Many suspensions, many problems: A review of self-suspending tasks in real-time systems

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Reasons for Suspension: Hardware Acceleration

Use FPGA in parallel (suspension aware).

Not use FPGA in parallel (busy waiting).
Reasons for Self-Suspensions: Locking Protocols

- Distributed PCP in the above example
- Semaphores in multiprocessor systems: remote blocking due to mutual exclusion
Purpose of the paper

**Motivation:** Several errors were discovered:

- Incorrect quantification of jitter for self-suspending task systems
- Incorrect assumptions on the critical instant
- Incorrectly counting highest-priority self-suspension time to reduce the interference on the lower-priority tasks
- Incorrect fixed-priority scheduling with period enforcement
- Incorrect conversion of higher-priority self-suspending tasks into sporadic tasks with release jitter
Purpose of the paper

Our Mission:
- summarize the existing self-suspending task models
- provide the general methodologies to handle self-suspension
- explain the misconceptions in the literature, their consequences, and potential solutions to fix those flaws
- examine the inherited flaws in multiprocessor synchronization, due to a flawed analysis in self-suspending task models
- provide the summary of the computational complexity classes of different self-suspending task models and systems
Suspension Induces Jitter under Fixed-Priority

Schedulability test of task $\tau_k$:

$\exists t \mid 0 < t \leq D_k \quad \text{s.t.} \quad C_k + S_k + \sum_{j=1}^{k-1} \left\lfloor \frac{t + S_j}{T_j} \right\rfloor C_j \leq t.$

The above analysis

<table>
<thead>
<tr>
<th>$\tau_i$</th>
<th>$C_i$</th>
<th>$S_i$</th>
<th>$T_i$</th>
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<tbody>
<tr>
<td>$\tau_1$</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>$\tau_2$</td>
<td>5</td>
<td>5</td>
<td>20</td>
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<tr>
<td>$\tau_3$</td>
<td>1</td>
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Suspension Induces Jitter under Fixed-Priority

Schedulability test of task $\tau_k$:
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\exists t \mid 0 < t \leq D_k \quad \text{s.t.} \quad C_k + S_k + \sum_{j=1}^{k-1} \left\lceil \frac{t + S_j}{T_j} \right\rceil C_j \leq t.
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Worst Case