Frame-based and Thread-based Power Management for Mobile Games on HMP Platforms

Abstract:
Games belong to the most popular but power-hungry applications on smartphones. Gaming workloads exhibit highly variable and user-interactive behavior, which makes it hard to predict the workload. Modern MPSoC (multiprocessor system-on-chip) platforms are equipped with heterogeneous multi-processing (HMP) processors comprising performance-oriented and energy-efficiency cores in order to better exploit power-performance trade-offs among different types of applications. To minimize the energy consumption of games on HMP platforms, it is essential to precisely predict the gaming workload and perform joint thread-to-core allocation as well as dynamic voltage and frequency scaling (DVFS). In this paper, we propose a frame- and thread-based MPSoC power management strategy for games. We focus on the fact that gaming workload has high temporal correlation among frames and evaluate selected workload predictors on a per-frame basis. Moreover, we find that there are two categories of thread workloads, periodic and aperiodic, and hence, propose to use a hybrid workload predictor. Based on the per-thread predictions, the power manager allocates the threads among the heterogeneous cores in an evenly distributed fashion in order to minimize the operating frequency while keeping the frames-per-second (FPS) constraint. We implement the game power manager as an Android governor on a state-of-the-art platform based on the Exynos5422 SoC, which is also
incorporated in the Samsung Galaxy S5 smartphone. Our measurement results show that we save on average 41.9% of energy compared to the Android default governor. Further, we have performed a user study to evaluate the user perception of our governor. The gaming experience was rated between good and very good for all games.