Case Study

Intel® Core™ i7 Processor

C-nario

Digital Signage Solutions

Improving Video Quality with Software Decoding

C-nario displays twelve 1080p MPEG-2 files across twelve 1920 x 1200 displays at 60 frames per second without stuttering

"The key is to maintain high video quality while increasing the number of outputs."

– Yael Elstein, Vice President Marketing, C-nario

The capabilities of high-end digital signage solutions are increasing at a rapid pace and delivering remarkable results. The latest in high-definition broadcast-quality solutions can handle more and more display screens, overlays, input content streams, output streams and multiple zones, which translates into processing hundreds of millions of pixels per second. The resulting high level of video flexibility and throughput is enabling companies and organizations to design truly eye-catching displays for airports, shopping malls, stock exchanges, sports arenas or just about anywhere.

Benefiting from this state-of-the-art technology, visitors entering Philadelphia's Comcast Center – a glass skyscraper and the tallest building in the city – are greeted by compelling digital screens situated in its 50 lobbies and 28 passenger elevators, among other places. "This comprehensive digital signage system, implemented by C-nario, creates a one-of-a-kind experience for the center's employees and visitors," says Charles Cerino, vice president of Comcast Center Technology.

The Comcast system runs Messenger* digital signage software from C-nario, a world-class provider of end-to-end software-based digital signage solutions, which enables the Center to feed and control a very large number of displays. When designing its Messenger software, C-nario's key objective was to optimize video flexibility in order to support increasingly complex content. To achieve this objective, C-nario migrated its video decoding software to the Intel® Core™ i7 processor from a graphic processing unit (GPU), a change that made it easier to integrate images. Additionally, this platform included the Intel® X58 Express Chipset with PCI Express* 2.0, used to move large amounts of High Definition (HD) video throughout the system. This case study describes how C-nario met its demanding video processing challenges through the use of power-efficient Intel® processors.

Challenge	**Provide maximum flexibility for the application** ▪ Increase overlay and downstream processing flexibility for video and other foreground layers ▪ Support more output channels at full high definition resolution ▪ Support practically an unlimited number of zones **Improve pre- and post-processing of images and video** ▪ Span images and video across a larger array of displays for either single or cascaded multiple-output systems ▪ Support pixel-perfect video, as well as other content types, for any size multiple display arrangement
Solution	▪ Migrate to a software-only decoding solution that provides more overlay flexibility and scales to more streams ▪ Run software on Intel® multi-core processors with the processing power needed for decoding, real-time rendering of text and dynamic feeds, and system management

Software-only Versus GPU Video Decoding

When designing its next-generation digital signage software, C-nario conducted a thorough analysis of the tradeoffs between using GPUs and general-purpose processors for demanding video decoding. With GPU solutions, known for their speed, it's nearly impossible to combine decoded streams containing different images. This limitation makes it difficult to create complex images by combining pre-processing and real-time processing, needed to meet the demand for more windows of blended video, animation, pixel perfect text and static images.

> "Overlaying a ticker on GPU decoded high-definition video is only partially supported by a GPU."
>
> *– Avishay Ben-Natan , Chief Technical Officer, C-nario*

Back-to-Back Support

One usage case for pre-processing is called back-to-back support, which ensures a seamless transition between two files. A buffer lookahead can be used to store the first few frames of the subsequent file, which must be ready when the last frame of the previous file ends. Such back-to-back support avoids stuttering by ensuring an imperceptible delay when transitioning between video files.

It's relatively easy to provide back-to-back support using general-purpose processors, because the next file can be decoded by the processor in a low-priority thread. As a result, sufficient resources can be allocated to files being displayed on the screen, as in the case of displaying frames from ending and beginning files without glitches. The uncompressed decoded stream can be downstream processed by scaling and compositing with additional media tracks, like overlaying text, logos or news tickers as shown in Figure 1, before it's outputted. On the other hand, GPUs are less flexible for decoding multiple files on the same output, and it's possible to experience stuttering when one video file ends and the next begins to play.

When using a general-purpose processor for software-only decoding, GPUs are still used for many functions, including alpha layering, motion, rotation and sizing. Alpha layering is a means to post-process decoded content such as overlaying text or additional video tracks onto a video output. This is done by assigning each pixel a transparency variable, a value between 0 and 255, that is used to composite multiple layers of content, which is a fundamental capability for building eye-catching images. Giving the GPU more time for alpha keying, a general-purpose processor performing video decoding allows access to the decoded content up until the time it is sent to the display.

Figure 1. Content Overlay Example

Video Decoding Performance

C-nario measured the decoding speed of three generations of Intel processors, as shown in Figure 2.[1] The results compare the decoding speed of the processors to the real-time incoming bit rate of a 50 megabit per second 1080i MPEG-2 test file while using the C-nario MPEG-2 decoder. In the case of the Intel Core i7 processor, it performed full decoding over 23 times faster than the incoming file duration, that is, faster than real-time and over 80 times faster for variable length decoding (VLD) only.[1] Comparing full decoding speeds, the Intel Core i7 processor was 2.4 and 4.6 times faster than the Intel® Core™2 Quad processor Q6600 and Intel® Core™2 Duo processor T7500, respectively.[1]

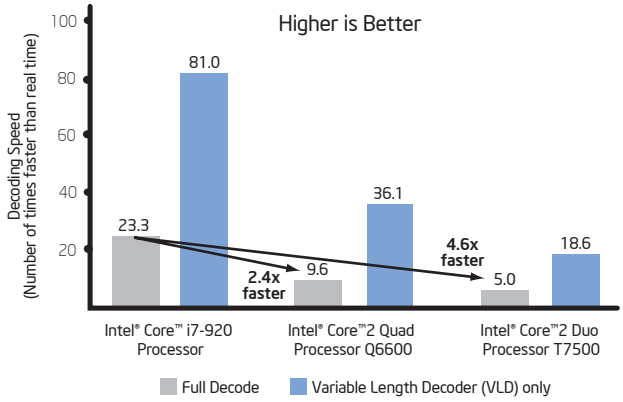

Figure 2. Decoding Speed[1]

"The Intel Core i7 processor helps us break though barriers in MPEG-2 decoding, our most demanding workload on the system."

