Reconfigurable Distributed Control
(Time Delays Disturbances)

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Objectives

•To model time delays in order to integrate this representation into control law design.

•To study the computer network behaviour in terms of processes managment and schedulling policies.

•To study external factors such as fault diagnosis for time delay modelling.

•To design Control law strategies that accomplish external factors like those mention before.

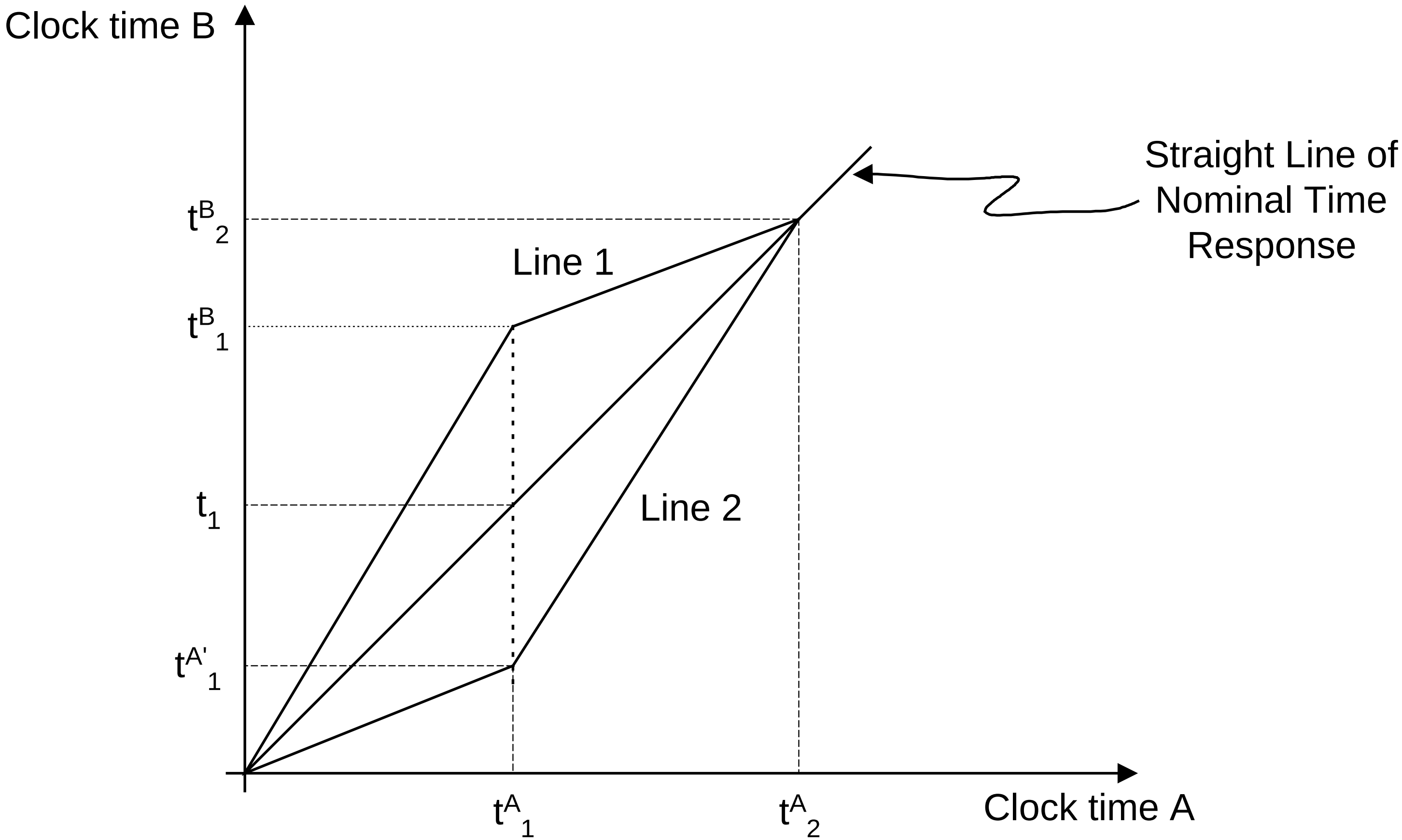
Previous Work

•The study of time delays has been widely spread from fault tolerance areas, computer network modelling, distributed systems design, control laws designs and others.

