SysScale: Exploiting Multi-domain Dynamic Voltage and Frequency Scaling for Energy Efficient Mobile Processors

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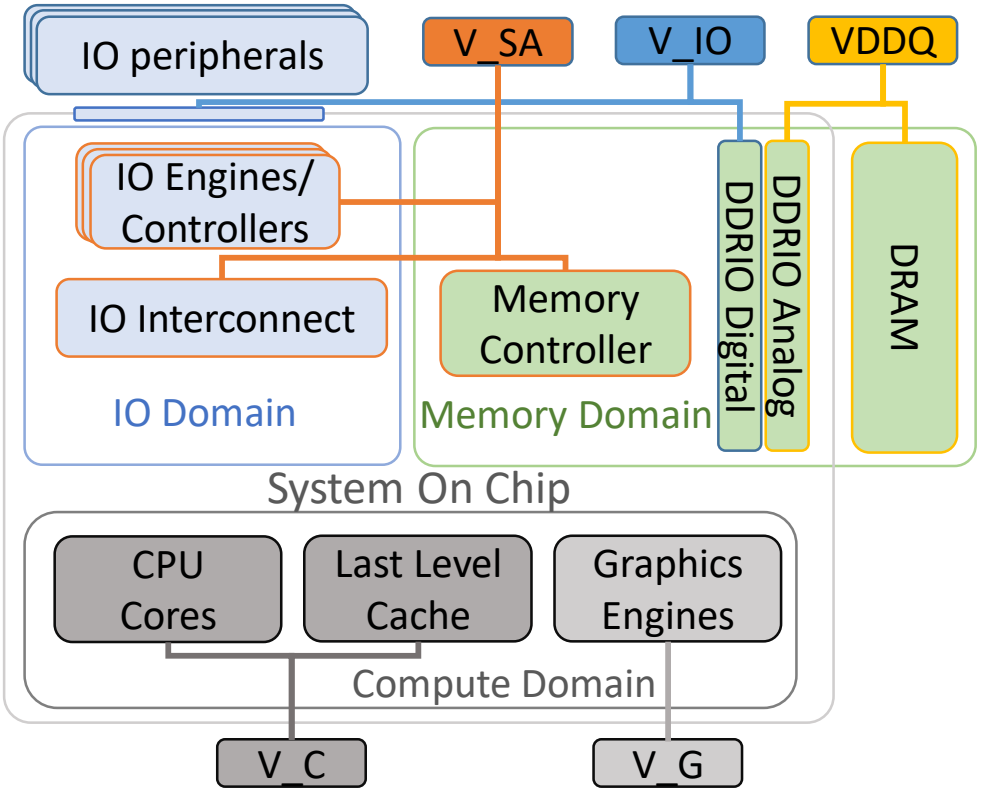
Overview of a Modern SoC Architecture

- 3 domains in modern thermally-constrained mobile SoCs: Compute, Memory, IO
- Several voltage sources exist, and some of them are shared between domains
- IO controllers and engines, IO interconnect, memory controller, and DDRIO typically each has an independent clock



- **Compute domain** supports dynamic voltage and frequency scaling.
- IO and memory domains have *fixed* clock frequencies and voltages.

Our Goal: Holistic SoC Power Management

- We conduct a motivational study on a real Intel Broadwell SoC
- We conclude that a *holistic power management approach* is **needed** to mitigate the power management inefficiencies in current mobile SoCs

- **Our goal is to provide such an efficient multi-domain power management approach**
  - by dynamically orchestrating the distribution of the SoC power budget across the *three* domains based on their actual performance demands

SysScale

- **SysScale** is a new multi-domain power management technique to improve the energy efficiency of mobile SoCs

- SysScale is based on three key ideas:
  1. A new DVFS (dynamic voltage and frequency scaling) mechanism to distribute the SoC power to each domain based on its predicted performance demand
  2. An accurate algorithm to predict each domain's performance demand
  3. Domain-specialized techniques to optimize the energy efficiency of each domain at different operating points

SysScale: Key Results

- SysScale is the first work to enable coordinated and highly-efficient DVFS across all SoC domains to increase energy efficiency

- SysScale optimizes and efficiently redistributes the total power budget across all SoC domains based on the performance demands of each domain

- We implemented SysScale on the Intel Skylake SoC for mobile devices
  - SysScale improves the performance of real CPU and graphics workloads (by up to 16% and 8.9%, respectively, for 4.5W TDP)
  - SysScale reduces the average power consumption of battery life workloads (by up to 10.7%) across all TDPs of the Intel Skylake system

- We **show** that SysScale is an effective approach to balance power consumption and performance demands across all SoC domains

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