Lab 3
Response Time Analysis using FpsCalc

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30 Nov. 2021

Lab Overview

Lab preparation

- Monday, 30th Nov. 08:15 – 10:00, Room 2001, Ångström
- Check lab web page
- Possibly print out assignment description (11 pages pdf)

Lab report

- Answers (incl. diagrams) to the questions. (pdf)
- FpsCalc codes. (.fps)
- **Deadline**: Sunday,12th Dec., 23:59

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Lab Overview

Before you start:

- Review the lectures about scheduling theory and resource sharing protocols. Make sure you understand the response time equation and all resource sharing protocols you have learned.

- Read FpsCalc User Manual
- Focus is on the theory and concepts

  FpsCalc is just a helping tool to make things easier. Don’t struggle with too much details of it.

Lab goals

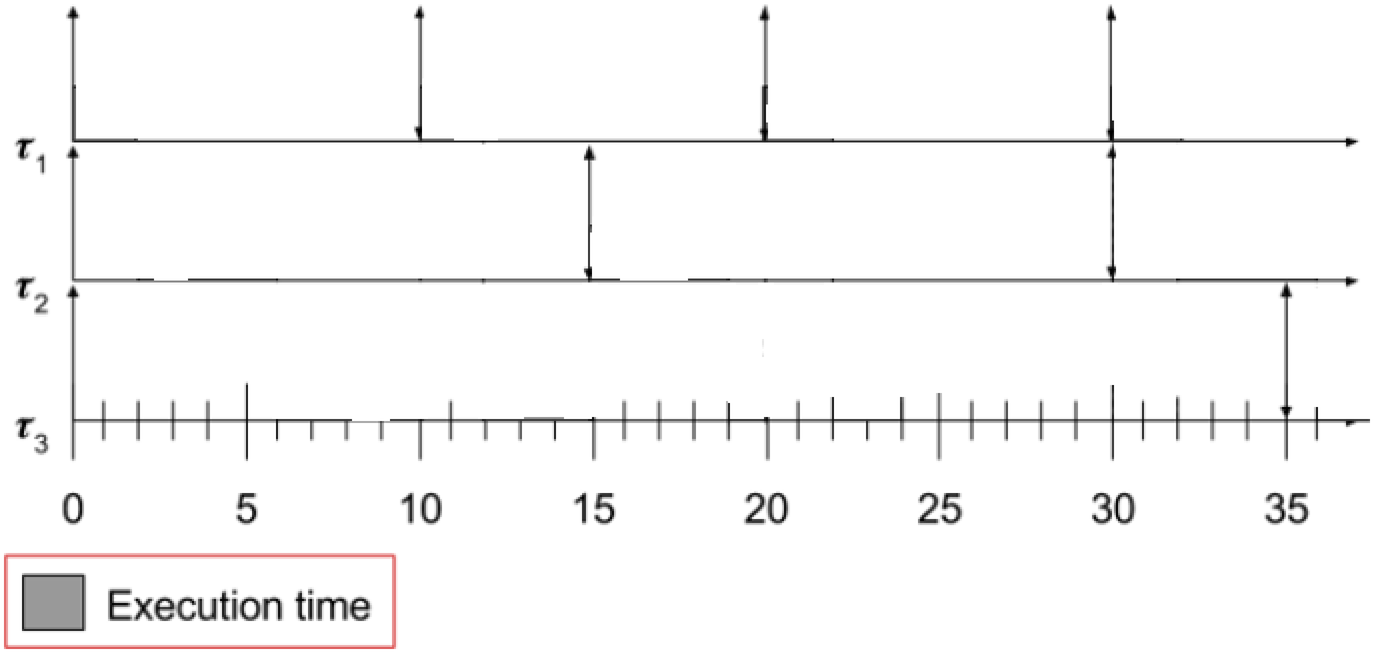
- Practice response time analysis
- Manual calculation, critical instant charts, tool FpsCalc
- Integrate blocking, jitter

$$R_i = C_i + \sum_{j \in hp(i)} \left\lceil \frac{R_i}{T_j} \right\rceil \cdot C_j$$

