Temperature-Aware Processor Frequency Assignment for MPSoCs Using Convex Optimization

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The increasing processing capability of Multi-Processor Systems-on-Chips (MPSoCs) is leading to an increase in chip power dissipation, which in turn leads to significant increase in chip temperature. Uneven thermal profiles in an MPSoC can cause transient reduction in overall system performance, unreliable timing delay variations, or even permanent damages in the devices. An important challenge facing the MPSoC designers is to achieve the highest performance system operation that satisfies the temperature and power consumption constraints. The frequency of operation of the different processors and the application workload assignment play a critical role in determining the performance, power consumption and temperature profile of the MPSoC. In this paper, we propose novel convex optimization based methods that solve this important problem of temperature-aware processor frequency assignment, such that the total system performance is maximized and the temperature and power constraints are met. We perform experiments on several realistic SoC benchmarks using a cycle-accurate FPGA-based thermal emulation platform, which show that the systems designed using our methods meet the temperature and power consumption requirements at all time instances, while achieving maximum performance.