A scheduler whose operation is entirely determined by a matrix of constants  $(\Delta_{j,k})_{j,k\in\mathcal{N}}.$ 





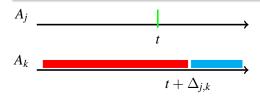
• The followings are  $\Delta$ -schedulers:

• GPS is not a  $\Delta$ -scheduler.

▶ FIFO:  $\Delta_{j,k} = 0$  ▶ SP, BMux:  $\Delta_{j,k} = \begin{cases} -\infty \\ +\infty \\ +\infty \end{cases}$  if flow j has higher priority if flow k has higher priority
 ▶ EDF:  $\Delta_{j,k} = d_j^* - d_k^*$ 

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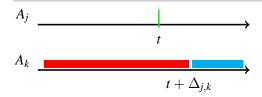
• The followings are  $\Delta$ -schedulers:

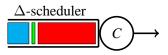
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 if flow j has higher priority
 if flow k has higher priority
 if flow k has higher priority
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A scheduler whose operation is entirely determined by a matrix of constants  $(\Delta_{j,k})_{j,k\in\mathcal{N}}.$ 





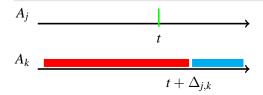
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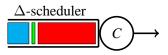
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A scheduler whose operation is entirely determined by a matrix of constants  $(\Delta_{j,k})_{j,k\in\mathcal{N}}.$ 





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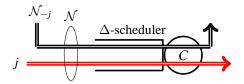
  - $\begin{array}{l} \bullet \text{ SP, BMux:} \quad \Delta_{j,k} = \begin{cases} -\infty \\ +\infty \end{cases} \\ \bullet \text{ EDF:} \qquad \Delta_{j,k} = d_j^* d_k^* \end{array}$

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#### A Service Curve for $\Delta$ -Schedulers



 $\Delta$ -service curve (Liebeherr, Ghiassi, Burchard'10)

For each  $\theta \ge 0$ , the following is a minimum service curve for flow *j* 

$$\mathcal{S}_{j}(t;\sigma_{s}) = \left[Ct - \sum_{k \in \mathcal{N}_{-j}} \mathbb{E}_{k}(t - \theta + \Delta_{j,k}(\theta))\right]_{+} I_{t > heta}$$

-j

where  $\Delta(a) = \min(a, \Delta)$ 

Provides necessary and sufficient delay bound constraints.

(University of Toronto)