COMP 7970 Storage Systems

Predictive Techniques

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Static Techniques – Example
StrongARM CPU

Break-even time for Sleep is 160ms. Timeout > 160ms.

Game trace
What about $T_{TO} = T_{BE}$?

- Timeout value = Break-even time

An energy consumption is at worse twice the energy consumed by an ideal policy

Reason?

The worst case happens for traces with repeated ideal periods of length $T_{idle} = 2 \times T_{BE}$
Timeout Schemes - Limitations

- **Issue 1**: Waste a sizeable amount of power
- **Issue 2**: Pay penalty upon wakeup
Predictive Shutdown

• To take PM decisions as soon as a new idle period starts, based on the observation of past idle and busy periods

• Approach 1: Nonlinear regression equation

\[ T_{\text{pred}} = \phi(T_{\text{active}}, T_{\text{idle}}, \ldots, T_{\text{active}}, T_{\text{idle}}) \]

If \[ T_{\text{pred}} > T_{BE} \] then? shutdown
Predictive Shutdown (cont.)

- Approach 2: A threshold

\[
\text{If } \frac{T_{n-1}^{active}}{T_{BE}} < \frac{T_{Thr}}{T_{BE}} \text{ then the idle period is assumed to be larger than } T_{BE} \text{ and the system is shut down.}
\]

Why?
Predictive Shutdown (cont.)

Short active periods are often followed by long idle periods.

$T_{Thr}$ is critical!  

L Shape
Predictive Shutdown (cont.)

$T_{Thr}$ is critical!
Adaptive Techniques

- Static predictive techniques are suboptimal (i.e., ineffective) when workload is unknown.
Adaptive Techniques (cont.)

• **Approach 1:**
  – A set of timeout values
  – An index indicates how successful a timeout value would have been
  – Choose the best timeout value

• **Approach 2:**
  – Assign a weight to each timeout based on how well it would have performed relatively to an offline strategy for past requests

• **Approach 3: (Feedback)**
  – One timeout
  – Increase it when it is causing too many shutdowns
  – Decrease it when more shutdowns can be tolerated
Stochastic Control

• Static Techniques vs. Adaptive Techniques
• Predictive approaches:
  – Address workload uncertainty
  – But assume deterministic response and transition times
• Stochastic model
  – Safe
  – General