Response time analysis

Task	C_i	T_i	D_i	P_i
τ_1	2 ms	10 ms	10 ms	1
τ_2	4 ms	15 ms	15 ms	2
τ_3	10 ms	35 ms	35 ms	3

Critical instant schedule:



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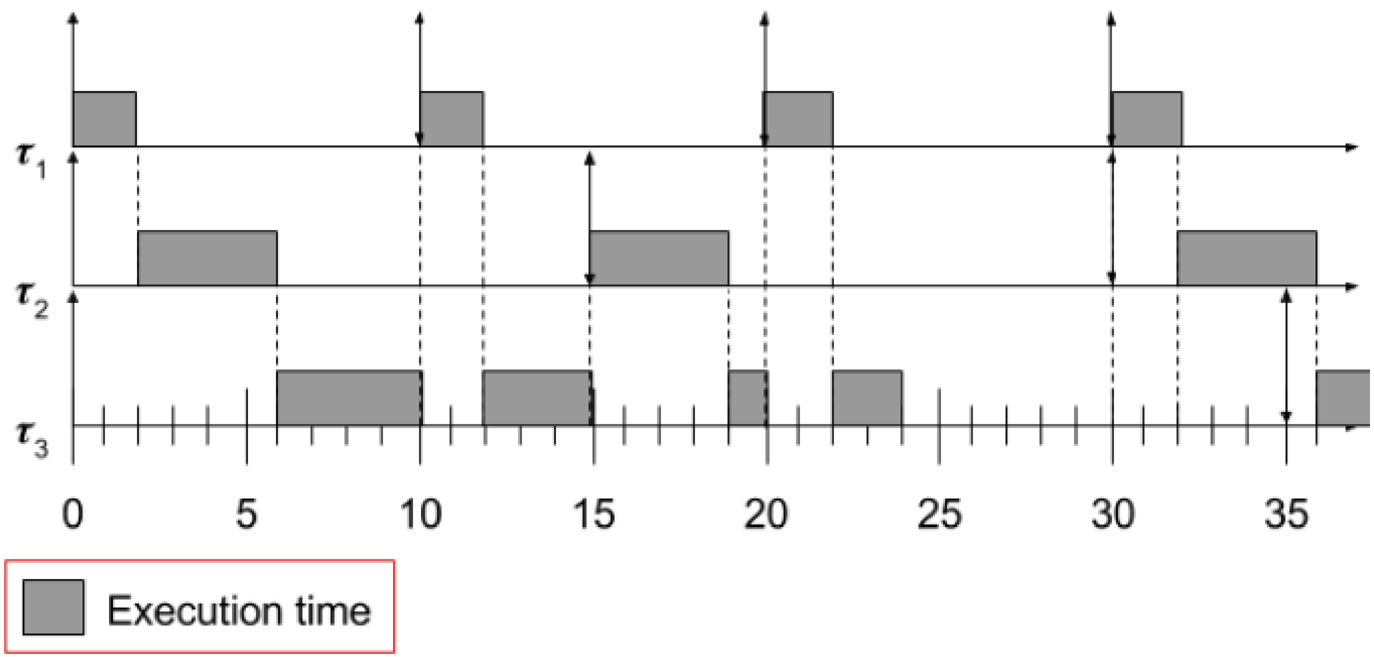
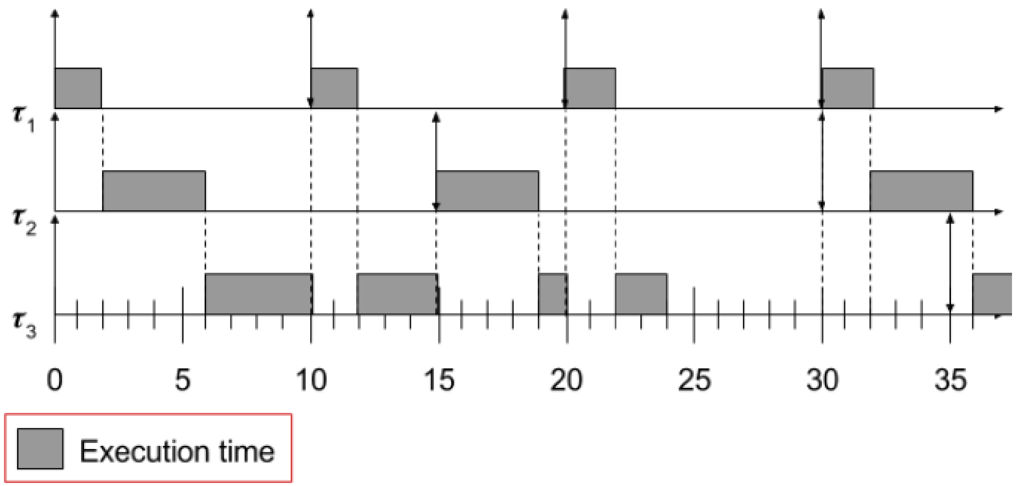