– Avishay Ben-Natan , Chief Technical Officer, C-nario

The high-level of performance of the Intel Core i7 processor is the result of changes made to microarchitecture that increased overall performance and power efficiency without adding more cores. This processor has four processor cores, like its predecessor the Intel Core 2 Quad processor Q6600, but with dramatically improved performance. The performance increase is due to various architectural enhancements: adding a thread per processing core, integrating L3 cache memory on-chip and migrating to faster memory technology. These enhancements translate into improved video encoding performance, as described in Table 1.

These changes to Intel processor microarchitecture and C-narios' video software expertise enable signage systems to display twelve 1080p MPEG2 files across twelve 1920 x 1200 displays at 60 frames per second without stuttering. This represents twice the typical targeted rate of 30 frames per second and indicates the solution has plenty of headroom. C-nario digital signage system is designed to support multiple displays and projectors creating a big "canvas." When the number of required displays exceeds the number of displays a single computer can drive, multiple computers can be cascaded to create any size canvas. Through the use of Intel Core i7 processors, C-nario dramatically decreased the number of computers required to drive a video wall, thereby providing energy and cost savings to customers. In addition, a multiple output digital signage player based on the Intel Core i7 processor can drive multiple discrete digital signage channels each including full high-definition video and additional layers.

Features Intel® Core™ i7 Processor Architecture	Benefits for Video Processing
Intel® Hyper-Threading Technology[2]	Delivers two processing threads per physical core for a total of eight threads, which substantially speeds up multithreaded video decoders.
Multi-level cache, including the addition of L3 (last-level) cache	Allows video software to efficiently share images between cores. Cache is dynamically allocated to the processing cores, in accordance to their workload.
New Intel® Streaming SIMD Extensions 4.2 (Intel® SSE4.2)	Includes additional instructions for faster computation and manipulation of media used to improve video decoding stream quality.
Integrated DDR3 memory controller	Offers memory performance up to 25.6 gigabytes per second, needed for multilayer processing of video files.
More efficient processor algorithms	Recovers lost performance due to stalls (dead cycles), which benefits multithreaded video encoding, particularly motion estimation algorithms. ▪ Faster handling of branch mispredictions ▪ Improved hardware prefetch ▪ Better load-store scheduling
Enhanced branch prediction	Fetches and executes instructions without waiting for branches to be resolved, which speeds up the execution of the outer and inner loops used by H.264 encoding algorithms.

Table 1. Mapping Video Decoding to the Intel® Core™ i7 Processor

Maximizing Parallelism Opportunities

Video decoding, an inherently parallel application, can run faster on multi-core processors because multiple threads are processed simultaneously. As such, C-nario's software can execute eight threads concurrently when running on the Intel Core i7 processor series with Intel® Hyper-Threading Technology.[2] This technology enables each physical core to simultaneously process two threads for a total of eight threads, which significantly speeds up C-narios' advanced multithreaded video decoders. This capability enables C-nario to support more output channels at full high-definition resolution.

Employing a second type of parallel processing, C-nario makes use of Intel® Streaming SIMD Extensions 4.2 (Intel® SSE4.2) to increase the performance of highly parallel video processing operations. These special instructions operate on multiple pieces of data, like servicing 16 pixels at a time when loading transparency variables (mentioned previously). A third way C-nario can scale its video application is by adding more processing cores. The modular design of C-nario decoding software allows for an easy, scalable migration to a dual Intel® Xeon® processor configuration, which will effectively double the video processing capacity in the future.

Transitioning to Video Over IP

When deploying a single canvas across multiple displays driven by multiple computer systems, the processing and manipulating of live video signals becomes a challenge. Similarly, more complex digital signage systems are pushing the limits of traditional LCD interfaces for carrying video content. As a result, video over IP is gaining traction, because it increases bandwidth and simplifies connections to large multiple display configurations. For example, the C-nario Cube* Input Processor uses low-latency HD video over IP to feed multiple computers with multiple video feeds using high-speed network infrastructure and encodes up to four 1080i HD video sources using a single Intel processor. As Avishay Ben-Natan explains, "When you drive live video over dozens of HD screens, you can't split the signal physically to every box. Our C-nario Cube system encodes video and sends it over IP infrastructure using an Intel processor. The Intel Core i7 processor delivers exceptional performance in our video over IP solution."

For more information on C-nario digital signage software solutions, please visit www.c-nario.com.

For more information on embedded Intel processors, please visit www.intel.com/embedded/index.htm.

Solution provided by:

[1] Performance tests and ratings are measured using specific computer systems and/or components and reflect approximate performance of Intel® products as measured by those tests. Any difference in system hardware or software design or configuration may affect actual performance. Buyers should consult other sources of information to evaluate the performance of systems or components they are considering purchasing. For more information on performance tests and on the performance of Intel products,visit http://www.intel.com/performance/resources/benchmark_limitations.htm

[2] Intel® Hyper-Threading Technology (Intel® HT Technology) requires a computer system with an Intel® processor supporting Intel HT Technology and an Intel HT Technology enabled chipset, BIOS, and operating system. Performance will vary depending on the specific hardware and software you use. See www.intel.com/products/ht/hyperthreading_more.htm for more information including details on which processors support Intel HT Technology.

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