

DATA CENTER EFFICIENCY

# 3M Teams with Intel and SGI on Sustainability Breakthrough

3M's two-phase immersion-cooling technology shows potential to transform the data center of the future

3M is a multibillion-dollar global manufacturer with a 40-year commitment to environmental leadership. It is also an innovation powerhouse that encourages employees to devote 15 percent of their work time to their own projects.

Now, 3M's leadership has combined sustainability and innovation in a breakthrough that the company says can reduce the energy required to cool data center equipment by 95 percent while enabling a tenfold increase in density. 3M teamed up with Intel and SGI to create a fully functional, proof-of-concept supercomputer that uses the Intel® Xeon® processor E5-2600 product family and SGI ICE\* X distributed memory supercomputer to demonstrate 3M's innovative, two-phase immersion cooling technology based on 3M™ Novec™ Engineered Fluids.

## Immersion Cooling at Atmospheric Pressure

3M's breakthrough is the brainchild of Philip Tuma, an advanced application development specialist in the company's Electronic Materials Solutions Division. Tuma works with semiconductor manufacturers and others to develop creative applications of Novec Engineered Fluids and other 3M technologies. Novec-brand fluids are environmentally sustainable, nonconductive liquids known for their efficient heat transfer properties. They're used everywhere from aerosol cleaners to fire suppressants.

Tuma saw a way to use Novec Engineered Fluids, applying techniques common in other industries, to solve problems that have plagued many liquid cooling technologies. Past approaches to two-phase immersion cooling have often required pressurized containers and hermetically sealed connectors, making the systems expensive, complex, and difficult to service.

"I saw an opportunity for us to not only find a new market segment for our products, but to increase overall energy efficiency, do something good for the environment, and solve a huge problem in the technology industry," Tuma recalls.

With his management encouraging him to explore the possibilities, Tuma found an elegant solution in open bath immersion. "None of the things we're doing are

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particularly radical," he explains. "One idea we've adapted is the concept of vapor degreasers, which are used for precision cleaning of everything from ball bearings to hip implants. You've got a tank like a chest freezer with a boiling solvent in it. The solvent vapor rises up to a condensing coil, creating a vapor zone beneath the coil. You put the parts in the vapor zone to be cleaned by the condensing solvent. Instead of a cleaning solvent for ball bearings, we're immersing servers in an open bath with a Novec Engineered Fluid. The Novec fluid vaporizes and carries away the heat to facility water flowing through the condenser coils."

In 3M's implementation, the open bath operates at atmospheric pressure, eliminating the costs and complexity of hermetically sealed connectors and providing easy access for swapping compute, memory, and power components. Freed of the need for airflow and cooling components, computing elements can be packed together more tightly. Heat generated by the process can be captured and reused. The result is a solution that dramatically increases energy efficiency, density, and sustainability while reducing water consumption and energy costs.

### Collaborating to Accelerate Progress

3M forges deep, open relationships with its industrial customers and industry collaborators, and the immersion cooling project was no exception. Tuma began publishing his work and collaborating with interested organizations. One, Lawrence Berkeley National Laboratory, recommended bringing SGI and Intel in to help create a full-scale demonstration of the 3M technology using industry-standard hardware.

"Intel and SGI are obviously very involved in energy-efficiency innovations and, like us, they want to get to the finish line faster," Tuma says. "SGI discounted the hardware and made firmware modifications. Intel provided processors, and we had great discussions with Intel thermal architects and green technology experts. You can meet a lot of skepticism when you're doing something that's so different, so to have such knowledgeable people validating your approach is very rewarding."

### Sustainable Technologies for a Warmer Planet

The project's next phase involves analyzing the supercomputer's heat transfer properties, using both the Berkeley Labs system and an identical model that is performing production high-performance computing (HPC) work in 3M's data center. Tuma also leads a team working with other companies to advance the use of the technology. More than 45 demonstrations of 3M's cooling technology are underway. And the 3M technology is in production use in Hong Kong, where a consulting engineering company has created a large-scale system for a company that's using it to process bitcoin transactions.

As a stepping stone to more energy-efficient data centers, 3M's cooling technology may prove crucial in supporting sustainable performance improvements for cloud computing, the Internet of Things, and HPC. 3M's approach also requires far less water than traditional air cooling, making it especially relevant for areas with high temperatures and tight water supplies.

## At a Glance

### Project

- Create a proof-of-concept supercomputer based on 3M's two-phase immersive cooling technology

### Accomplishments

- Built a fully functioning supercomputer with the potential to reduce energy consumption by 95 percent and provide a tenfold increase in density compared to typical air-cooled systems

### Key Technologies

- 3M™ Novec™ Engineered Fluids
- SGI ICE<sup>+</sup> X supercomputer with half a 21U rack (144 sockets) of the Intel® Xeon® processor E5-2600 product family

### Lessons Learned

- To increase innovation in your organization, give employees time to explore new ideas. Provide resources to go further with promising concepts. Collaborate with other industry leaders to solve significant problems.
- As you plan your next data center, keep abreast of advancing technologies. Talk with vendors about their next-generation strategies. Make sustainability a priority.

"Climate change represents a risk to the data center," says Il Ji Kim, marketing manager at 3M's Electronics Materials Solutions Division. "If you're in a hot environment or an area that experiences drought conditions, you don't want to be using water to cool the data center. This technology has a lot of benefits for environmental sustainability."

3M expects two-phase immersion cooling technology to appear first in containerized data centers. "We believe two-phase immersion cooling with Novec Engineered Fluids will be available as a commodity technology for HPC within the next five years," Kim says. "Once this technology is available at a commodity level, we see it benefiting any large data center, especially in harsh environments."



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