Real Time Load Switching for Peak Peripheral Efficiency

# Abstract

Embedded systems are characterized by a narrow focus on sensing, control and communications. Each of these tasks requires the expenditure of energy outside the predictable computational energy budget of the embedded processor. It follows that there efficiency gains to be harvested if the system were able to accurately characterize and predict load-changes while enabling the most efficient source of energy to supply it.

# Related Work

Embedded power management to date is split into two distinct fields: Dynamic Power Management (DPM) and Dynamic Voltage and Frequency Scaling (DVFS).

## Dynamic Power Management

DPM techniques exploit power switching capabilities (clock-gating for example) in order to disable sections of the system while they are unused. Of course, disabling the section entirely results in a wake-up time for that section and therefore, significant research has gone into determining the optimal time to wake up the disabled section so as to have no increase in latency.

The break-even time is the figure of merit for DPM as it pertains to energy savings. If a device requires a long wake-up time (a time in which it is incapable of being used), then it is incumbent on the system to determine how to best schedule the disabling of the device.

## Dynamic Voltage (and Frequency) Scaling

Modern embedded Systems on Chip (microcontrollers) consume power at a rate of where f is the switching frequency of the circuit and C is the MOSFET gate capacitance. Vdd, the switching voltage is ripe for optimization because power consumption is proportional to the square.

In addition to the substantial power savings afforded by decreasing Vdd, microcontrollers also have a linear relationship between maximum possible switching frequency and the switching voltage. Thus, reductions in voltage result in decreasing the maximum possible frequency of the microcontroller.

In situations where peak performance is not required of the system, the frequency is adjusted downwards simply to minimize the linear part of the power consumption equation. Thus, if possible, it is also desirable to adjust the switching voltage to match the switching frequency.

## Embedded Peripherals

Most research to date regarding the energy optimization of embedded peripherals makes use of DPM. This is natural because most embedded peripherals include some form of ‘shutdown’ mode that allows the system to drastically decrease the static power consumption of the device. Thus, a significant amount of research has gone into determining the optimal breakeven time of embedded peripherals.

No research to date has investigated the voltage / performance relationship of embedded peripherals.