors, organized as FFmpeg modules or managed via direct APIs.

Conclusion

Today, video comprises the bulk of Internet traffic as video-based applications are increasing in number and complexity. At the same time, users are contributing ever more video at larger file sizes as camera resolutions on mobile devices are now reaching beyond 1080p to 4K. For this reason, the need to store, track, transcode, and deliver these video assets is increasing rapidly, which places pressure on operators as they compete to preserve and expand their subscriber base by offering interesting video applications with a smooth, responsive viewing experience.

The drive to increase density in transcoding infrastructure is central to securing competitive advantage for multi-service providers, over-the-top (OTT) providers, and content distribution networks. At the same time, video system architects must enable the delivery of new types of advanced entertainment content, by embracing HEVC, HDR, and 4K. This tuned solution stack enhances the density, efficiency, quality, and flexibility of video-encoding operations in on-premises, cloud, and hybrid data centers, giving service providers the ability to build capabilities for tough current demands while positioning themselves for agile response to challenges in the years to come.

The Beamr 5 4K HEVC Encoder running on Intel Xeon Scalable processors offers a robust, forward-looking approach to solving this set of technical and business needs, while the TCO benefits that this combination brings to the market will provide a meaningful improvement to the video processing capabilities of any content management and distribution solution.

Find the solution that is right for your organization. Contact your Intel representative or visit intel.com/xeonscalable.
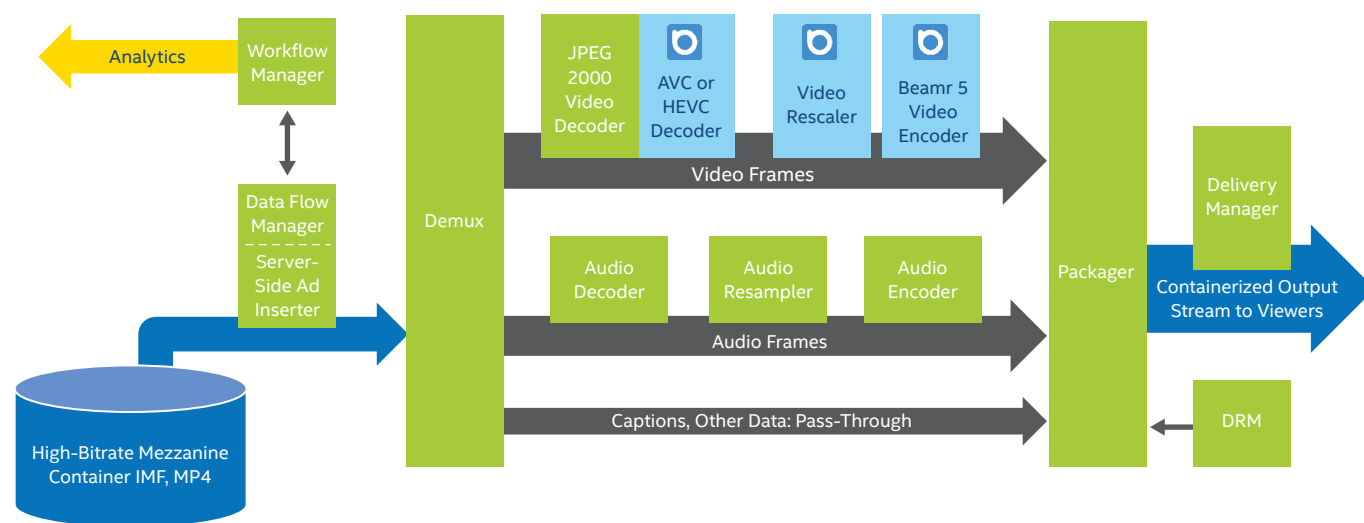

Figure 4. Origin transcoder (one of multiple instances running simultaneously).

Learn More

You may also find the following resources useful:

- **Beamr 5 4K HEVC Encoder Product Page** details the advantages, features, and benefits of the product and offers a free evaluation.

- **Intel® Xeon® Processor Product Page** explores features, capabilities, and offerings for a wide range of data center workloads.

- **Intel® Network Builders** enables the ecosystem by accelerating the shift to agile, cloud-ready network architectures.

Solution provided by:

[1] Data reflects performance measurements by Beamr in September 2017 on one socket of a 2S Intel® Xeon® Platinum 8180 processor @ 2.5GHz, 28 cores, Intel Turbo Boost Technology disabled, Intel Hyper-Threading Technology enabled, BIOS "Intel Corporation SE5C620.86B.01.00.0412.020920172159", SMBIOS v2.8, 192 GB total memory, 12 slots / 16 GB / 2666 MT/s / DDR4 DIMM, 800GB INTEL SSDSC2BA800G4, Ubuntu 16.04.2 LTS kernel 4.4.0-78-generic. Test clip: Netflix_Tango_3840x2160_60fps_10bit_420.yuv, 10bit/8bit, 588 frames, available from https://media.xiph.org/video/derf/ElFuente/Netflix_Tango_4096x2160_60fps_10bit_420.y4m, and clipped to 3840x2160.

[2] Test and system configuration: Beamr 5* (version 4.0) 4K HEVC encoding load, tested by Beamr in June 2017.

Baseline: Data reflects performance measurements on one socket of a 2S Intel® Xeon® processor E5-2699 v4 @ 2.2 GHz, 22 cores, Intel® Turbo Boost Technology disabled, Intel® Hyper-Threading Technology enabled, BIOS "Intel Corporation GRRFSDP1.86B.0271.R00.1510301446", 64 GB total memory, 8 slots / 8 GB / 2133 MT/s / DDR4 DIMM, 500 GB Hard Disk, CentOS Linux* 7.2 kernel 3.10.0.

New: Data reflects performance measurements on one socket of a 2S Intel® Xeon® Platinum 8180 processor @ 2.5 GHz, 28 cores, Intel Turbo Boost Technology disabled, Intel Hyper-Threading Technology enabled, BIOS "Intel Corporation SE5C620.86B.01.00.0412.020920172159", SMBIOS v2.8, 192 GB total memory, 12 slots / 16 GB / 2666 MT/s / DDR4 DIMM, 800GB INTEL SSDSC2BA800G4, Ubuntu 16.04.2 LTS kernel 4.4.0-78-generic.

[3] https://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-indexvni/complete-white-paper-c11-481360.html.

[4] https://www.intel.com/content/dam/www/public/us/en/documents/product-briefs/xeonscalable-platform-brief.pdf.