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Ligos MediaRig*:

Elevating PC Platforms to Meet
Professional Broadcasting Demands

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Table of Contents

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> Vice President of Business Development
> Oregan Networks

From its inception in 1997, Ligos has worked its video encoding magic from a platform centered on Intel processors. The Ligos GoMotion* codec, one of the first high-quality software-only MPEG-2 encoders to run on machines powered by the Intel® Pentium® III processor, found a home in a succession of best-selling consumer video products, including applications from ATI, MGI/Roxio, Ulead and others. The core encoding engine and digital video algorithms, steadily improved over more than a decade by the Ligos founding engineers, proved highly scalable and adaptable to the demands of the professional broadcasting industry. As off-the-shelf desktop computer systems equaled and then surpassed the power and performance of dedicated proprietary systems of years past, Ligos tuned their components to the requirements of professional broadcasters and released MediaRig*. Delivering fast, flexible and scalable capabilities in a cost-effective package, MediaRig capitalizes on the advanced performance of Intel Pentium 4 and Intel® Xeon™ processors. The professional broadcast community gains the benefits of proven technology that delivers the quality of conventional broadcast equipment at comparable costs with significantly more flexibility and reduced total cost of ownership. This paper discusses the evolution of Ligos video compression expertise and the complementary benefits achieved through reliance on Intel® architecture components.

Scaling Performance to Address Different Markets

Video codec performance represents a prime concern of digital media developers, as well as the professional broadcasting community. Speed is essential, whether developing broadcast applications, authoring DVDs, delivering High-definition (HD) video or transcoding content for rendering to consumer electronic devices. The performance capabilities of codecs—as much as the functionality—becomes an important differentiator in the marketplace. Designing a successful codec for multiple markets requires attention to the hardware architecture of the target platform. It also requires optimization of the code to capitalize on processor features and specialized instructions geared to improve digital signal processing.

Traditionally, in the professional broadcast industry and related fields, performance comes at a price. Specialized hardware encoders, commonly employed to ensure performance levels suited to high-volume media tasks, can increase the price of an end solution by thousands of dollars. The engineers at Ligos reversed this trend by developing a versatile MPEG codec tuned to the performance advantages of hardware architecture based on the latest generation of Intel processors. The result is a set of encoding/decoding solutions well suited

to the requirements of professional high-performance computing (HPC) applications, but equally capable at handling consumer-level applications. From the cost-effective Intel Pentium 4 processor to the scalable, dependable Intel Xeon processor, real-time MPEG performance requirements can be met at every level and for a wide range of applications. The exceptional performance of Intel architecture platforms made it possible for Ligos to create a flexible MPEG codec that delivers high quality without the expense of a dedicated hardware encoder, giving broadcasters in the industry an ideal tool for cutting expenses without sacrificing speed or precision.

Optimizing for the Latest Generation Processors

Ligos employs the latest advances in microprocessor technology to speed up both encoding and transcoding applications. Hyper-Threading (HT) technology[1], in particular, offers abundant opportunities for performance boosting when manipulating digital video signals, whether performing compression or transcoding operations.

Transcoding and Hyper-Threading Technology

"Transcoding is one of those things," Robert Saint John, Marketing Lead at Ligos, said, "that will use every available cycle to get the job done faster or at higher quality. Transcoding might involve one file format to another or from a file to signal output or from signal input to file. We will use every available cycle to get that job done as fast as we can at the highest quality levels possible. We absolutely use HT Technology to perform efficient dual-channel encodes, as well as other operations that require multiple processes."

Saint John pointed out that a segment of media typically consists of multiple elements and each of those elements requires a different process to perform

operations on it. "Even within a single video file," he said, "there are a number of processes involved in processing the encoding of the video, whether it be motion estimation or a dual-pass routine or noise reduction to ensure higher quality. Demultiplexing all of those elements and then remultiplexing requires more processes. We use hyper-threading so that even for a single piece of media, we can process everything in real time or faster. Our software is designed to the latest Intel architecture and to HT Technology such that on the latest systems based on the Intel Pentium 4 processor supporting Hyper-Threading Technology, we can take advantage of a single processor working two threads to simultaneously encode those streams. A year ago, we were running those two programs on dual-processor machines powered by Intel Xeon processors."