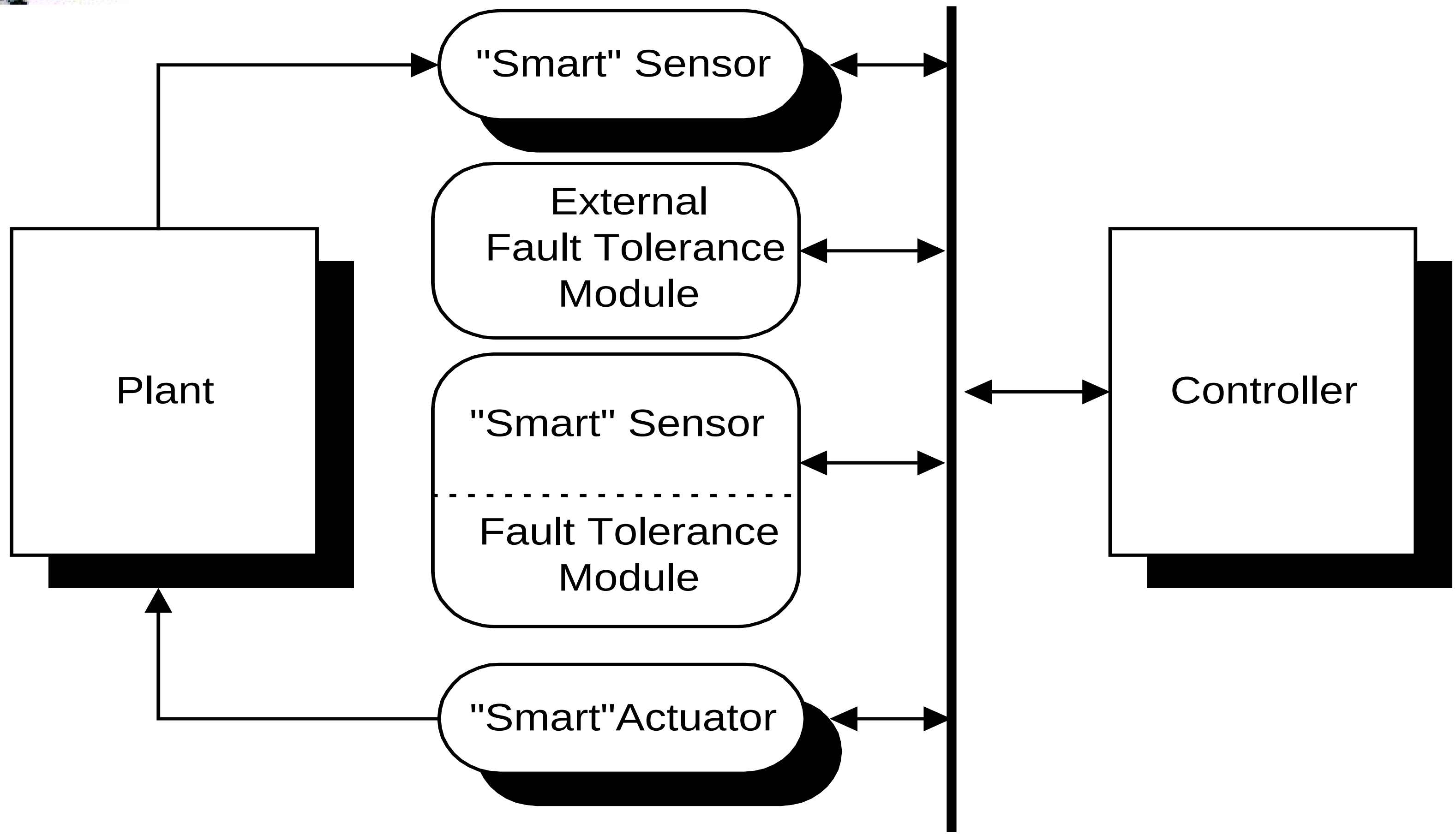
•Several implementations have been performed in order to understand the behviour of processes.

• Different approaches have been followed like time graphs as shown next.

