Too Hot to Handle

When things get too hot, that’s a problem for electronic systems of all shapes and sizes. When chips in your smartphone get too hot, the device literally burns your hand. Chips in a supercomputer get too hot, too, and their cooling systems end up burning a lot of money on electricity bills. Cooling costs are starting to dominate total expenses in datacenters, ranging from 30 to 60 percent of the total electricity charges.

Seda Ogrenci-Memik, electrical engineering and computer science, and her group develop tools, methods, and devices to manage, sense, and dispose of heat accumulated in integrated circuits and the rest of computing systems. Her efforts range from enabling thermal-aware operating systems for supercomputers to devising thermal management software for reducing heat-induced discomfort in smartphones.

Ogrenci-Memik’s team develops thermal models and run-time temperature prediction mechanisms. In the past her thermal models have been embedded into DRAM memory management to optimize data layout so that fewer access requests are sent to hotter memory banks. One of her current projects, in collaboration with Argonne National Laboratory, focuses on providing hints to a supercomputer’s operating system on the thermal consequences of its job allocation policies. For instance, constantly pounding on a hot rack with high-intensity computing jobs would make the system slow down when the heat-induced leakage power wasted by that rack’s chips begins to snowball, leaving much less power available for crunching numbers. With proper guidance, when allocating computing jobs that need to be well synchronized, the operating system can successfully avoid allocating them on racks of wildly different temperatures and, hence, execution speeds.

Ogrenci-Memik also applies her expertise on thermal-aware design to new ways of sensing and monitoring chip temperatures. Her team develops novel nanoscale sensors, using thin film materials that can be layered between stacks of semiconductors and effectively organized as a large thermal monitoring network.