Specialized Instruction Sets

Both consumers and professionals benefit from optimizations that take advantage of progressively improving Intel processor instruction sets, from Intel® MMX™ technology, Steaming SIMD Extensions (SSE), SSE2 instructions, to the expanded set of performance-oriented SSE3 instructions. Membership in Intel® Developer Services and the Intel® Early Access Program for the Pentium 4 processor gave Ligos engineers a pipeline to resources for optimal tuning of their codec to the emerging hardware platform. Communication throughout the development process with the Intel Desktop Product Group helped Ligos equip their applications with well-designed codecs optimized for the newly released desktop processors at their launch dates.

Matching Performance and Parallelism

Performance and parallelism go hand-in-hand with video applications. For networked media applications, handling multiple pieces of content requires optimal performance at the operating-system level, as well as algorithms that take advantage of instruction-level parallelism at the lowest levels of the middleware layers. The latest generation of Intel Pentium 4 processors supporting Hyper-Threading Technology provides a capable home media server with the inherent advantages of parallelism. At the application level, networked media applications can take advantage of Hyper-Threading Technology to serve multiple streams of content to different devices.

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[1] Hyper-Threading Technology requires a computer system with an Intel® Pentium® 4 processor supporting HT Technology and a Hyper-Threading Technology enabled chipset, BIOS and operating system. Performance will vary depending on the specific hardware and software you use. See http://www.intel.com/info/hyperthreading/ for more information including details on which processors support HT Technology.

Networked media applications realize benefits in parallelism similar to the Ligos MediaRig application. MediaRig utilizes Hyper-Threading Technology on Intel Xeon processors to improve performance for the professional market—transcoding multiple streams of content to broadcast audiences.

While the home and professional applications are worlds apart, the underlying functionalities are quite similar, involving the transcoding of media streams in real time. However, in comparison to networked media middleware, MediaRig is a finely tuned application designed for a very specific task. Networked media server applications for the digital home require a more general-purpose design. Significant performance advantages can't be achieved simply by spawning more and more threads. In addition to streaming one or more channels of video, a networked media application may also be required to simultaneously transcode and stream multiple channels of audio and digital photos while sharing the processor time with typical office applications. While someone using an office application might not notice a brief interruption in processor operations, any pause in content delivery in an audio or video application is visually unacceptable. Techniques employed by Ligos ensure that the media being delivered is smooth, fluid and uninterrupted.

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Where opportunities for application-level parallelism end, instruction-level parallelism begins. Broadcast applications utilizing Ligos MediaRig can be tailored to a specific hardware configuration designed to generate a precise number of media streams, using codecs built to handle specific loads without difficulty. In comparison, general-purpose media adapter middleware operates in a fairly unpredictable environment, where streaming video being delivered to the television may compete with someone in the home playing an action-adventure game or someone burning MP3 music to disc. For this reason, instruction-level optimizations at the codec level can make the difference between a smooth-running set of applications and a disjointed, poorly presented media experience.

MediaRig Enters the Professional Market

In 2002, Ligos saw a viable strategic opportunity in the broadcast and professional video market. Relying on the rapidly increasing capabilities of hardware platforms based on Intel architecture, Ligos engineered a system based on their proprietary software to duplicate and enhance the functionality of existing DSP-based MPEG-2 encoders, decoders and transcoders. With the economies of scale generating price/performance advantages of as much as 50 percent on Intel processor-based platforms, Ligos found they could deliver professional broadcast functionality much more cost effectively than the competition and the MediaRig line of products was born.

The transcoding, encoding and decoding requirements of MediaRig demanded a high-performance processor solution and the advantages of multi-threaded operations had been well established in enterprise and scientific applications. The performance gains achieved through Intel Hyper-Threading Technology on mainstream desktop computers powered by Intel Pentium 4 processors proved an effective technique for gaining cost-effective performance on standard hardware equipment. These benefits are even more noticeable on platforms powered by the high-performance Intel Xeon processor family.

Ensuring Quality Output

From the vantage point of professional broadcasting, quality is still one of the biggest issues when evaluating a software-based approach to encoding. This becomes particularly important when many media content transitions are involved. "Media these days tends to go through lots of encoding and decoding and re-encoding before it actually hits the TV," Saint John said. "The quality at the initial stage of encoding is exceptionally important. When we first launched the MediaRig product line last year, we went to great ends to do actual benchmarks based on industry-standard ways of measuring quality."

