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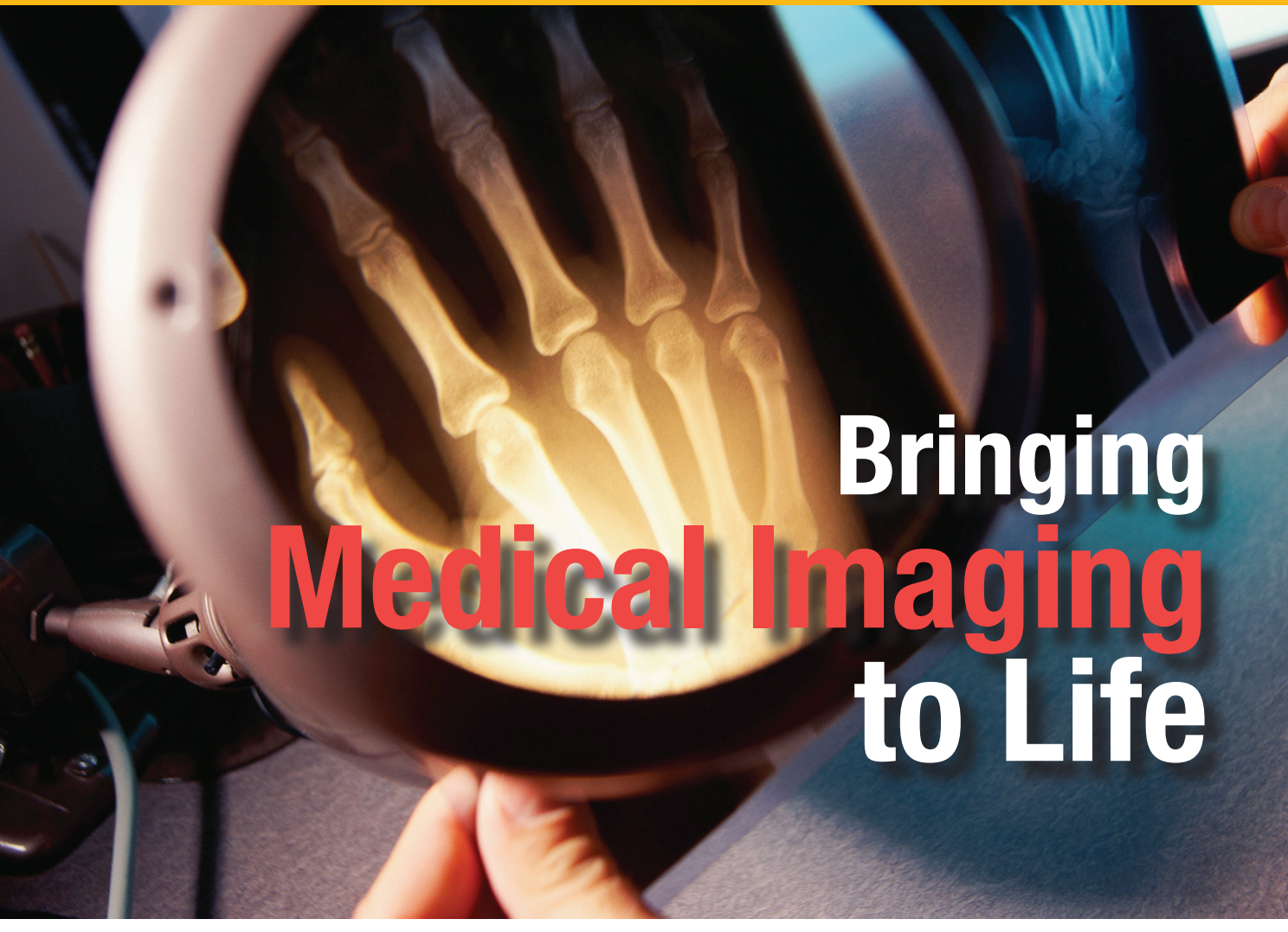
Embedded & Communications ENGINEERING

The INTEL STRATEGY for Processor Design Series



Bringing Medical Imaging to Life

Until recently, crucial medical diagnostic imaging relied upon grainy renderings that strained the eyesight of the medical professionals who read them. Today, 4-D real-time images shatter bandwidth and computational barriers.

Today's ultrasound, digital radiography, MRI and CT images are achieving previously impossible diagnostics. Illustrating a full beating cycle of a human heart, using virtual endoscopy to improve cancer detection, examining a fetus in utero in three dimensions from all possible angles and training the next generation of surgeons on the placement of organs and blood vessels — these are just a few of the exciting results of enhanced medical imaging.

Meeting the demands of protecting and enhancing the quality of life, these mirrored images and real-time diagnostics require speed, resolution, reconstruction capability and high bandwidth. Advances in embedded multi-core parallel

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processing, virtualization and acceleration represent the vigorous force behind the unprecedented performance that represents today's imaging, satisfying a solution-starved industry.

