SOLUTION BRIEF

Service Providers
Media and Entertainment

Accelerate UHD Encoding on Demand with x265 HEVC Encoder and Intel® Xeon® Scalable Processors

Video-on-demand providers can deliver up to 2x performance gains per server using the x265 HEVC Encoder on Intel® Xeon® Scalable processors, compared to previous-generation server platforms.[1]

MulticoreWare is the company behind the open-source x265 project, as well as supporting toolkits and technologies:

- **The x265 HEVC Encoding Library** is an open-source, cross-platform encoder also available under a commercial license (supported by MulticoreWare, without GPL requirements).
- **UHDkit*** is an extended encoding library built on top of the x264 AVC encoder and x265 HEVC encoder libraries, designed for use by commercial video solution providers.
- **UHDcode*** is a cross-platform HEVC decoder library, available under commercial license.

Executive Summary

High Efficiency Video Coding (HEVC) support is a strategic necessity for video providers as they transition to new broadcast standards, across the range of customer devices from mainstream TVs to smartphones. The vast majority of platforms have embraced support for the HEVC video-compression specification (also known as H.265 and MPEG-H Part 2) to improve resolution, compression rate, and video quality. This is true across smart TVs, set-top boxes, and the full range of computer devices, as illustrated in Figure 1. And in the fall of 2017, Apple will release new operating systems that make native HEVC capability available to millions of devices, including iPhones*, iPads*, and Macs*.

HEVC can deliver twice the compression efficiency of its predecessor, Advanced Video Coding (AVC) technology (also known as H.264 and MPEG 4 Part 10), but that greater efficiency doesn't come for free. In fact, HEVC typically requires 5 times more computational power than AVC. Software optimizations by developers such as MulticoreWare, leveraging the performance and features of the new Intel® Xeon® Scalable processors, increase the viability of those requirements. With more cores, memory, and I/O bandwidth than the previous generation of data center processors, and built-in accelerators like Intel® Advanced Vector Extensions 512 (Intel® AVX-512), Intel Xeon Scalable processor-based platforms are well-suited to power these optimizations.

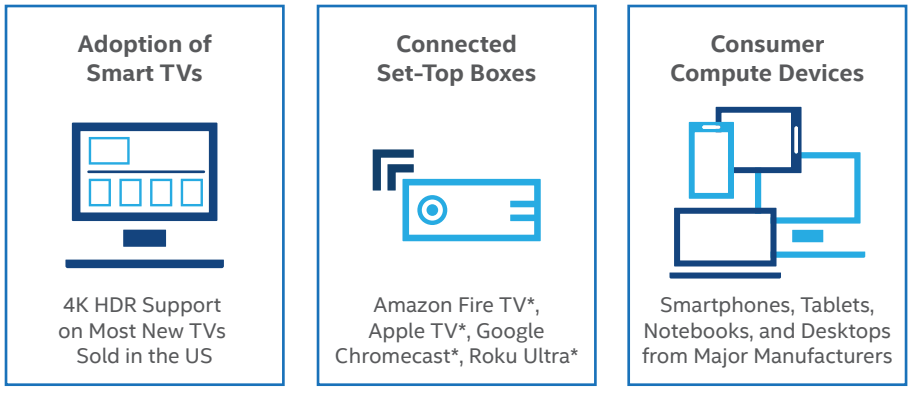

Figure 1. Broad-based adoption makes HEVC mandatory for content providers.

Open-Source Support for HEVC with x265

Available since 2013, x265 is an open-source library for encoding video into the HEVC compression format. Taking advantage of open-standards hardware, x265 offers superior quality and flexibility compared to hardware encoders. Encoding software based on x265 also takes advantage of Intel® Advanced Vector Extensions instructions that are built into Intel® processors.

Unlike fixed-function hardware encoders, software encoders have theoretically near-infinite flexibility in the way they can be configured, while also benefiting from regular, ongoing refinements to the software. The quality produced by software encoders improves over time as software evolves and takes advantage of emerging features and capabilities of open-standard Intel® architecture, including inherent hardware advances as well as optimizations made using new instruction sets. Those performance and quality improvements are typically accompanied by cost advantages as well.

