Cache Persistence Aware WCRT Analysis for FPPS

Syed Aftab Rashid, Geoffrey Nelissen and Eduardo Tovar
Context

- CPU
- Cache
- Main Memory

Fast

Slow

Limited capacity
**Context**

Diagram showing the flow of data between CPU, Cache, and Main Memory. The diagram illustrates the limited capacity of the cache and the distinction between fast and slow memory access.

- **CPU** to **Cache**: Fast
- **Cache** to **Main Memory**: Slow

Limited capacity

**Graphs**

- $T_1$
- $T_2$
Context

Limited capacity

CPU

Fast

Cache

Slow

Main Memory

T₁

T₂

Cache Related Preemption Delay (CRPD)
Motivational Example

- Taskset \{T_1, T_2\}
  \[C_1 = 100 \text{ and } T_1 = 200\]
  \[C_2 = 400 \text{ and } T_2 = 1000\]
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![Diagram showing cache contents and task sets](image)
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\[MD(R_2) = MD_2 + 3MD_1 + \text{CRPD}\]

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\begin{align*}
\text{MD}(R_2) &= \text{MD}_2 + 3\text{MD}_1 + \text{CRPD} \\
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\begin{align*}
\text{MD}(R_2) &= \text{MD}_2 + 3\text{MD}_1 + \text{CRPD} \\
\text{MD}(R_2) &= \text{MD}_2 + \text{MD}_1 + 2(\text{MD}_1 - |\text{PCB}|) + \text{CRPD}
\end{align*}
\]
Contributions
Contributions

• Improved WCRT analysis for fixed priority preemptive systems

\[ R_i(t) = P_i + MD_i + \sum_{\forall j \in hp(i)} P_j + MD_j + \sum_{\forall j \in hp(i)} CRPD_{i,j} \]

\[ + \sum_{\forall j \in hp(i)} \left[ \frac{R_i}{T_j} - 1 \right] \times (P_j + MD^r_{j} + CPRO_{j,i}) \]
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Considering the effect of PCBs
Contributions

• Improved WCRT analysis for fixed priority preemptive systems

\[ R_i(t) = P_i + MD_i + \sum_{\forall j \in hp(i)} P_j + MD_j + \sum_{\forall j \in hp(i)} CRPD_{i,j} \]

\[ \sum_{\forall j \in hp(i)} \left[ \frac{R_i}{T_j} - 1 \right] * (P_j + MD^r_j + CPRO_{j,i}) \]

Considering the effect of PCBs

Considering evictions of PCBs
Contributions

• Improved WCRT analysis for fixed priority preemptive systems

\[ R_i(t) = P_i + MD_i + \sum_{\forall j \in hp(i)} P_j + MD_j + \sum_{\forall j \in hp(i)} CRPD_{i,j} \]

\[ + \sum_{\forall j \in hp(i)} \left[ \frac{R_i}{T_j} - 1 \right] \times (P_j + MD^r_j + \text{CPR}O_{j,i}) \]

Considering the effect of CRPD

Considering evictions of PCBs

Considering the effect of PCBs
Preliminary Results

- Proposed WCRT analysis
- State-of-the-art WCRT analysis
Future Work

• Extend the analysis to set associative and data caches.
• Provide a less pessimistic multi-set approach to calculate the impact of PCBs.
• Combine approaches to calculate both CRPD and impact of PCBs.
• Extensive experimental evaluation using available benchmarks.
Thank You

Questions