"Designing an energy efficient climate supercomputer for the exascale era"

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Traditional approaches to the scaling of commodity desktop processor technology that focus on raw per-core sequential performance are running into an insurmountable power wall. It is clear from both the cooling demands and the electricity costs, that the growth in scientific computing capabilities of the last few decades is not sustainable unless fundamentally new ideas are brought to bear. In this talk we propose a novel approach to supercomputing design that leverages the sophisticated tool chains of the consumer electronics marketplace. We analyze our framework in the context of high-resolution global climate change simulations – an application with multi-trillion dollar ramifications to the world economies. A key aspect of our methodology is hardware-software co-tuning, which utilizes fast and accurate FPGA-based architectural emulation. This enables the design of future exaflop-class supercomputing systems to be defined by scientific requirements instead of constraining science to the machine configurations. Our talk will provide detailed design requirements for a kilometer-scale global cloud system resolving climate models and point the way toward Green Flash: an application-targeted exascale machine that could be efficiently implemented using mainstream embedded design processes.