Selective QoS Guarantees for Heterogeneous Applications in Android Memory Management

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1. INTRODUCTION
With the recent advances in mobile embedded system technologies, computing paradigms are shifting from desktop PCs to smart embedded devices. Such transitions require an embedded device to provide general-purpose computing functionalities like desktops, beyond its traditional single-task real-time features. However, Android, which is most promising operating systems for embedded devices, has no awareness of supporting heterogeneous jobs, i.e., real-time and non real-time tasks [1]. As for the memory management, Android manages memory spaces in an on-demand manner that allocates memory upon a request and reclaims it if not used for a long time. This is efficient in terms of space-efficiency, but it cannot support real-time applications as memory access time is not predictable. Note that traditional real-time operating systems reserve entire memory spaces necessary for a real-time task, thereby preventing unpredictable delay due to page faults. However, this pinning policy essentially degrades the performance of non real-time jobs. Motivated by this, we present a new memory management technique that guarantees the deadline requirements of real-time application and also minimizes the performance penalty of non real-time applications.

2. THE PROPOSED POLICY
Our policy predicts the minimum memory size required for a real-time application to guarantee a certain level of QoS. The prediction relies on the Belady’s lifetime model which obtains the minimum memory size for achieving the given hit ratio, by monitoring past behaviors of applications [2]. Then, we ensure the memory space for real-time programs as required, while allowing remaining spaces for non real-time applications. This policy strikes a balance between supporting a real-time application and overall system performances in a judicious way.

3. PERFORMANCE EVALUATIONS
Performance evaluation is performed through trace-driven simulations. Figure 1 shows the performance of the proposed policy (DQ) compared to on-demand memory allocation (OND) and pinning (PIN) policies. We assume two scenarios where heterogeneous jobs are running together, Facebook and Youtube, and Navermap and Tictoc (real-time chatting program), respectively. As shown in the figure, the proposed policy improves the performances of non real-time applications to a comparable level with an on-demand policy without nearly incurring deadline misses of real-time programs. Specifically, the performance gap between on-demand policy and the proposed policy is within only 0.4% in non real-time applications. As for the real-time applications, the proposed policy satisfies deadlines by almost same ratio with the pinning policy. This demonstrates that our memory requirement prediction is fairly accurate.

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5. REFERENCES