Thermal and Energy Efficiency of Heterogeneous Mobile SoCs: Current and Upcoming Trends/Challenges

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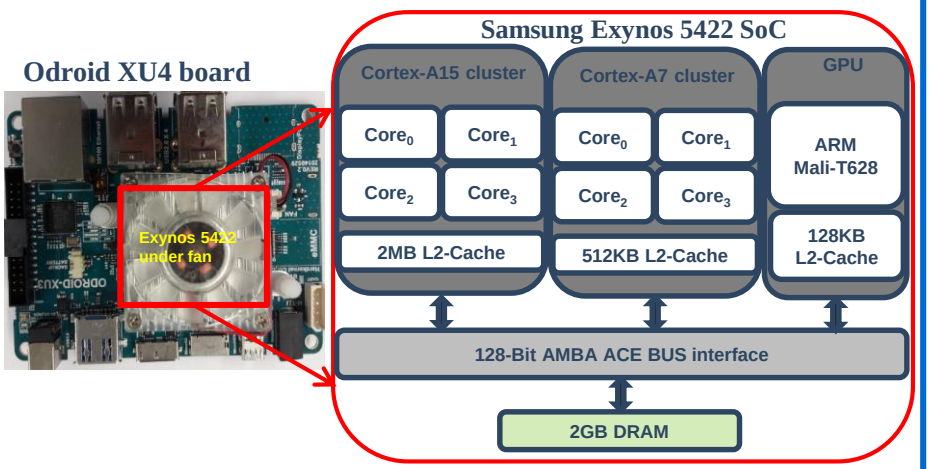
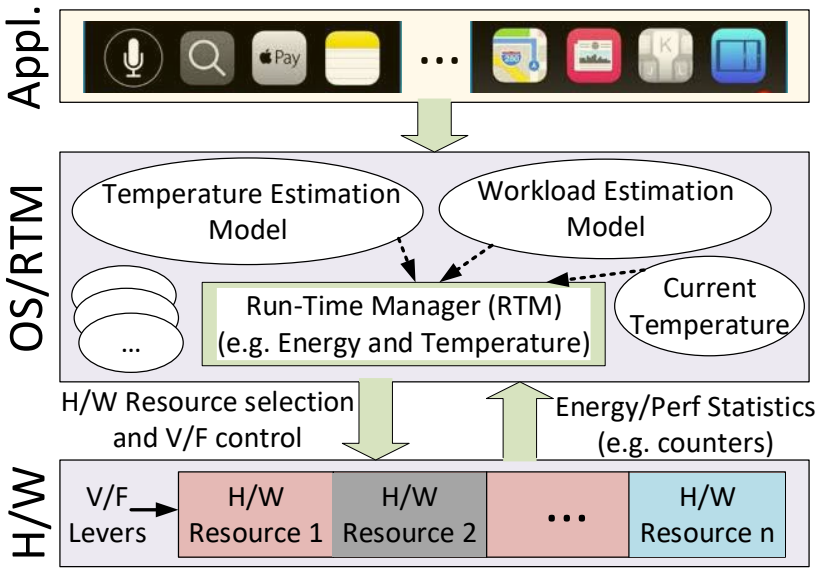
Introduction

- Modern mobile SoCs are containing greater number of heterogeneous cores to support highly diverse and varying workloads
- To meet performance, energy consumption and thermal efficiency requirements, the process of thread-to-core mapping and setting DVFS levels can be exploited
- The process becomes complex with increasing concurrent applications and heterogeneity

A Heterogeneous Mobile SoC



Mapping and DVFS Process



State-of-the-art: Shortcomings

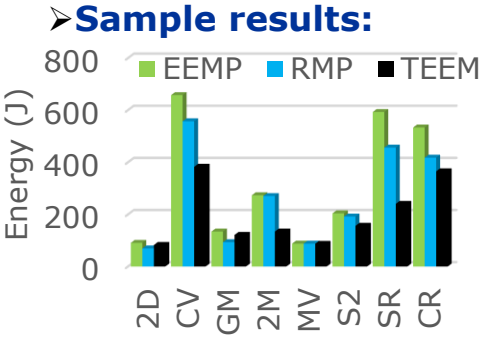
- Mostly use heavy application-dependent profile data -> not efficient in managing dynamic workloads with unknown applications
- Do not perform adaptations (changing the mappings and/or DVFS settings) at an application arrival/completion, and performance variations.

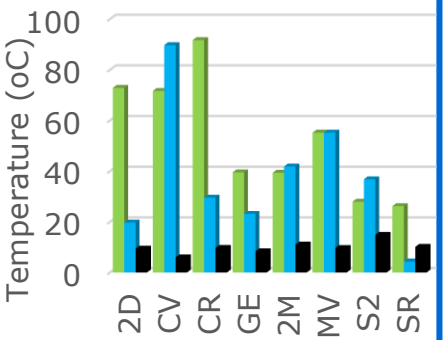
Adaptation for Thermal and Energy Efficiency

- **Adapting DVFS with reliance on profiled data**
  - Predictive Thermal Management for Energy-Efficient Execution of Concurrent Applications on Heterogeneous Multicores, *in IEEE TVLSI 2019*
  - EdgeCoolingMode: An Agent Based Thermal Management Mechanism for DVFS Enabled Heterogeneous MPSoCs, *in IEEE VLSID 2019*
  - Teem: Online thermal-and energy-efficiency management on cpu-gpu mpsocs, *in IEEE DATE 2019*
- **Adapting DVFS without reliance on profiled data**
  - User Interaction Aware Reinforcement Learning for Power and Thermal Efficiency of CPU-GPU Mobile MPSoCs, *in IEEE DATE 2020*
- **Adapting Mapping and DVFS with reliance on profiled data**
  - Collaborative adaptation for energy-efficient heterogeneous mobile SoCs, *in IEEE TC 2019*
    - Adaptation happens at application arrival and departure
    - It can be extended to consider a thermal threshold
- **Adapting Mapping and DVFS without reliance on profiled data**
  - AdaMD: Adaptive mapping and DVFS for energy-efficient heterogeneous multi-cores, *in IEEE TCAD 2019*
    - Adapts to runtime execution scenarios efficiently by monitoring the application status, and performance/workload variations.
    - It can be extended to consider a thermal threshold

Experiments

- On Odroid XU3/XU4, Galaxy Note 9, Huawei P20 Lite
- Currently considering Google Pixel 3
- **Sample results:**





Upcoming Trends & Conclusions

- Hierarchical Management for Multi-cluster SoCs
- Increasing Application Domains
- Multi-objective Optimizations
- Secure and Efficient Interaction with Cloud
- Adaptation for thermal and energy efficiency
- Dynamic Energy and Thermal Management of Multi-Core Mobile Platforms: A Survey, *in IEEE D & T, 2020.*

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