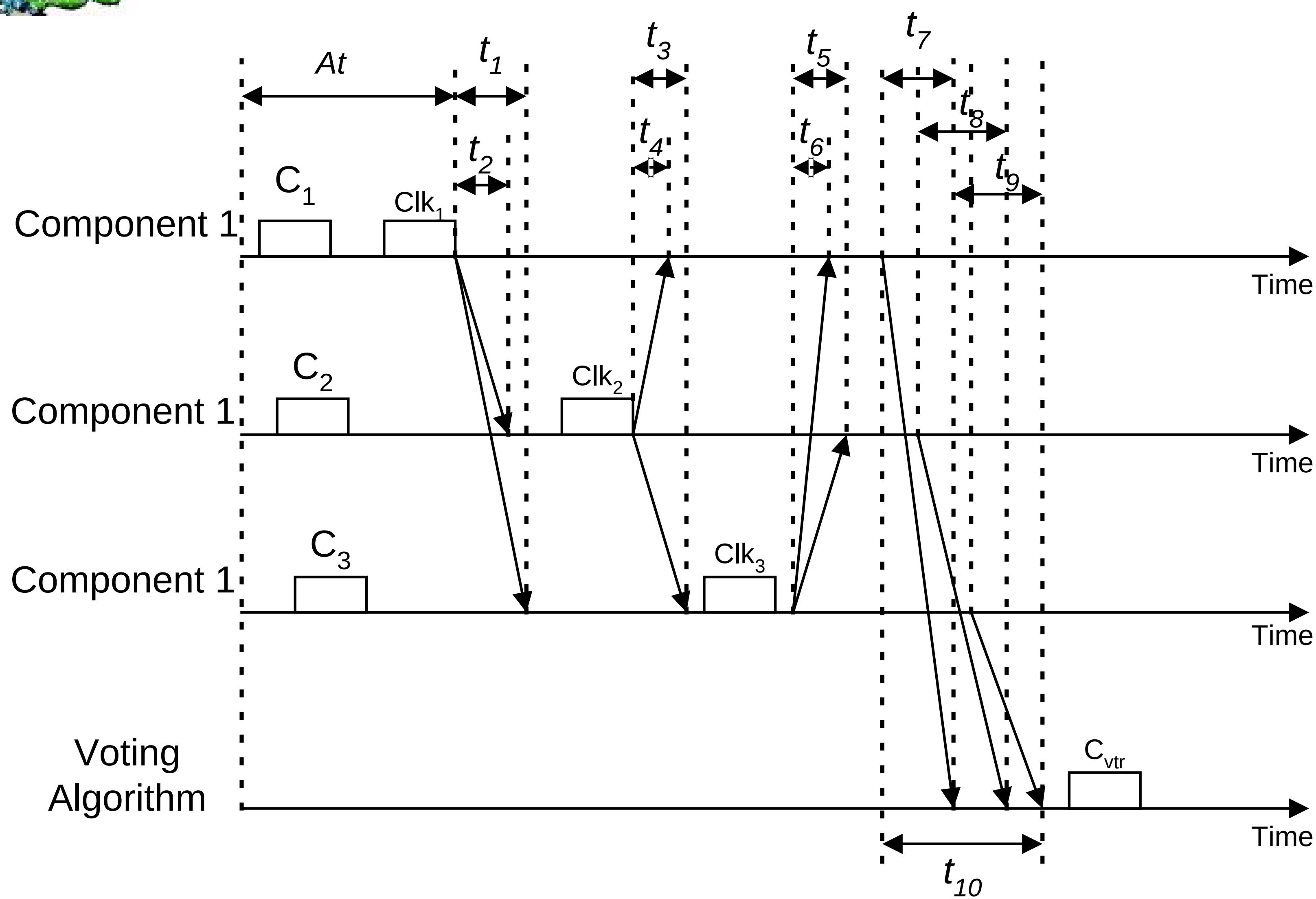
Clock Managment



Basic Configuration



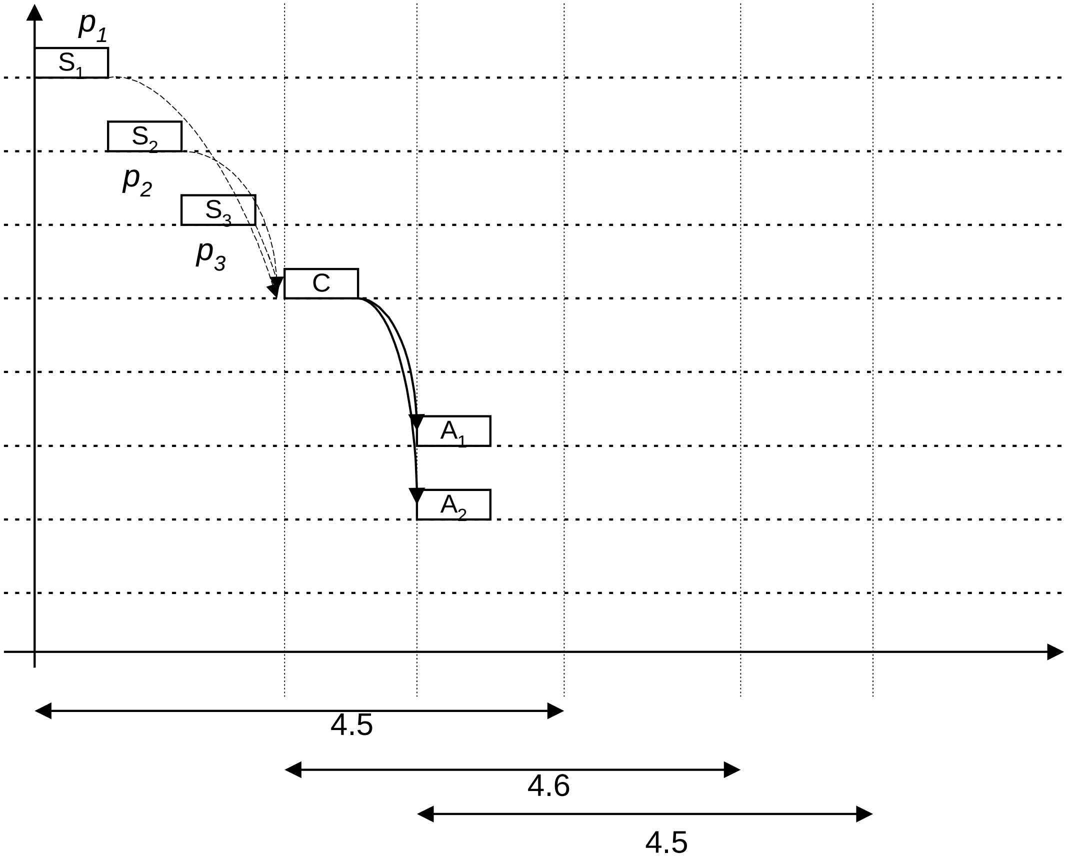
Time Diagram considering Clock Sinchronization and Voting Algorithm



