Delivering More Video Streams with Better Quality

Solving the quantity/quality challenge for HD and On-Demand video

The combination of widespread video on demand (VOD) service and an increasing number of HDTV channels poses new challenges for content distributors and broadband system operators. They need to deliver increasing amounts of bandwidth-intensive content on their existing infrastructure to compete effectively in today's battle for premium subscribers – yet they cannot afford to sacrifice quality. Up to 40 percent of all customer churn is caused by video quality issues,[1] and the pervasiveness of HD and large-screen home theater is making consumers more sensitive to this issue than ever before.

The Imagine ICE* Video Platform is helping Comcast and other system operators solve this critical challenge by enabling up to 50 percent more video streams to be delivered over existing infrastructure, while simultaneously ensuring the highest video quality at any given bit rate. Imagine's video processing appliance plugs seamlessly into the existing IP technology ecosystem and provides a quick, cost-effective way to expand premium services and improve customer satisfaction. Since it is implemented on industry-standard servers based on Intel technology, it also provides a uniquely scalable, flexible and adaptable platform for meeting both current and future requirements.

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A Better Way to Deliver Advanced Video Services

To transmit video content over today's networks, video assets are first encoded and then combined (multiplexed) for efficient transmission. Imagine ensures high quality for digital broadcast signals (HD and SD) by integrating an accurate and objective video quality measurement system (ICE-Q*) into its video processing architecture. Multi-pass encoding is applied to every macroblock. The resulting quality is then compared to the compressed source using the ICE-Q algorithms. This allows the Imagine solution to reduce the bit rate, while ensuring there is no viewer discernable impact on video quality. As a result, operators can dramatically expand their digital HDTV broadcast capacity while maintaining excellent video quality and performance.

Imagine has also developed an innovative and highly scalable architecture for PersonalizedTV* applications based on Intel architecture. In traditional systems, encoding and multi-plexing are tightly integrated. As a result, encoding must be performed for each video asset at the time of transmission. The Imagine ICE Video Platform for PersonalizedTV applications separates encoding and multiplexing. First, servers based on Intel processors are used to create Interchangeable Compressed Elements (ICE*). These elements are then transmitted using dense edge multiplexing devices. This approach enables video quality and bandwidth utilization to be optimized for each individual video stream. The principle is relatively simple.

1. Each video asset is processed once with ICE technology (in the Imagine ICE Video Processor server), enabling precise calibration of video quality levels. Multiple ICE versions can be stored for each asset to support various quality requirements, each at the lowest possible bit rate. The ICE-Q video quality measurement algorithms are built into the video processing engine to ensure that the ICE quality is closely aligned with the actual end-user perceptual experience.

2. When consumers request content, the appropriate ICE elements are selected at the network edge to deliver the optimal combination of video quality and system utilization for the particular viewing device. Since the video assets do not have to be re-encoded for every transmission, workloads at the network edge are reduced by up to 98 percent.

The bandwidth efficiency and superb video quality enabled by this novel approach to scalable video processing is not only applicable to traditional broadcast services, but also to the future of on-demand personalized services. Network operators get the best of both worlds. Better bandwidth utilization to deliver advanced services on existing infrastructure and assured quality to reduce churn – all delivered on industry-standard Intel processor-based servers.

A Flexible Foundation for Growth

A key advantage of the Imagine ICE Video Platform is the flexibility of its design. Imagine's software is pre-integrated on Intel® Xeon® processor-based servers that are designed to meet the stringent demands of network environments. Compared with traditional video processing solutions based on proprietary architectures and custom semiconductor devices, this standards-based hardware foundation provides:

▪ **Excellent performance with lower total cost of ownership (TCO).** Network operators can roll out new premium services faster by delivering more video streams to more users while maintaining superior video quality. They can also increase capacity easily by adding additional servers.

▪ **Reduced risk.** Since the software and hardware are developed separately, Imagine can deliver enhanced functionality to its customers through simple software upgrades. Hardware perfor-mance can be scaled independently, by taking advantage of the dramatic gains delivered by each new Intel Xeon processor generation. With this development strategy, operators can avoid locking themselves into the high costs and long development cycles associated with tradi-tional network-edge solutions. They can deploy quickly, scale easily, and take advantage of rapid innovation at both the hardware and software levels.

▪ **High Availability.** By plugging seamlessly into the system operator's existing IP infrastructure and leveraging the standards-based Linux* OS software environment, Imagine's video processing solutions are able to provide industry-leading availability.

Doubling Performance while Reducing Energy Consumption

The latest Intel® Xeon® processor 5500$^\Delta$ series (code named Nehalem) demonstrates just how rapidly application performance can scale with successive Intel processor generations. This new family of processors has higher performing and more efficient cores than the previous gen-eration. It also includes new Intel® QuickPath Interconnect technology and integrated memory controllers, which dramatically increase band-width for core-to-core and core-to-memory communications.

These processors introduce a new era of integrated intelligence for optimizing performance versus energy-consumption based on specific workloads. Intel® Hyper-Threading Technology[3] enables two software threads to run on each core, which doubles the number of concurrent threads that can run on the server. When loads are lighter, the processor can automatically reduce power consumption by maintaining processor and memory resources at lower energy states. Network operators can configure these features to meet specific needs.