The power of multi-core solutions

Reconstruction algorithms — taking many two-dimensional projections, combining them and registering data among the hundreds of images rendered to yield a three-dimensional data set — require a tremendous amount of computational power. Parallelization of the algorithms allows processing to be performed across multiple cores, yielding dramatic performance improvements. The inherent nature of multi-core technology allows for unprecedented algorithm segmentation and linear performance, yielding up to a 4x or 5x improvement over single-core/single-threaded applications.

"Ten years ago, custom hardware, custom ASICs and special boards were used in medical imaging, and they were expensive and inflexible," says Bob Ghaffari, Intel medical segment manager. "Today, as a result of our new microarchitecture, we're able to address and streamline a significant portion of the imaging platform architecture for next-generation systems. In addition, our architecture offers a level of modularity that provides multiple options for scaling up and down the performance curve while preserving the software investment."

What imaging delivers

High-end imaging and monitoring technology enables accurate, rapid and in-time diagnosis, curtails the number of invasive and unnecessary surgeries, and supports preventive care. Improvements in real-time X-ray imaging enable either noninvasive outpatient surgery or a greater ability to select alternative forms of medical treatment.

"The cost of health care has never been higher. Yet an important aspect of keeping costs in check revolves around the timely diagnosis of disease," says Dave Hillyard, Intel medical solutions platform architect. Unclear imaging can account for substantial misdiagnoses, as well as missing a problem entirely. Today's medical imaging modalities are based on complex algorithms that demand more computational power and provide a much clearer picture of hard and soft tissue. Multiple processing cores allow for the use of new and increasingly complex algorithms that may address higher resolution and performance quality. An example of improved performance can be seen in such routine exams as annual mammograms, which typically take up to a week to obtain results but which can now be viewed and diagnosed in real time.

When patient care moves from a hospital to a doctor's office or to a home monitoring environment, the cost of treatment declines. This shift depends on creating an infrastructure that takes monitored data, gathers it and delivers it in real time for

Harnessing the Power of Virtualization

Kontron is a major force globally. Expert at understanding its customers' supply chain, revision control and longevity of product requirements, Kontron is adept at handling the maze of worldwide regulatory requirements.

"One of the key elements of dual core is that with the Intel® processor, we can run multiple applications with the same processor — harnessing the power of virtualization. It is very useful specifically for imaging, given the volume of data to be crunched," says Nancy Heinrich, general manager, Kontron America, Pittsburgh. "Instead of having a card perform imaging, a dual-core processor processes substantially more data."

Multiple applications run simultaneously — a user interface runs on one core, while data crunching is performed on another. In the past, when the processor was performing all of the analysis, the machine could not respond to two tasks at the same time. With virtualization, however, one core can be completely dedicated to performing the complex computations required for imaging.

"In the embedded world, the Intel and Kontron relationship is critical to our success. Based on our relationship with Intel and the support provided, we can work with our customers and prepare them for what is coming in advance," Heinrich says.

"There used to be a lag of 18 to 24 months between the time Intel launched a product and the time our customers were ready to implement it. Today, by comparison, when Intel launches a product, our customers are ready," he continues. "As a Premier member of the Intel® Communications Alliance, we know what is available from Intel, what our customers need, how to provide it and how to receive support when needed from Intel. Intel is excellent at managing the life cycle of its product."

The medical space requires strict revision controls and longevity of the product. Customers select Kontron to ensure that what they receive is consistent and that they pass certifications. Consistency of product is vital, since it must be qualified by regulatory agencies. The Kontron and Intel combination consistently and effectively meets the challenge of managing product life cycles.

analysis. Home health monitors, for example, may routinely monitor glucose levels, ECG or blood pressure and feed data back to health-care managers as part of a patient's electronic medical records. Embedded technology provides the necessary key building blocks to enable the platform. And one company, Intel, has proven embedded, multi-core and advanced technologies such as virtualization to ensure sufficient performance for success.

Why Intel?

Intel is actively driving the next generation of high-end imaging equipment by providing a complete and accurate picture of the performance its multi-core technology can achieve. Taking a great deal of time and effort, Intel is aggressively opening up its grade book — substantiating performance benchmark results. Proven performance improvement of dual-core over single-core solutions without any change in code has been measured at greater than 1.7x. In moving from a single-core, single-threaded application to a multi-core, multi-threaded application like image rendering, improvements of 5x have been documented.

Intel's scalable solutions can be implemented the entire length of a customer-design cycle, saving precious resources. A customer designing a high-end imaging system using high-end Intel® Xeon® processor performance, for example, will preserve and reuse substantial segments of software in low-end, portable imaging applications.

Intel's stable, proven, embedded processors enable the right sets of products for the industry and the longevity required for customers to be successful. Intel's product road-map breadth, the reliability and scalability of its architecture, and its support, tools and ecosystem offer customers an unsurpassed combination.

Power and Performance

At the heart of imaging capabilities are the Intel Xeon processors and the Intel® 5000 chipset, a combination enabling the performance increases associated with multi-cores and the parallelization of algorithms. Moving the huge volume of data throughout the system and into the reconstruction and rendering engines requires high bandwidth — the very purpose and nature of PCI Express* multiple x8 or x16 interfaces.