The improvements to compression efficiency that are possible using x265 make it possible for providers to either reduce bitrate at a given video quality level or improve video quality at a given bitrate (or some combination of both). Accordingly, companies can either improve quality for a better customer experience or improve cost efficiency for a better bottom line. In either case, the enhanced efficiency possible using x265 can make providers more competitive.

MulticoreWare provides UHDkit as a core library that builds on x265 for H.265 encoding, and x264 for H.264 encoding, with full support for the full range of both sets of specifications. For adaptive-bitrate streaming, parallel encoding using UHDkit to multiple, simultaneous bitrate tiers dramatically improves efficiency compared to the use of multiple independent encoders. While encoding multiple bitrates in parallel, data is shared across multiple x264 and x265 instances, dramatically accelerating encoding with no discernable loss of quality, while enabling an "encode once, stream many times" approach.

- **Video-on-demand offline encoding** with UHDkit supports 10 performance presets to allow providers to achieve their preferred balance between encode speed and bitrate efficiency. Faster performance presets allow for improved density while higher quality presets deliver greater compression efficiency, enabling cost savings from reduced bandwidth requirements, or providing higher video quality using available bandwidth.
- **High-performance live encoding** enables the generation of high-bitrate 4K, 10-bit video at 60 frames per second on mainstream dual-socket servers. This ability makes delivery of advanced video streams to customers possible at dramatically improved price points, compared to previous approaches that required expensive four-socket or cluster-based systems.
- **Quality-optimized live encoding** using an advanced control system eliminates the need for conservative quality settings to be used. Dynamic optimization between quality and performance ensures that the system meets real-time performance requirements while delivering the highest possible quality for any type of content, at any target bitrate.

Accelerated Encoding with MulticoreWare and Intel® Xeon® Scalable Processors

File-based encoding using x265 is widely used to enhance efficiency, performance, and density for video delivery. Software advances enabled by MulticoreWare for Intel Xeon Scalable processors make 4K video at 60 frames per second feasible and affordable by taking advantage of the greater compute power provided by these systems.

MulticoreWare makes ongoing software improvements to improve both speed and efficiency for encoding. Algorithmic enhancements allow software to make faster, better decisions to tune encoder behavior and improve results. On the whole, these software optimizations are targeted to the best use possible of the computational resources of systems based on Intel Xeon Scalable processors. This includes a high degree of parallelization, maintaining a sufficient number of active software threads to keep the platform's up to 28 cores per socket busy, as well as load-balancing among those threads to take full advantage of hardware resources.

Testing by MulticoreWare in collaboration with Intel shows up to a 1.56x increase in performance per core on the Intel® Xeon® Platinum 8180 processor, compared with the previous generation, as shown in Figure 2.[1] This result corresponds to accelerated turnaround for offline, file-based 1080p and 4K encoding at a given quality level and bitrate. Alternatively, providers could improve quality without requiring additional encode time.

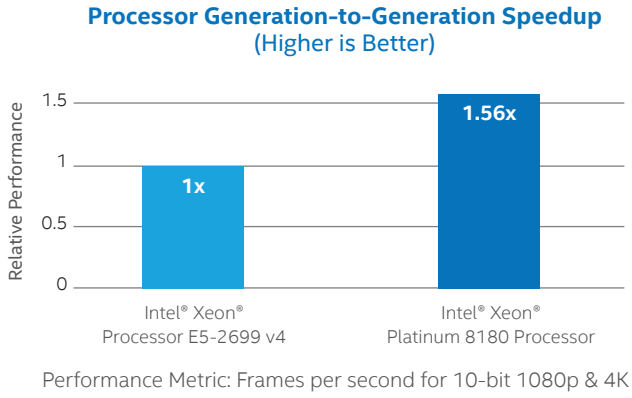

Figure 2. Increased performance of the x265 HEVC encoder on the Intel® Xeon® Platinum 8180 processor.[1]

The platform advances that underlie these performance increases stem from a new microarchitecture based on 14-nanometer process technology that enables more throughput from each hardware core. In addition, Intel Xeon Scalable processors offer increased memory bandwidth, higher maximum CPU frequency, and more cores per socket (28 compared to 22 in the previous generation), for a significantly more capable execution engine overall.