Servers based on these new processors deliver significant performance and energy-efficiency gains for the Imagine ICE Video Platform. Intel and Imagine engineers worked together to maximize these gains, by optimizing the code using Intel® Software Tools.

▪ **Intel® Compilers** are tuned for the latest Intel microarchitecture, so they deliver substantial performance gains for a wide range of applications. They are compatible with standard development environments, including the GNU Compiler Collection (GCC).

▪ **Intel® Energy Checker** is used to determine the energy consump-tion[4] of a software application. The primary goal of Intel® Energy Checker tool is to help the software developers to measure the energy efficiency of their applications and determine the impact of hardware, code optimizations and changes to algorithms on the application's energy profile. Using this tool, developers can instru-ment their source code using a simple API to expose the amount of useful work generated and correlate it to the amount of energy consumed by the application. The tool is compatible with standard development environments including Microsoft Windows 2000,* Windows XP,* Linux,* Solaris* 10 and Mac OS X.*

▪ **Intel® VTune™ Performance Analyzer and Intel® Performance Tuning Utility (Intel® PTU)[5]** are used to profile workloads during runtime and to better understand how the software is using avail-able hardware resources. These tools help developers identify the most time-consuming software functions and determine the best compiler settings and other software optimizations for improving performance. They are valuable tools for focusing optimization efforts to deliver higher performance gains with less effort.

Using these tools, Intel and Imagine engineers were able to identify and optimize a critical code segment, increasing performance of that function by a factor of four. They also modified the software config-uration by running two instances of the Imagine ICE Video Platform application, each running on a dedicated socket. Since the Intel Xeon processor 5500 series supports non-uniform memory access (NUMA), this helps to reduce memory latencies, by ensuring that each appli-cation instance accesses only "near" memory. The number of worker threads was also modified to further optimize performance.

Compared with the original code running on a previous-generation server, these efforts increased total workload capacity by 4x, and throughput (in frames per second) by 2.4x (Figure 1 on the next page)[6] With these increases, a single server can now support two simultane-ous HD streams at 30 frames per second, versus just a single stream on the earlier platform. In addition, system energy consumption has been reduced by over 50 percent per HD stream to provide additional savings in utility costs. Software optimization efforts continue, and another doubling of performance is expected by the end of 2010.

Achieving Sustainable Advantage Across the Network

Intel has been doubling processor performance approximately every two years, in accordance with Moore's Law. A few years ago, a critical threshold was passed, and Intel Xeon processors became capable of processing real-time HDTV video. The rate of innovation continues to accelerate, and a vast community of hardware and software vendors is adding value across diverse applications. Imagine is one of the first companies to deploy this standards-based development strategy in the mainstream digital television market. Imagine's strategy of optimizing its software on Intel technology-based platforms has given Imagine a sustainable competitive advantage, generating high demand by cable operators and other service providers.

As new solutions continue to emerge, network operators can begin moving away from costly proprietary architectures and start riding the wave of innovation delivered by industry-standard, Intel technology-based solutions. The Imagine ICE Video Platform is a great example of this value proposition. By helping operators deliver up to 50 percent more video streams without compromising quality, it helps solve one of today's toughest network challenges. With its flexible design and rapid development model, it also provides operators with a uniquely scalable and adaptable platform for growth. As content becomes increasingly personalized and is distributed at higher resolutions to a broader range of viewing devices and screens, Imagine's service provider customers will be exceptionally well positioned to provide an industry-leading Quality of Experience (QoE).

Imagine Communications IVP Power/Performance Matrix

Metric	Intel® Xeon® processor 5500	Intel® Xeon® processor 5400
Relative Performance Normalized to CPU Clock	2.93	1.00
Energy Consumption (W)	2,055	2,176
Total Workload	4	1
Total FPS	65	27
Number of HD Streams	2	1

■ Intel® Xeon® processor 5500 series-based server
■ Intel® Xeon® processor 5400 series-based server
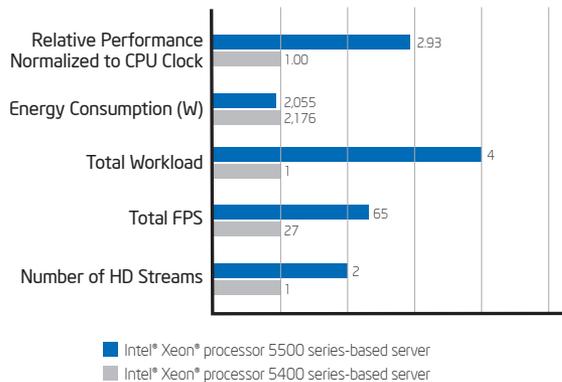
Figure 1. The combination of optimized code and the latest Intel® Xeon® processor 5500 series-based servers increases throughput (in frames per second) by 2.4 times for the Imagine Communications ICE* Video Platform and total workload throughput by 4 times. The platform can now support two HD video streams and software optimizations are on track to double performance yet again by 2010.

For more information about:

- The Imagine ICE Video Platform, visit www.imaginecommunications.com

- Intel Xeon processor-based servers, visit www.intel.com/p/en_US/products/server/processor

- Intel Software Development Tools, visit software.intel.com/en-us/intel-sdp-home

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