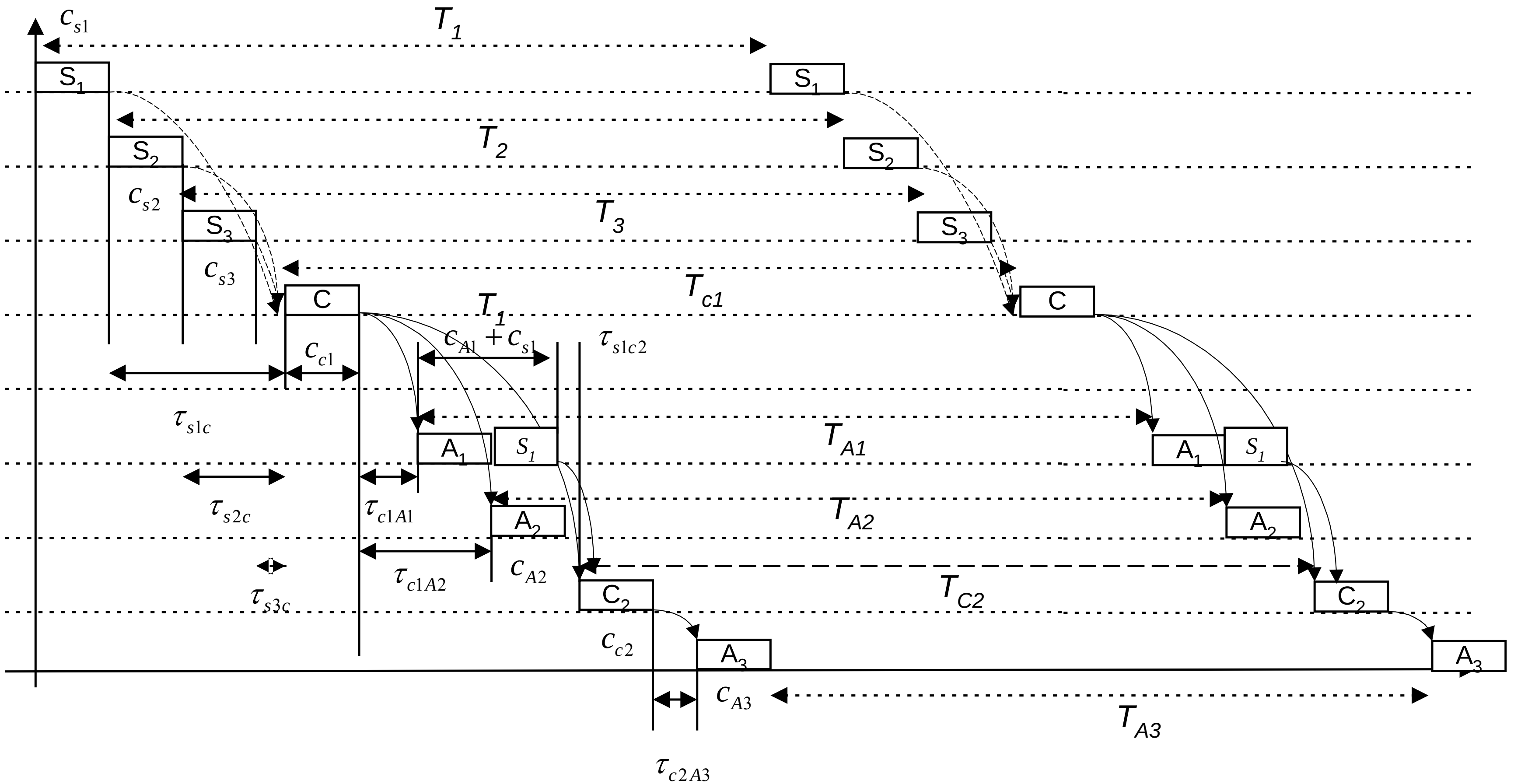
Time Delays in the Dynamics of the Processes

