



Success Brief  
 Intel® Parallel Studio 2011  
 Healthcare



# Massachusetts General Hospital\* Achieves 20X Faster Colonoscopy Screening Processing Time

**Massachusetts General Hospital (MGH) 3D Imaging Research\*, working with Intel, Microsoft\*, and Vectorform\*, used Intel® Parallel Studio 2011 to optimize key image processing libraries, reducing the compute-intensive colon-screening processing time from 60 minutes to 3 minutes.**

“By utilizing technology that we developed in close collaboration with Intel, Microsoft, and Vectorform, we were able to significantly reduce the processing time and make the virtual colonoscopy a practical and efficient, and potentially life-saving colon cancer screening technique.”

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|------------------|---|
| <b>Company</b>   | <p>Massachusetts General Hospital (MGH) offers sophisticated diagnostic and therapeutic care in virtually every specialty and subspecialty of medicine and surgery. MGH has been consistently named one of the top hospitals in the United States by <i>U.S. News and World Report*</i> and is the oldest and largest teaching affiliate of Harvard Medical School*.</p> <p>MGH Imaging* provides a full range of diagnostic testing services utilizing state-of-the-art imaging equipment. MGH Imaging’s roots date back to 1896, and it is world-renowned for making of one of the first X-rays in the United States. It employs more than 100 board-certified radiologists specializing in one of 11 clinical areas and performs more than 600,000 imaging exams per year. MGH Imaging has gained distinction for its subspecialty expertise in abdominal and interventional, breast, cardiac, musculoskeletal, neurological, nuclear, pediatric, thoracic, and 3D imaging.</p> <p>With 3D imaging, images obtained from computerized tomography and magnetic resonance imaging scanners are used to create lifelike 3D images that physicians can use to visualize organs and diseases and to make diagnoses, treatment, and surgical planning. This level of precision not only increases clinical productivity, but also enhances patient care: 3D imaging can help facilitate noninvasive surgical planning, reduce operating times, minimize damage to healthy tissues through more accurate targeting of treatment areas, serve as a visual tool for patient education, and ultimately help reduce healthcare costs.</p> |
| <b>Mission</b>   | To offer specialty-trained radiologists, leading-edge medical imaging technology, and a caring staff who are committed to patient safety and comfort.   |
| <b>Product</b>   | Virtual colonoscopy (VC), also known as computed tomography (CT) colonography, is a computed tomographic (CT) scan of the colon.  |
| <b>Challenge</b> | Manage highly <a href="#">parallel processing</a> and real-time virtual cleansing of the colon, while reducing wait and processing times as well as improving reliability and diagnostic image quality.   |
| <b>Results</b>   | MGH 3D Imaging Research saw a 20x speedup (from 60 minutes to 3 minutes) and achieved a forward-scaling cross-platform solution utilizing one code base for multiple processor targets.   |
| <b>Impact</b>    | Achieved reduced wait times for patients and medical experts by enabling more performance and reliability, in addition to accelerating the speed in processing and image display.   |

**Intel® Parallel Studio 2011** is a comprehensive tool suite that provides Microsoft Visual Studio\* C/C++ developers with an innovative threading assistant, compiler and libraries, memory threading error checker, and threading performance profiler.

Boasting an array of innovative features and capabilities, Intel Parallel Studio equips developers to enhance productivity and enable reliable applications that leverage legacy serial code, take advantage of multicore, and scale for manycores.

From one-person startups to enterprises with thousands of developers working on a single application, Intel Parallel Studio makes it simple for developers to achieve a quick start, a fast finish, and the best results for code quality, reliability, and performance for serial and parallel applications.

Intel Parallel Studio provides powerful tools that can be used independently or together to meet the needs of workflows and development teams, advancing all phases of the development lifecycle:

### **Design—Innovative Threading Assistant**

#### **Intel® Parallel Advisor**

Simplify threading and transform code by identifying those areas in C/C++ applications that can benefit most from threading.

### **Build and Debug—Compiler and Libraries**

#### **Intel® Parallel Composer**

Develop effective applications with easier, and faster multithreading of serial and parallel applications and parallel models that meet your needs.

### **Tune—Threading and Performance Profiler**

#### **Intel® Parallel Amplifier**

Speed and simplify finding multicore [performance bottlenecks](#), and remove the guesswork for faster, improved decision making.

### **Verify—Memory and Threading Error Checker**

#### **Intel® Parallel Inspector**

Ensure application reliability—regardless of your parallelism programming model—with root-cause analysis of crash-causing bugs.