Field-programmable gate arrays provide a mechanism for custom-built FPGA design architectures to interface with PCI Express and maintain the high bandwidth and high throughput necessary to satisfy a broad range of products. Finally, virtualization provides numerous usage-model opportunities, allowing the segmentation of operating systems as well as processing systems.

Intel solves imaging's insatiable need for power and

4-D Resolution Excellence

RadiSys' value is picture perfect. It designs and develops embedded computing platforms that, in the world of medical imaging, are used for image processing, high resolution display, and system control. Addressing customer needs for top-of-the-line performance, coupled with attention to bottom-line costs, RadiSys builds systems based on Intel® technology tailored for medical imaging, achieving high performance in 2-D through 4-D systems that previously required very expensive and inflexible custom hardware.

Specifically, within the embedded medical space addressed by RadiSys, customers perform image processing using powerful single instruction multiple data (SIMD) commands for efficient parallel processing.

"A big surprise recently was the performance benefit of the new Intel® Core™ microarchitecture for applications that include a lot of SIMD processing," says Michael Reunert, Sr. Marketing Manager, RadiSys. "Most SIMD instructions are 128 bits wide and the older architecture had a 64-bit pipe in the internal architecture. This meant it took two clock cycles to execute one of these very powerful instructions. The new Intel Core architecture includes a 128-bit internal pipe. Now SIMD instructions execute in one clock cycle — a 100 percent performance improvement for the specific processing our medical-imaging customers perform. We were told to expect 1.3x to 1.6x improvement over single core processors for the new Dual-Core Intel® Xeon® processors and we actually saw 2x improvement when running SIMD code."

RadiSys acknowledges that being an Intel ecosystem member is particularly helpful, as it allows the company to give the best possible guidance to its customers — designing not only for the current generation, but for future generations as well. RadiSys, through the ecosystem, is able to have early access to prototypes of such products as the Quad-Core Intel® Xeon® 5300 series processor and boards — in turn placing the technology in the hands of its customers long before they could access it in the open market.

"We're involved early with Intel® products, and the relationship lasts a long time, through many product generations — both companies address the critical need for long-life products in medical applications. It takes a long time to move through regulatory approvals, so long life is particularly important," Reunert says. "We use Intel to produce products so that our customers experience the most compute power per dollar — tailored specifically to their needs."

performance. Customers today are not interested in incremental performance improvements — but radical and dramatic improvements that enable them to provide incredible performance. That trend will continue.

From high-end imaging to global medicine

Complex images created from multiple modalities are becoming more common. These allow for the best of each imaging type — enabling the characterization of portions of anatomy or portions of individual organs that are impossible to see with a single-modality image. Intel aligns with that vision by increasing the number of cores and dramatically increasing bandwidth.

The rapid evolution of some of these modalities, specifically ultrasound, is opening up markets and bringing imaging capabilities down to lower price segments. As the price point of ultrasound equipment comes down, the potential market expands significantly — all the way to small villages around the world. When that ultrasound is in a handheld-size unit, volume and opportunities increase.

Intel® architecture's outstanding power and performance will continue to be the basis of a new and rapidly growing generation of patient-monitoring equipment. Intel® technology will deliver additional functionality to better display patient data from charting through the monitoring of oxygen, temperature and blood pressure.

Vendor Community

The Intel® Communications Alliance ecosystem comprises third-party hardware and software vendors that deliver Intel®-based solutions at multiple levels of integration. Alliance members often specialize in imaging, monitoring or other types of medical applications. Working with a variety of solution providers, Intel's ecosystem provides customers with a trusted supply line of companies that offer integration, components, engineering, consultation and design services.

In addition to major players such as Kontron and RadiSys (see sidebars), the Alliance program includes various members with a worldwide presence that play a critical global role in the supply chain. Advantech, for example, a global company that specializes in the computing and patient-monitoring category, creates cost-effective solutions that garner FDA and safety approvals crucial to the medical segment. Advantech's wide variety of products feature Intel® processors and deliver integrated services and solutions capabilities from board level to complete off-the-shelf OEM products. A second Alliance member, Granite Microsystems, designs and develops medical board-level products featuring Embedded Intel® Architecture Processors. Working with large OEM customers, Granite integrates software on top of the boards to produce complete solutions for the imaging and computing segment.

Additional members that are key to Intel in the medical segment include Portwell, a specialist in low-cost productivity boards for the computing segment, and ADLink, which provides patient monitoring and instrumentation products to OEMs using Intel architecture products. Finally, AAEON develops boards for security and home/patient monitoring.

Intel provides "go-to-market" solutions at various levels of integration via collaboration with the Intel Communications Alliance. Intel cultivates its ecosystem carefully, forming close relationships with high confidence in companies that provide design assistance, engineering, manufacturing and full support, all leading to a successful launch and long product life.

For more information, please visit www.intel.com/go/embedded

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