$$x(k+1) = Ax(k) + \sum_{i=0}^{l} B_i^k u(k-i)$$

$$B_i^k = \int_{t_i^k}^{t_{i-1}^k} \exp(A(T-\tau))Bd\tau$$



Time Delays Definitions Considering Dynamic Processes



Time Delays Definition

Elements	Consumption Time	Period (ms)	Communication Time Delay
s_1	c_{s1}	T_1	τ_{s1c}
s_2	c_{s2}	T_2	τ_{s2c}
s_3	c_{s3}	T_3	τ_{s3c}
c_1	c_{c1}	T_{c1}	$\tau_{c1A1}, \tau_{c1A2}, \tau_{c1s1}$
A_1 s_1	$c_{A1} + c_{s1}$	T_{A1}	τ_{s1c2}
A_2	c_{s1}	T_{A2}	
C_2	c_{c2}	T_{c2}	τ_{c2A3}
A_3	c_{A3}	T_{A3}	

Fuzzy Approximation

$$R_j : \text{if} x_1(k) \text{is} A_{j1} \text{and} x_2 \text{is} B_{j2} \text{ then} \quad x(k+1) = A_j x(k) + B_j u(k) + \Delta B_j u(k)$$

$$v_j(k) = \prod_{i=1}^{n} w_{ji}(k)$$

$$w_{ji} = A_{ij}\left(x_i(k)\right)$$

$$x(k+1) = \frac{\sum_{j=1}^{N} v_j(k)\left(A_j x(k) + B_j u(k) + \Delta B_j e(k)\right)}{\sum_{i=1}^{N} v_i(k)}$$

Stability approach for TSK

$$\Delta B^{p} = \sum_{i=1}^{N} \rho_i \Delta B_i \sum_{j=1}^{M} \int_{\tau_j^i}^{\tau_{j-1}^i} e^{-a^{p}(t-\tau)} d\tau$$

