WHAT'S NEXT

WHAT'S NEXT; Wiggling Fans and Other Ways to Keep a Computer Cool

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HOT air rises, but none too easily inside computers, because the source of most of the heat -- the silicon chips that run the show -- are buried deep in the machine.

These chips are getting ever hotter as more and more transistors are crowded onto them and made to switch on and off faster and faster. How hot do they get? Put your hand close to a 100-watt light bulb and then imagine that much heat and more beaming out of a space the size of a small postage stamp. That is the wattage generated by a typical high-performance microprocessor these days, and next-generation chips are expected to put out 150 to 200 watts.

All that heat concentrated in a small, enclosed space must be dissipated for the computer to do its job, because the hotter the processor grows, the lower its performance and reliability.

Temperatures warmer than about 200 degrees Fahrenheit significantly hamper performance and reliability.

To deal with the problem, researchers across the country are working on innovative techniques, from noiseless fans to microchannels carved into silicon chips themselves.

One such group is at Purdue University in West Lafayette, Ind., led by Dr. Suresh V. Garimella, an associate professor of mechanical engineering.

"The cooling problem is huge at various levels, at the chip level, the ceramic or plastic level where the chips are packaged, and at the printed wireboard level -- it all multiplies," Dr. Garimella said. "But the worst problem is at the chip level because there is such small access to it."

His group plans a conference at the end of the month on the subject of cooling. Among the possible solutions to be highlighted is a tiny fan that its inventors say provides air flow with minimal power consumption and almost no noise. It was developed by Dr. Garimella with colleagues including Dr. Arvind Raman, another mechanical engineer Their work is sponsored in part by Apple Computer.

The fan has tiny, flexible blades that are less than an inch long and about one-tenth of an inch wide that are bonded to a special material, a piezoelectric ceramic that deforms, bending the blades, when a current is applied to it.

Current is then applied in the alternate direction, making the blades bend the other way. The blade bends back and forth this way, moving air with little power consumption and little sound.

The fans are not meant as a replacement for regular rotary fans but are rather intended for

tight spots on laptops. "It's as bad as Manhattan on a laptop," Dr. Raman said. "Really crowded." There are many sources of heat in addition to the central chip, he said, including CD or DVD drives. Throughout the computer are other components that also impede the flow of cooling air.

Ancestors of the piezoelectric fans adapted by Dr. Garimella's group have been in development since the 1970's, but the surge in development of portable electronics in the last few years that has made their use more attractive.

Dr. Garimella is leading another research project that takes a different tack on the problem of heat. He and colleagues including Steven Wereley are carving microchannels in the silicon chips to conduct the heat elsewhere.

In many current cooling systems, the central processing unit uses cooling fins and a fan to suck heat away as the unit performs millions of operations per second and the temperature rises.

Microchannels, in contrast, move the cooling process to the chip. "One side of the chip typically has the logic, that is, the gates," Dr. Wereley said, "and the other side has the channels."

The width of the channels varies from large (the size of a human hair) to small (the size of a white blood cell). The research group is examining ways to force liquid coolant through the small channels, including acoustic pumping, in which a thin vibrating membrane is used to create the flow. "Pulling the heat out of these things is tough," said Dr. Wereley, who will present some of this research at the conference.

Other approaches, too, will be discussed, including a miniature version of the vapor compression cycles used to cool refrigerators, and advanced versions of the heat pipes widely used in laptops.

Conferences like the one being held at Purdue are essential, said Dr. Yogendra Joshi, a professor of mechanical engineering at the Georgia Institute of Technology in Atlanta.

Dr. Joshi is an expert in the thermal management of electronics and is taking part in a project financed by a Defense Advanced Research Projects Agency grant to examine the problems of cooling.

Right now, heat in computers is still relatively easy to remove, he said. "But in the next generation, when we have chips throwing off 200 watts, this is going to be a major showstopper," Dr. Joshi said.

For high-performance computing technology to go forward, he said, "a whole community of mechanical and electrical engineers is going to have to get around this roadblock."

Drawing (Terry Miura)


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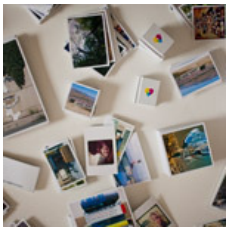
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