The tools that proved extremely useful in this regard was a product from Sarnoff Corporation called JNDmetrix*. JNDmetrix (Just Noticeable Difference) is based on a proprietary model of the human visual system that generates metrics for comparing video quality. JNDmetrix measurements correlate with subjective judgments of video quality, but they employ computational techniques to establish quality levels.

"In metrics values compiled with JNDmetrix," Robert Saint John said, "we were able to consistently meet or exceed the quality of those blackbox-based encoders against which we are competing directly. We've continued to make advances in the software on the exact same platforms that we were using last year by making updates in the software—just by means of optimizations and improvements. We're actually starting to step up the ladder to compete with encoders that cost much more than standard $15,000 encoders—encoders that are focused on the cable and satellite market. In this market, each channel only gets somewhere between two and three megabits, but the content has to look just as good as a DVD, using only a third of the bit rate. Broadcasters pay dearly for flexible algorithm functionality, such as noise reduction, temporal filtering, and so on. Those are things that we are implementing and optimizing completely in software as we step up the attack on those blackbox models we compare most favorably against."

The Ligos MPEG-2 codec, capable of transcoding multiple streams of video on Intel® Xeon™ processor-based servers for professional broadcasters, delivers exceptional performance on the latest generation of desktop computers equipped with Intel® Pentium® 4 processors.

Professional Broadcast Applications

At the high end of the spectrum, Ligos MediaRig technology has been successfully implemented at the professional-broadcast level in the SeaChange Digital Transcoder.

"SeaChange, which provides video-on-demand and advertisement-insertion systems for cable multiple service operators (MSOs), uses the MediaRig system to develop their own encoder and transcoder products," Robert Saint John said. "These systems are based on the MediaRig Core product and are designed and marketed by SeaChange. The MediaRig Core product is essentially a software development kit and an engine that system developers use."

The SeaChange Digital Transcoder, the first MediaRig-based product, takes advantage of the flexibility and scalability of software to provide an automated system that seamlessly reformats content from various sources, and reformats it for delivery matched to channel and network requirements. Systems are easily and cost-effectively paired into redundancy groups to ensure automatic recovery in the event of a critical failure, an important consideration for the broadcast market. Time-Warner and Cox Communications cable

operators currently use the Digital Transcoder to handle local advertisement insertion, even in High-definition format, for a number of their cable headends.

Building upon the success of this product, SeaChange and Ligos are now working together on a new product, a real-time encoder based on the PC platform and MediaRig Core. Ligos has already introduced its own MediaRig Encoder product targeted at the satellite contribution and digital terrestrial-emission markets, becoming one of the first software-based encoders to address Digital TV standards, such as Advanced Television System Committee (ATSC) and Digital Video Broadcast (DVB). The SeaChange/Ligos relationship takes it a step further with support for cable industry-specific requirements, and the hardware interfaces necessary for the PC platform to integrate seamlessly with other headend equipment.

In addition to the quality and features that multi-channel operators expect as standard, this new encoder can provide more features than traditional digital signal processor-based (DSP-based) systems. Options such as multi-channel encoding, integrated multiplexing and User Datagram Protocol (UDP) output are generally handled by additional devices external to the encoder. With MediaRig systems, these features and more are integrated by means of the software and provided within a single, cost-effective box. As new technologies and applications such as High-definition video and H.264 become important to the professional markets, MediaRig software-based systems will be well suited for field upgrades, rather than requiring hardware replacements to support emerging standards.

Consumer Benefits of High-Performance Codecs

The benefits and performance of Ligos transcoding capabilities extend beyond the backend professional media server market. Real-time and better than real-time transcoding also provides a means for streaming digital media content to consumer electronics devices within the digital home. Support for media in MPEG-2 format is a core component of the Intel® Networked Media Product Requirements (Intel® NMPR). While Intel NMPR is not an actual standard, it does provide reasonable baseline recommendations that suggest

what standards a device should support for maximum industry interoperability. As home appliances and other consumer devices become networked, a well-connected personal computer gains the capability to repurpose and stream existing content to other devices, such as networked media players, digital video recorders and home entertainment systems. For these types of uses to become commonplace, the performance of the underlying codec and middleware is crucial.