$$V(X(k)) = x(k)^{T} p x(k)$$

$$A^{T}PA + B^{T}PB - 2P + \Delta B^{T} P \Delta B < 0$$

$$\Delta V(x(k)) = v(x(k+1)) - v(x(k)) < 0$$

Where the controllers are local implementations as shown in last equation

The plant is expressed as

$$\dot{x}_p^j = A_p^j x_p^j(k) + B_p^j x(k) u_p^j(k) + \Delta B_p^j e(k)$$

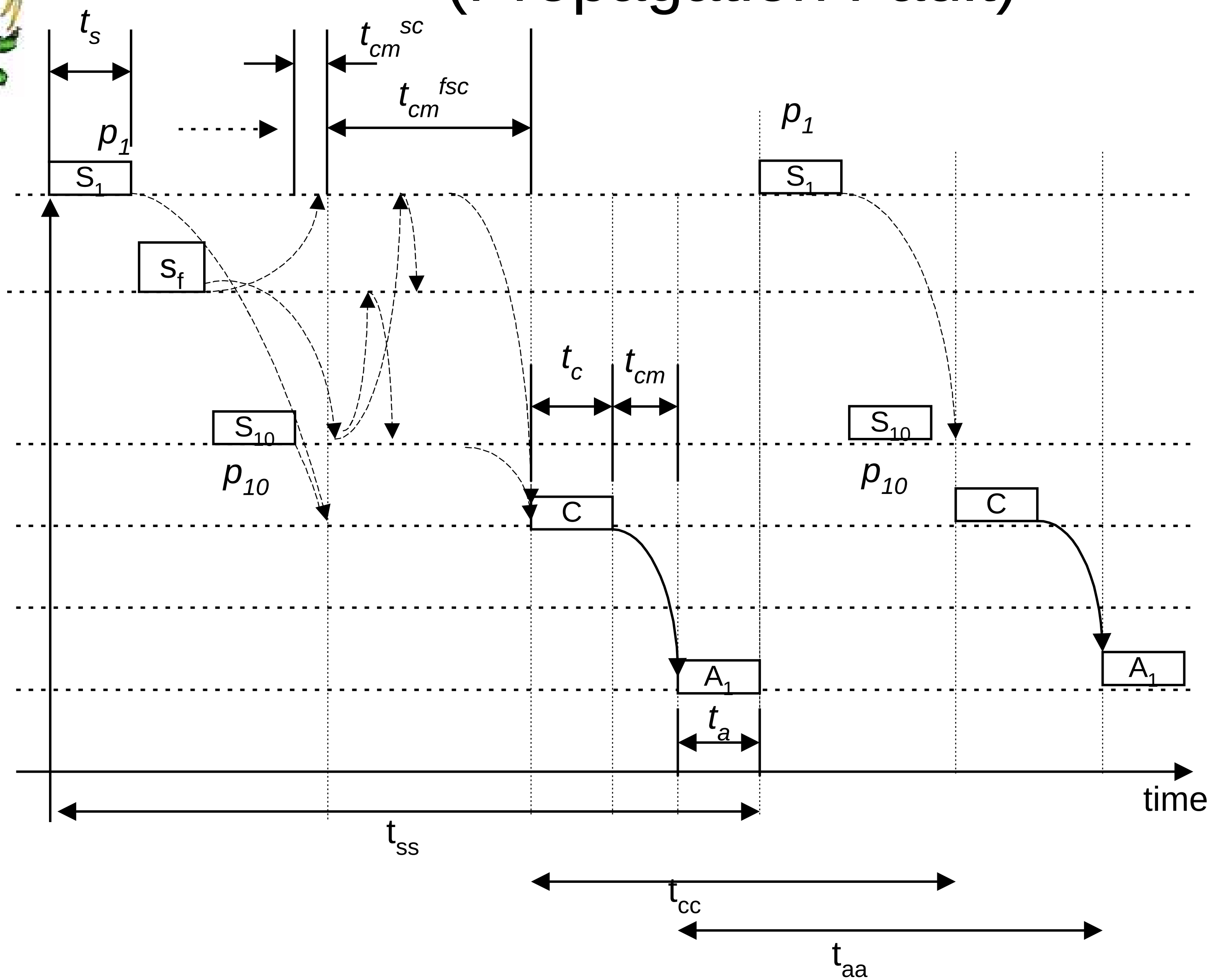
$$y_p^j = C_p^j x_p^j(k)$$

And the controller as:

$$\dot{x}_c^j = A_c^j x_c^j(k) + B_c^j x u_c^j(k)$$

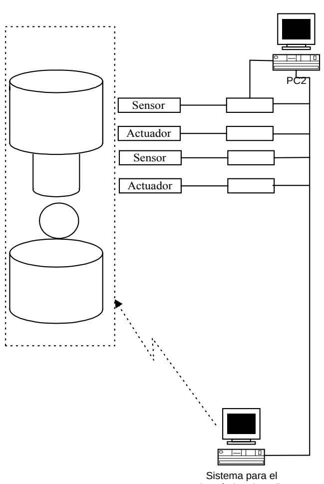
$$y_c^j = C_c^j x_c^j(k - \tau_c^j) + D_c^j u(k - \tau_c^j)$$

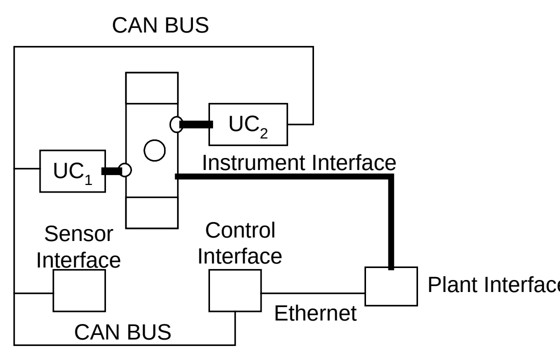
Case Study
(Propagation Fault)