Response time analysis

Critical instant schedule:



R1 =

R2 =

R3 =

Response time analysis

$$R_i^{n+1} = C_i + \sum_{j \in hp(i)} \left\lceil \frac{R_i^n}{T_j} \right\rceil C_j$$

How to calculate this recursive equation?

Response time analysis

$$\mathcal{T} = \{\tau_1, \tau_2, \tau_3\} = \{(1,4,4), (2,3,5), (3,9,10)\}$$

$$\begin{aligned} R_i^1 &= C_i \\ R_i^{k+1} &= C_i + \sum_{\tau_j \in \mathrm{hp}(\tau_i)} \left\lceil \frac{R_i^k}{T_j} \right\rceil \cdot C_j \end{aligned}$$

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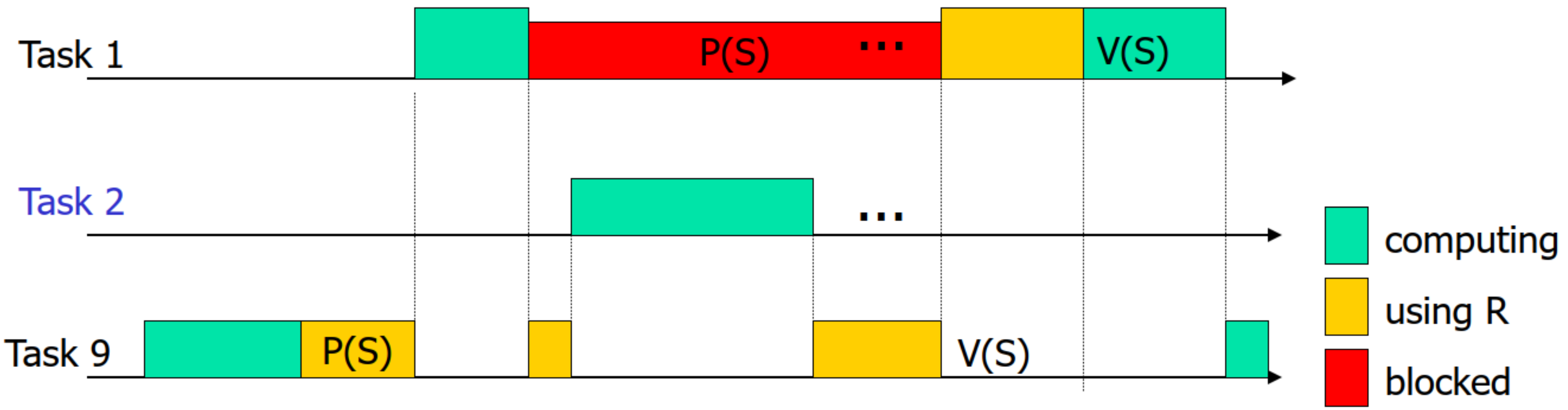
Blocking

$$R_i = C_i + B_i + \sum_{j \in hp(i)} \left\lceil \frac{R_i}{T_j} \right\rceil C_j$$

Task i can be blocked by lower priority tasks when resource sharing exists!

