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TITLE:

Matching Demand & Supply in Cooling of High Performance Microprocessors: From Scaling Laws to Device Applications

ABSTRACT:

In this presentation, I will frame a problem of thermal management of high performance electronic devices in the context of matching resources with demands in time and space domains in order to achieve a target performance with minimal system overhead. To this end, scaling laws will be developed and used to demonstrate how a suitable metric(s) of cooling performance, different for different applications and device architectures, should drive design of the thermal management system and selection of the proper cooling method and substance. I will follow with several specific examples of cooling solutions that exploit the fundamental physical principles, which transpired from the scaling laws, to address the challenges of heat removal and microprocessor temperature control in a resource-efficient fashion. These include (1) a "perspiration nanopatch" for evaporative phase-change cooling of ultra-high power dissipation "hot spots", (2) a "thermal transformer" (fluid-to-fluid/spot-to-spreader F2/S2 heat sink) for managing heat removal from both the large-area background and multiple hot spots, and (3) a "composite thermal capacitor" (CTC) network for transient thermal management of multicore 2D&3D architectures. If time permits, I will also introduce new ideas on "supercharging" the conventional air-cooled heat sinks using integrated evaporative cooling.