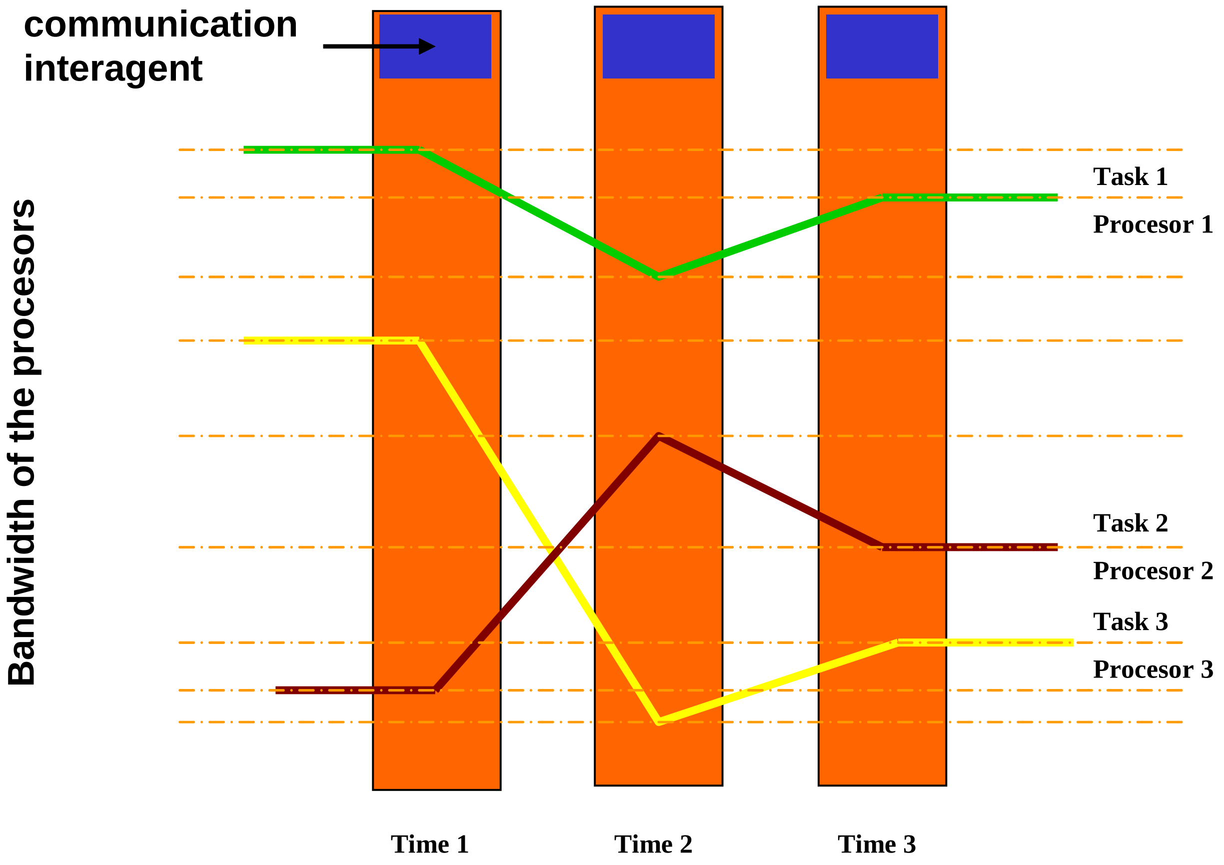
Magnetic Levitation System

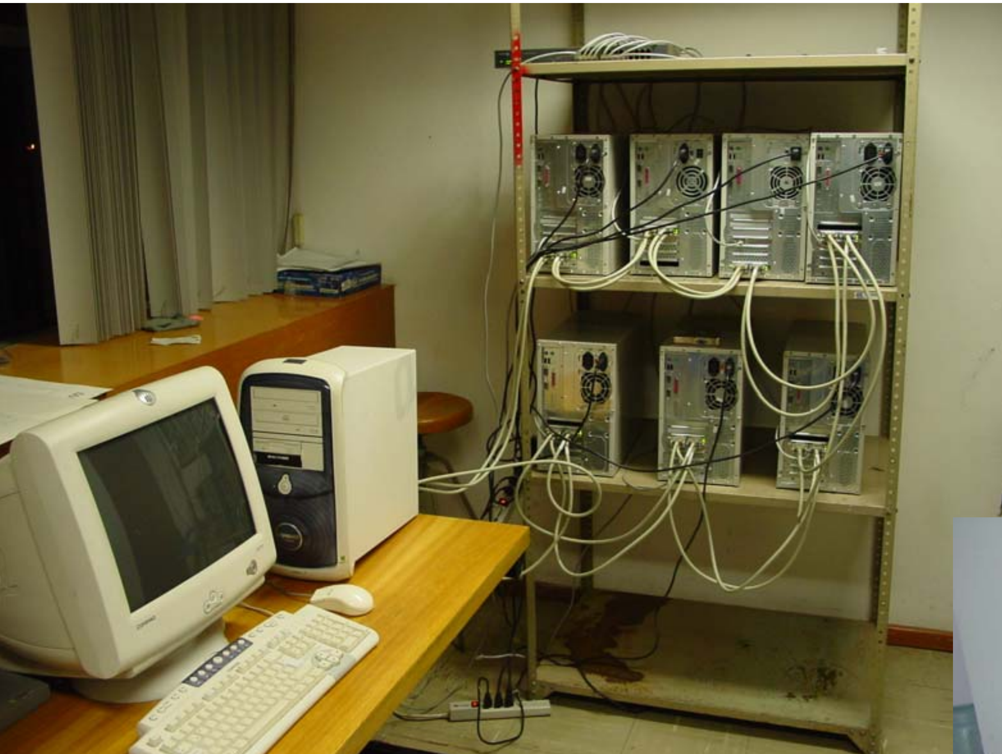
- Magnetic Levitator
  - Cooperative Agents by using FTT
  - Fuzzy control as TKS