Blocking

Example:



Task 1 can be blocked by task 9.

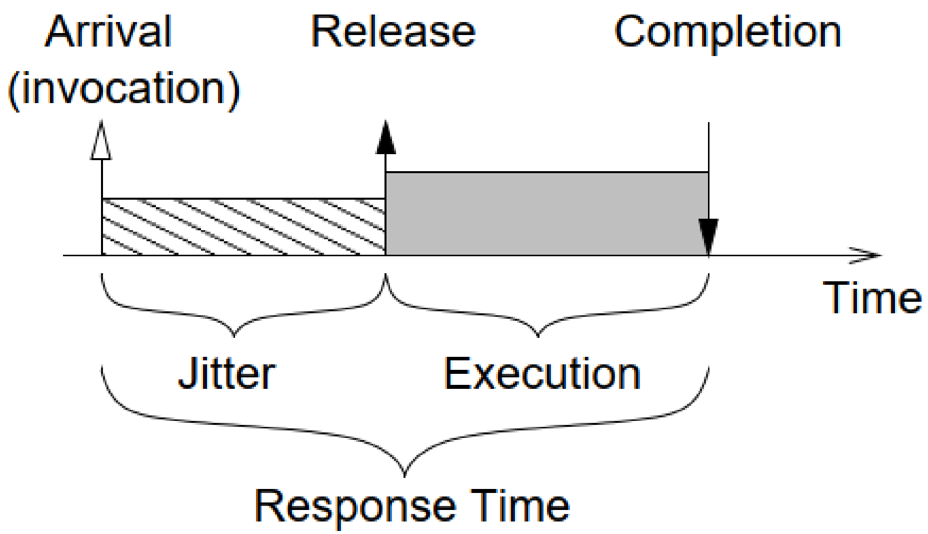
Blocking

$$R_i = C_i + B_i + \sum_{j \in hp(i)} \left\lceil \frac{R_i}{T_j} \right\rceil C_j$$

For different resource sharing protocols, the blocking time of the same task could be different.

$$\boxed{B_i}$$

Jitter



The jitter Ji for a task i is the difference between the maximal jitter and the minimal jitter.

$$J_i = J_i^{max} - J_i^{min}$$

Utilization bound

- Based on system's utilization bound $U := \sum_{i \leqslant n} C_i / T_i$
- For EDF: $U \leqslant 1 \iff \tau$ schedulable (sufficient and necessary)
- For RM: $U \leqslant n(2^{1/n} - 1) \implies \tau$ schedulable (only sufficient!)

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$U = 2/10 + 4/15 + 10/35 = 0.752381 < 3*(2^{1/3}) - 1 = 0.7798$

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U = 2/10 + 4/15 + 10/35 = 0.752381 < 3*($2^{1/3}$) – 1 = 0.7798

RM Schedulable!

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If U > 3*($2^{1/3}$) – 1 , schedulable or not?

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If U > 3*($2^{1/3}$) – 1 , schedulable or not?

We don’t know. Do response time analysis (draw schedule table)

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EDF Schedulable!

FpsCalc

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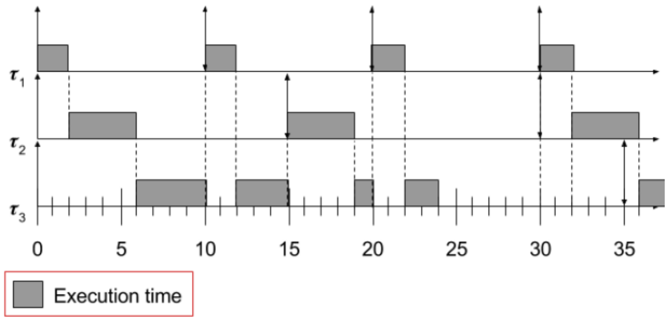

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FpsCalc

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FpsCalc

```
R[t1] = 2.000000
R[t2] = 6.000000
R[t3] = 24.000000
```

FpsCalc

system

- **declarations**
- **Semaphores(optional)**
- **initialise**
- **formulas**

FpsCalc

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Demos and Report examples