CASE STUDY
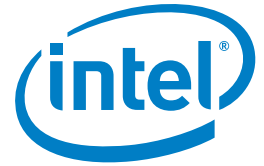**Intel® Xeon® processor 5600 and 7500 series**
Manufacturing
Technologies for Tomorrow's Cloud
High-Performance Computing

(intel)®

3M Transforms Research and Development with an Innovative Hybrid Cluster

System with Intel® Xeon® processor 5600 and 7500 series delivers 50 percent performance gains on a range of applications

3M

"We are a little different in how we support and provide services to our R&D organization. We don't just give them off-the-shelf tools and say, 'Go at it.' We listen to them and try and come up with innovative ways to help them do their job better and faster. More often than not, we are able to help them solve what would have been an intractable problem maybe just a few months ago."

– Peter Bye
Systems Architect,
3M

3M is a science-based enterprise. Its high-performance computing (HPC) IT team works closely with the company's scientists and engineers to provide optimal solutions to their computing needs. In April 2011, the HPC IT team installed an innovative Intel® Xeon® processor-based hybrid cluster that combines shared-memory and cluster computing and a virtualization environment. Peter Bye, 3M HPC system architect for over 15 years, says the 7.2 TF machine runs a full range of technical applications and provides an average 50 percent performance increase compared to 3M's previous Intel Xeon processor X5365-based HPC platform.

CHALLENGES

- **Memory limits.** The Intel® Xeon® processor 3.0 GHz in 3M's five-year-old cluster delivered adequate performance but was limited to single jobs with no more than 16 GB of RAM.
- **Changing business model.** 3M is developing more custom designs for its manufacturing customers. Researchers and engineers need to innovate more rapidly.

SOLUTIONS

- **Intel Xeon processor-based hybrid.** 3M's hybrid cluster combines an SGI Altix* UV 100 with the Intel Xeon processor X7560 and an SGI C2112-based cluster with the Intel Xeon processor X5650. The system runs Red Hat Enterprise Linux* 6.1 and has 624 cores, 3.136 TB of RAM, and a unified Dell Force10* 10 Gigabit Ethernet (GbE) fabric.
- **Virtualization.** 3M virtualizes with Kernel-based Virtual Machine (KVM), an open-source solution that uses Intel® Virtualization Technology (Intel® VT) to run virtual machines (VMs) across shared-memory and cluster resources.
- **High-performance storage and backup.** The system connects to 52 TB of external storage using Panasas PAS* 8 network-attached storage with Intel Xeon processor-based controllers. A new SGI ArcFiniti* file-based archiving solution will use the Intel Xeon processor 5600 series to control 150 TB of backup and archival storage.

IMPACT

- **Flexibility.** 3M increases business agility by running a broad range of HPC software without specialized hardware or custom modifications.
- **Energy-efficient performance.** 3M's applications run an average of 50 percent faster, helping users increase design productivity and innovation. The total system power under load for all equipment in the configuration is an estimated 25.5 kW running the LINPACK* benchmark.
- **Cloud foundation.** The system's virtualized performance gives 3M a solid base for cloud services that will provide additional flexibility. CPU-bound applications show little virtualization penalty.

3M sees promise in the Intel® Many Integrated Core architecture for future performance gains

Virtualization Across Multiple Architectures

3M designs and manufactures more than 40,000 products across nearly every market segment. Its business model has evolved to include more custom design work aimed at helping its manufacturing customers differentiate their products and innovate quickly.

3M's Intel Xeon processor-based hybrid cluster gives the company new power for that work by providing a flexible, one-rack platform that runs the full range of HPC applications. 3M's application set ranges from off-the-shelf packages such as ANSYS*, Abaqus*, Accelrys*, and Fluent* to custom codes developed for niche operating systems. It includes Microsoft Windows*-based applications scaling up from engineering workstations, interactive jobs that need massive amounts of memory, and highly scalable applications that execute across large numbers of cores.

"In the past, we got requests from folks who needed to run something that we couldn't do without making some serious architectural changes or purchasing additional hardware," Bye explains. "More often than not, we wound up having to buy hardware and custom-configure it for a project that might only last six weeks. With the new system, we can give them a lot of flexibility for experimentation, and the resource load on our team for those requests is reduced to almost zero. We can provide them with a resource almost on demand. They can test out their ideas quickly without spending a lot of time or money. We're giving them the freedom to fail or succeed faster."

As a result, HPC users can refine their designs more quickly, improving product quality and engineering productivity. 3M can respond more quickly to its customers, delivering greater value and innovation.

Price-Performance and Relationships

3M chose the hybrid cluster after following best practices for systems procurement. "We wrote a Request for Proposal (RFP) that had a rather loose architectural design, and ran the system acquisition as a Six Sigma New Systems Introduction (NSI) project," Bye recalls. "We had a team of end users involved in selecting proposals and scoring them."

Although 3M's RFP did not specify a processor, all the proposals were based on Intel Xeon processors. "Intel and its competitors have leapfrogged themselves over and over again, but it seems that Intel keeps pulling a better rabbit out of the hat," says Bye. "This solution came down to flexibility and the most bang for the buck. It provided good density and an excellent price-performance point between the number of cores and the work it can do in a given time period. We've had good relationships with Intel and SGI, and we like the fact that they work together very well when we ask for something 'a little different.' We have a good three-way collaboration that gives us an optimal solution at a good price-point."

Next-Generation Performance
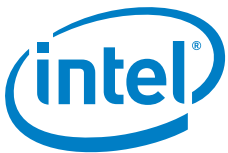
Always looking ahead, Bye says he's interested in the Intel® Many Integrated Core (Intel® MIC) architecture the company demonstrated in 2011. "We definitely have applications that can use it," he says. He plans to expand the hybrid cluster's flexibility by developing cloud-based services that will automate the delivery of system resources—in particular, Microsoft Windows in a virtualized environment.

And he's eying the Intel Xeon processor E7 and E5 families to keep him ahead of his users' steadily increasing performance needs. "Our primary interest is higher performance per core, and we definitely have an eye on Intel's next generation," Bye says in conclusion. "We will keep looking for ways to innovate in IT so our HPC users can innovate in their work and do what they need to do."

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