Process Managment

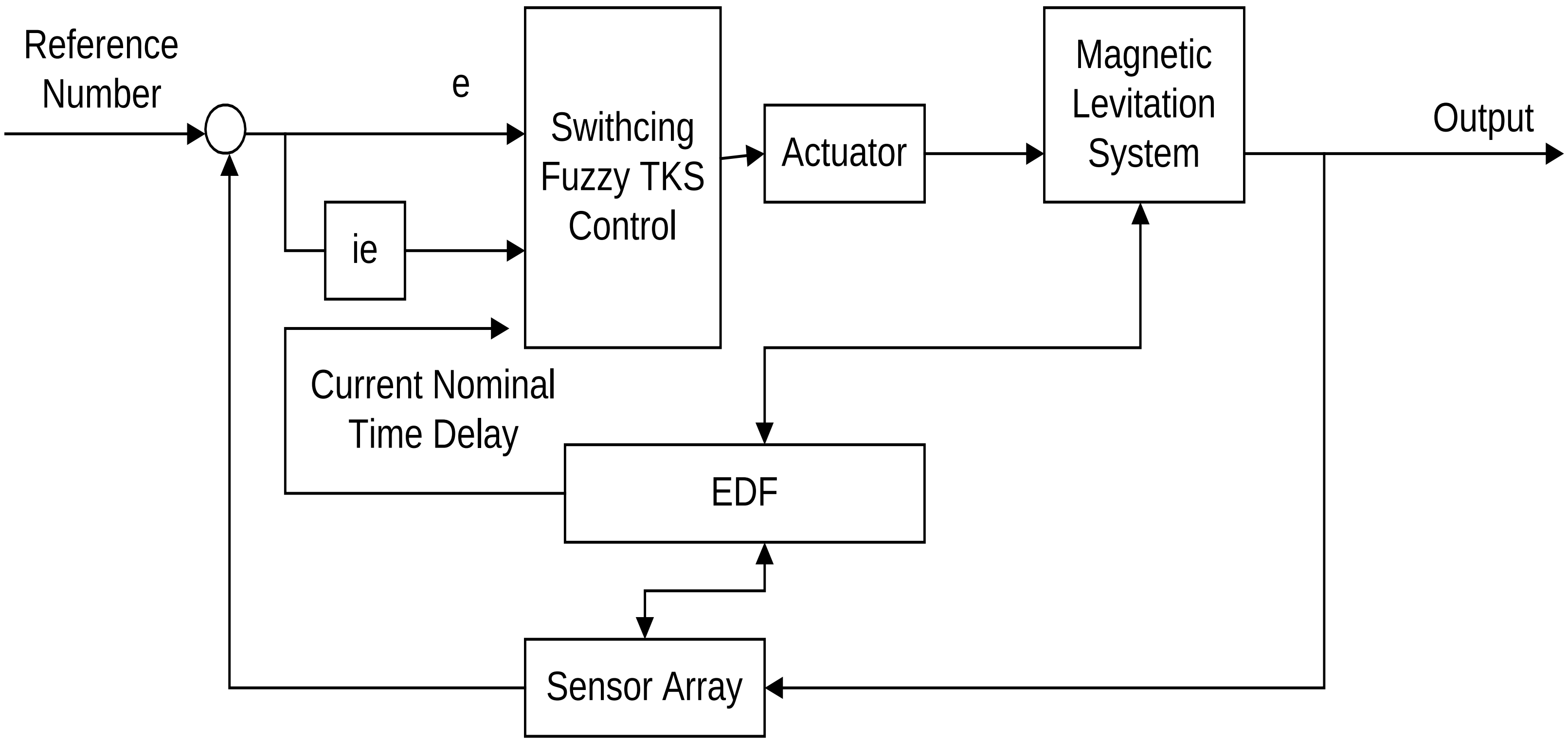




Process Managment

- Schedulling of Distributed Processes using Neural Networks
- Schedulling of Processes based upon worst case scenario.
- Optimization of processes managment on-line by using tao Genetic Algorithms

Current Approach



Conclusions

•Time Delays can be modelled in terms of stochastic procedure where switching control model becomes a feasible strategy to accomplish stability.

•Other strategies like time delays modelling are available but become difficult to implement due to the complexity of the source of these time delays. In this case a computer network system.

•Control law modelling can be approximated as a robust approximation but mainly in a hybrid manner.

Process Management (Future Work)

- Real-Time Modelling of Distributed Schedulling

- Metric Characterizations like Load Distribution, Timming Analysis and others.

- Dynamic Load Balancing

- Dynamic Process Migration

- Congestion Control

- Cooperative Control

Future Work

•To study the source of time delays in terms of DifferentialEquations, from the point of view of processes managment.

•To implement TSK Control strategy based upon Helicopter case study.