HiPER-NIRGAM: A TOOL CHAIN BASED FRAMEWORK FOR MODELING THERMAL-AWARE RELIABILITY ESTIMATION IN 2D MESH NoCs

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Abstract—Every three years, power density in system-on-chip (SoCs) gets doubled. As the semiconductor technology is scaling, the number of cores and interconnect network connections are increasing. To improve system performance while meeting permissible power limits, Chip-Multi Processors (CMPs) and many-core processors have emerged as an appealing solution. One of the significant aspects of many-core design is an on chip interconnect network that can effectively support intra-core and inter-core communications. This interconnect should be scalable, support high communication bandwidth and multiple concurrent connections among cores. Network-on-chip (NoC) replaces the traditional bus based interconnect architecture as former is scalable, has higher bandwidth, fault tolerance and offers parallelism. Regular NoC topologies improve scalability too. Adaptive NoC routing solutions distribute power densities and delay onset of hotspot creation. With ever-growing demand of computation and communication bandwidth by applications, the system designer need to consider and address resultant power and thermal issues in SoC as well as NoC design. Design tools need to incorporate thermal effects in design and evaluation of prototypes.

Figure 1. HiPER NIRGAM Framework

Regional temperature differential and hotspots are two thermal problems in network-on-chip. On-chip thermal problems have an adverse impact on system performance and reliability. We propose creation of a toolchain based framework for incorporating thermal evaluation of NoC through existing simulation tools. Our proposed framework provides an integration of NoC simulator with power and thermal simulation models for analyzing the thermal hotspots and can be used for thermal-aware reliability estimation. In our framework, reliability estimation is based on life time failure models such as TDDB (Time dependent dielectric breakdown), NBTI (Negative bias temperature instability) and SM (Stress Migration). In our proposed reliability measurement is based on MTTF (Mean time to failure) comparative value. Our tool chain consists NIGRAM [1] as a NoC simulator, NoC configuration parameters such as number of virtual channel, buffer size, routing logic, simulation cycles and application traffic are passed to power models (Orion 2.0 [3] and McPAT [4]). Power models provide the power trace and area of given NoC configuration. The power model results are further used in Hotspot 5.02 [2] thermal simulation model for generating floorplan and temperature trace (steady temperature file). The steady temperature trace used in reliability estimation tool REST [5] to estimating MTTF values. Figure 1 shows the work flow of proposed HiPER-NIRGAM framework.

We believe that this generic framework can be used by researchers on academia and industry to incorporate thermal-aware reliability estimation in their design exploration.

Key words : Power density, Hotspot, Reliability, MTTF.

REFERENCES