To achieve this vision of the digital home requires the same attention to performance that Ligos delivered for the professional marketplace. The Ligos MPEG-2 codec, capable of transcoding multiple streams of video on Intel Xeon processor-based servers for professional broadcasters, delivers exceptional performance on the latest generation of desktop computers equipped with Intel Pentium 4 processors.

Distributing Digital Media Seamlessly

While the streaming media usage models in the digital home are still evolving, Ligos is ahead of the curve when it comes to support. MPEG-2 is the minimum standard for digital video in the Intel 2003 Networked Media Requirements for networked devices. The expertise that Ligos has gained serving the performance-conscious video editing and authoring market translates well to a range of other markets. The ability to transcode media in real time for a wide range of devices—from desktop PCs to enterprise media servers—is a natural progression of technologies that Ligos has helped pioneer.

Instead of delivering a single type of media to a single desktop monitor, developers create applications that channel multiple streams of audio and video to networked devices throughout the home. The rising popularity of wireless networking in the home makes it easier to share digital media in many different forms, distributing it to portable players, storage devices, notebook computers, home entertainment systems and optical disc recorders.

Licensing a Codec to Accelerate Development

For Oregan Networks, one of the leading middleware providers for networked media applications, licensing a third party MPEG-2 codec as a near-term solution made perfect sense. "When you are cutting ground on a product with so many variables, you don't want codec development to be one of them," says Reed Hinkel, VP of Business Development at Oregan Networks. "Performance was simply a must-have, but we wanted our engineers to be focused on functionality, not optimization." Oregan architects were working long hours on a number of development projects, creating tools and products to enable their customers to meet compliance with the Intel® Networked Media Product Requirements (Intel® NMPR) specifications. Designing an MPEG-2 codec from the ground up did not represent an efficient use of their time. From the perspective of Oregan Networks, the attention that Ligos devoted to the performance of its GoMotion MPEG-2 codec provided the ability to support a greater number of content streams to more devices. The interoperability framework being established by Intel and other companies as a part of Intel NMPR creates an environment within which consumers can enjoy a positive entertainment experience and easy interconnection of devices. The middleware solutions developed by Oregan Networks help device manufacturers deliver products that comply with Intel NMPR guidelines. By applying validation tests and utilizing an extensive collection of development tools, companies poised to enter the digital home market can shorten their time to market and create products with maximum interoperability. This framework makes it possible to freely exchange and share digital media content in a variety of formats and across a range of devices.

Realizing the Vision

It was a number of years from the time the first television camera and receiver sent a grainy image to a roomful of viewers to the time that people around the country could turn on the set in their living room and choose from a variety of broadcasts. Similarly, the tools and technologies that make it possible to efficiently deliver digital media to a wide range of devices in the home are still evolving. Intel and a number of supporting companies, by championing the Intel NMPR guidelines, provide a framework within which the building blocks for delivering digital content can be created and deployed. Companies such as Ligos, SeaChange and Oregan Networks make the vision a reality, by offering the means to efficiently transfer digital media content to devices that are designed to present the content for an optimal audience experience. The talents of the development community and the supporting efforts by Intel and other companies combine to bring us closer to a time when digital media entertainment can be enjoyed on any conceivable device—from a smart phone to a notebook computer to an elaborate home entertainment system.

As the broadcasting community becomes more open to the possibilities of software-based encoders running on standard hardware, sometimes it only takes a simple demonstration to highlight the advantages of this approach. At the National Association of Broadcasters (NAB) convention in 2004, Ligos presented a demo at their booth that caught the eye of visitors. The demo involved both outputting the stream as a broadcast format stream (using a DVB-ASI interface) while taking the same stream encoded at a lower bit rate and outputting it over Ethernet as a UDP multicast to a totally separate station on the other side of the booth.

"Most NAB visitors thought that was really cool," Robert Saint John noted. "They can see all sorts of practical applications of that technique, whether it is doing a simulcast over two different networks or having the flexibility to both encode and broadcast. Or, they can encode and contribute to a broadcast system through one output and create a low bit rate or alternative format proxy for an archive server that could be browsed or accessed at a later time. That kind of functionality would be very expensive to reproduce in DSP-based systems. It would require multiple pieces of equipment. But, it's a snap for MediaRig."

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