Jitter and Drift

Abstract

In this note, we will briefly consider the notions of jitter and drift by looking at the AFAP and time-driven AFAP variants of the cyclic executive. We start this note with the specification of the characteristics of tasks.

Specification of tasks

Let:

- φ_1 denote the *phasing* of task τ_1, and φ_2 for τ_2
- BC_1 denote the *best-case computation time* of task τ_1, and BC_2 for τ_2;
- WC_1 denote the *worst-case computation time* of task τ_1, and WC_2 for τ_2,
- Where $BC_1 \leq WC_1$ and $BC_2 \leq WC_2$.

Moreover, let the first activations $a_{1,0} = \varphi_1$ of task τ_1 and $a_{2,0} = \varphi_2$ of task τ_2 be equal to zero.

AFAP

The tasks running based on the "AFAP" variant of the cyclic executive may result in both fluctuations in activation times of tasks, i.e. *activation jitter*, and *drift*, i.e. "*unbounded*" activation jitter.

Task τ_1

The *minimal* inter-arrival time $T_1^{\min}$ of task τ_1 is given by $T_1^{\min} = BC_1 + BC_2$, and
the *maximal* inter-arrival time $T_1^{\max}$ of τ_1 by $T_1^{\max} = WC_1 + WC_2$.
Hence, the inter-arrival times of subsequent jobs of task τ_1 may fluctuate when $T_1^{\min} < T_1^{\max}$, i.e. when $BC_1 + BC_2 < WC_1 + WC_2$, giving rise to *activation jitter*.
An arbitrary activation time $a_{1,k}$ of task τ_1 is constrained by

$$kT_1^{\min} \leq a_{1,k} \leq kT_1^{\max}.$$

Let the *length* of the interval in which job k of task τ_1 can be activated be denoted by $AJ_1(k)$. We now get

$$AJ_1(k) = kT_1^{\max} - kT_1^{\min} = k(T_1^{\max} - T_1^{\min}).$$

When $T_1^{\min} < T_1^{\max}$, this interval can become arbitrarily large, i.e. there does not exists a value AJ_1 that provides an upper bound for all k, indicating *drift*.

Task τ_2

Similarly, the *minimal* inter-arrival time $T_2^{\min}$ and the *maximal* inter-arrival time $T_2^{\max}$ of τ_2 are given by $T_2^{\min} = BC_1 + BC_2$ and $T_2^{\max} = WC_1 + WC_2$, respectively.
An arbitrary activation time $a_{2,k}$ of task τ_2 is constrained by

$$BC_1 + kT_2^{\min} \leq a_{1,k} \leq WC_1 + kT_2^{\max},$$

and the length $AJ_2(k)$ of the activation interval of task τ_2 is given by

$$AJ_2(k) = WC_1 + kT_2^{\max} - (BC_1 + kT_2^{\min}) = WC_1 - BC_1 + k(T_2^{\max} - T_2^{\min}).$$

When $BC_1 < WC_1$ or $T_2^{\min} < T_2^{\max}$, task τ_2 may experience activation jitter. When $T_2^{\min} < T_2^{\max}$ this activation jitter interval can become arbitrary large, indicating *drift*.
Note that $T_1^{\min} = T_2^{\min}$ and $T_1^{\max} = T_2^{\max}$.

Time-driven AFAP

When all executions of the tasks remain within the period of the time-driven AFAP variant of the cyclic executive, the tasks only experience activation jitter, but no drift. In the remainder of this section, we assume $WC_1 + WC_2 \le T$, where T notes the period.

Task τ_1

The jobs of task τ_1 are activated strictly periodically, i.e. $T_1^{\min} = T_1^{\max} = T$ and $a_{1,k} = kT$. As a result, $AJ_1(k) = 0$, i.e. task τ_1 does not experience activation jitter and hence no drift.

Task τ_2

When $BC_1 < WC_1$, the jobs of task τ_2 are released with jitter, i.e. $T_2^{\min} = T - (WC_1 - BC_1)$ and $T_2^{\max} = T + (WC_1 - BC_1)$, hence $T_2^{\min} < T_2^{\max}$. An arbitrary activation time $a_{2,k}$ of task τ_2 is constrained by

$$BC_1 + kT \le a_{1,k} \le WC_1 + kT.$$

The length of the activation jitter interval $AJ_2(k)$ of the activation interval of task τ_2 is given by

$$AJ_2(k) = WC_1 + kT - (BC_1 + kT) = WC_1 - BC_1.$$

Hence the length of this activation interval is *bounded*, indicating no drift. Such a task is said to be *periodic with activation jitter*.

Note that the activation jitter of task τ_2 is independent of the fluctuations in its computation times.