Event-Driven Power Management

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Energy consumption of electronic devices has become a serious concern in recent years. Power management (PM) algorithms aim at reducing energy consumption at the system-level by selectively placing components into low-power states. Formerly, two classes of heuristic algorithms have been proposed for PM: timeout and predictive. Later, a category of algorithms based on stochastic control was proposed for PM. These algorithms guarantee optimal results as long as the system that is power managed can be modeled well with exponential distributions.We show that there is a large mismatch between measurements and simulation results if the exponential distribution is used to model all user request arrivals. We develop two new approaches that better model system behavior for general user request distributions. Our approaches are event-driven and give optimal results verified by measurements. The first approach we present is based on renewal theory. This model assumes that the decision to transition to lowpower state can be made in only one state. Another method we developed is based on the time-indexed semi-Markov decision process (TISMDP) model. This model has wider applicability because it assumes that a decision to transition into a lower-power state can be made upon each event occurrence from any number of states. This model allows for transitions into low-power states from any state, but it is also more complex than our other approach. It is important to note that the results obtained by renewal model are guaranteed to match results obtained by TISMDP model, as both approaches give globally optimal solutions.We implemented our PM algorithms on two different classes of devices: two different hard disks and client–server wireless local area network systems such as the SmartBadge or a laptop. The measurement results show power savings ranging from a factor of 1.7 up to 5.0 with insignificant variation in performance.