To enjoy a free 30-day evaluation of Intel® Parallel Studio, download it here: [www.intel.com/software/products/eval](http://www.intel.com/software/products/eval).

## **Challenge: Why MGH benefits from utilizing parallelism**

Virtual colonoscopy (VC) is a computed tomographic (CT) scan of the colon, and it has shown to be sufficiently accurate for detecting pre-cancerous polyps. MGH 3D Imaging Research recognized that a successful VC procedure would need to be conducted in less than five minutes and at a lower cost.

To achieve this goal, MGH needed the right processor and software technology that could manage highly parallel processing and real-time virtual cleansing of the colon. 3D Imaging Research also required the software development tools to build a parallel virtual colonoscopy application that leveraged the latest processor technologies. Speed and performance were major requirements to sufficiently reduce wait and processing times, while improving reliability and diagnostic image quality. This required tools to modernize serial applications to parallelism, tune applications for best performance, and provide dynamic analysis for reliability.

## **Expediting the processing time**

The results of the study demonstrated that processing time could be expedited to make VC an increasingly effective option for a growing number of patients who are candidates for the procedure. 3D Imaging Research saw performance gains that equaled a 20x speedup, cutting time from 60 minutes to 3 minutes. Productivity was also enhanced, enabling the hospital to meet a critical deadline for demos at the Supercomputing 2010\* and Radiological Society of North America\* 2010 conferences. Utilization of the forward-scaling cross-platform capabilities was similarly advanced, leveraging one code base to be used across multiple processor targets, saving time and cost.

The reduced waiting times for patients and medical experts were achieved by enabling more performance and reliability, as well as accelerating the speed in processing and displaying images. Enhancing and reducing the image processing time from 60 minutes down to 3 minutes resulted in a time and cost-saving benefit for patients.

Intel® Parallel Studio and the structured workflow approach made possible on-time delivery of code that met the performance, robustness, and maintainability requirements. It also led to a potentially dramatic reduction in the cost of a colonoscopy, thereby making the procedure more comfortable and more widely available. In recognition, MGH 3D Imaging Research earned the award for “Excellence in Design” from the Scientific Assembly at the 2011 Radiological Society of North America conference.

## **How Intel® Software Development Products enabled the solution**

Intel Parallel Studio tool suite was pivotal in improving the speed of the MGH virtual colonoscopy application by exploiting the performance benefits of the cluster and multicore processor technologies. The suite was used to speed up the virtual colonoscopy processing application by up to 20x. To achieve this target, several components of the Intel Parallel Studio tool suite were used.

The Intel® Parallel Advisor component was used first. This initial step identified those areas in the application where the most time was being spent. It clarified which spots would benefit most from parallelism, including those places with the most to gain from significant execution time reduction, whether from serial improvements, parallelizing the code, or by using existing optimized libraries. Several areas were identified where changes to the serial code were worthwhile. Some data structures and algorithms were changed, and the convolution and compression functions in the [Intel® Performance Primitives \(IPP\)](#) were introduced.

## Benefits

- 20X faster processing time, resulting in a reduction from 60 minutes down to 3 minutes, more cost-effective and enhanced patient experience by reducing the typical procedure time, inconvenience, wait time, and cost
- Improved medical specialist with faster access to results and reduced wait time

Following this step, various strategies for introducing [parallelism](#) were proposed and the performance benefit of each was simulated. For a given proposal, Intel Parallel Advisor also simulated any potential conflicts in the parallel regions (e.g., deadlocks, race conditions). This helped assess the correctness of a proposal. Any errors identified by the tool were fixed. After examining several proposals, the one with the highest performance benefit was selected and implemented. The performance of the implementation was characterized using Intel® Parallel Amplifier, while correctness was tested using Intel® Parallel Inspector. Intel Parallel Inspector was then used on the now-parallelized unit test, and on a few occasions it found obscure issues regarding the precise way in which parallelism had been added. It quickly found the causes of crashes that were very hard to see in the source code, and very hard to debug with a debugger.

The working program then had its performance characterized using Intel Parallel Amplifier. The parallelism could be seen, and the next site to address could be chosen. This enabled the work to stay focused on the high-payoff areas. In a few cases, this resulted in deciding to improve a serial algorithm because the benefit would be higher than the next parallel benefit.

Intel Parallel Studio incorporated the parallel model that best fit the virtual colonoscopy application for display, processing, and performance. The result was parallel code that met the target requirements. At the same time, the structured workflow approach helped the developers achieve their performance goals in a well-organized and rapid manner.

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