> "56 percent higher x265 performance per core, combined with higher core counts, enables up to 2x performance per server!"[2]
>
> – Tom Vaughan, Vice President and General Manager, Video, MulticoreWare

In addition to taking advantage of hardware parallelism, the x265 encoder implements vectorization enhancements based on Intel AVX-512. These software instructions allow more data to be processed per clock cycle than predecessor technologies, with each processor register operating on up to 256 bits of data (for example, eight floating-point values) in a single step.

The ability to handle larger data sets more quickly can accelerate floating-point-intensive operations such as video encoding. Moreover, Intel Xeon Scalable processors add support for Intel AVX-512 instructions, which are expected to increase performance even further when a future version of x265 is enabled with that technology to support 512-bit instructions.

HEVC encoding workloads are very sensitive to memory performance, enabling substantial benefits from enhancements built into the hardware platform's redesigned memory subsystem. A new, low-latency L1/L2 cache improves on-die data-handling efficiency, while six memory channels (an increase of 1.5x over the four in the predecessor platform) provide greater memory bandwidth.[3] In addition, data communication among cores uses a mesh topology, providing substantially greater efficiency and scalability over the ring topology used in prior generations. At the system level, the new Intel® Ultra Path Interconnect provides increased inter-socket bandwidth to further improve data handling.

Conclusion

As video providers work to optimize their support for HEVC, MulticoreWare optimizations for the x265 encoder—including expanded capabilities delivered with UHDkit—enhance the ability to do so with higher performance and density. Intel Xeon Scalable processors provide the hardware platform of choice to implement those advances in the data center, whether on-premises, in the cloud, or using hybrid infrastructure.

Embracing the full spectrum of user devices, the video industry can use this combination of hardware and software to put the next generation of content into customers' hands. That translates into a competitive advantage for organizations that include multiservice providers, over-the-top (OTT) providers, and content distribution networks. These advances pave the way for providers to look ahead to expanded support for 4K and even emerging types of content such as 360-degree video and virtual reality, while optimizing cost and flexibility.

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

Learn More

You may also find the following resources useful:

- **MulticoreWare H.265/HEVC Tools & Libraries page** describes MulticoreWare's leadership role in the x265 HEVC encoder project.
- **x265 HEVC Upgrade Site** offers further information, instructions, and downloads for the x265 Encoder, UHDCode HEVC decoder, and UHDkit video encoding library.
- **Intel® Xeon® Scalable Processors Product Page** introduces the technologies and range of options available from this processor family.
- **Intel® Network Builders** powers the visual cloud ecosystem by enabling hardware and software solutions for video delivery, cloud graphics, and media analytics.

Solution provided by:

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[1] Testing done by MulticoreWare, August 2017. x265 configuration: Version 2.4+28-f850cdbe381c, GCC 4.8.5, 64-bit, main-10 profile, assembly until Intel® Advanced Vector Extensions 2 enabled, Videos: Netflix Boat, Crosswalk, FoodMarket, PierSeaside, RitualDance, Tango 10-bit 4:2:0 4096x2160p @ 50 fps, offline encoding with slower preset averaged across 12.5, 15.0, 17.5, 20.0 Mbps, 1080p60 live encoding with ultrafast preset @ 6.5 Mbps.

Baseline: 2S Intel® Xeon® processor E5-2699 v4@ 2.2 GHz, 22 cores, Intel® Turbo Boost Technology and Intel® Hyper-Threading Technology enabled, BIOS American Mega Trends* v2.0, 256 GB total memory, 16 slots / 16 GB / 2133 MHz / DDR4 two-rank DIMMs, 7x 480 GB, Intel® SSD SC 2BB48, CentOS* Linux* Release 7.2.1511 (Core), kernel 3.10.0.

New: Intel® Xeon® Platinum 8180 processor @ 2.5 GHz, 28 cores, Intel Turbo Boost Technology and Intel Hyper-Threading Technology enabled, BIOS Intel Corporation SE5C620.8 6B.01.00.0412.020920172159, 187 GB total memory, 12 slots / 16 GB / 2666 MHz / DDR4 two-rank DIMMs, 1x 800 GB Intel SSD® SC 2BA80, CentOS Linux Release 7.3.1611 (Core), kernel 3.10.0.

[2] 1.56 (perf/core) x (28/22 more cores per socket) = 1.985x performance/server

[3] www.intel.com/Xeon/Scalable.