Minimizing System Modification in an Incremental Design Approach

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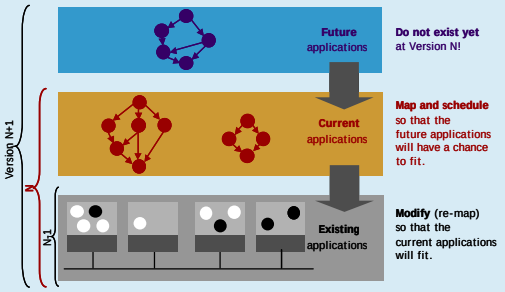
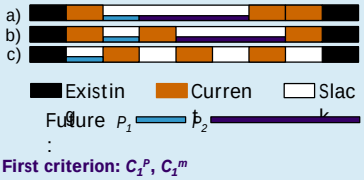
Incremental Design

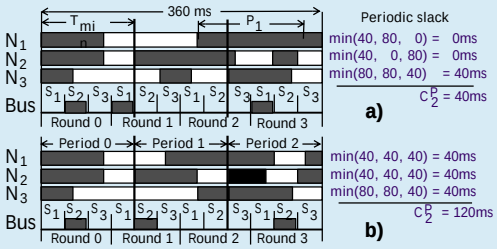


- Start from an already existing system with applications
- Implement new functionality on this system
  Mapping and Scheduling
- To reduce design and testing time:
  As few as possible modifications of the existing applications
- After the new functionality has been implemented:
  It should be easy to add functionality in the future

Design Criteria



- **First criterion: C_1^P, C_1^m**
  How well the resulted slack sizes accommodate a future application

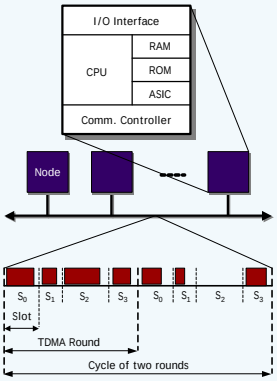


- **Second criterion: C_2^P, C_2^m**
  How well the slack is distributed in time to accommodate T_{min}, t_{need} and b_{need}

Paul Pop, Petru Eles, Traian Pop, Zebo Peng:
An approach to Incremental Design of Distributed Embedded Systems,
Design Automation Conference, 2001

Summary

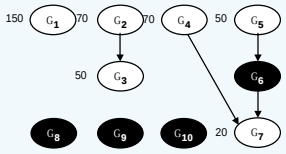
- Mapping and scheduling of distributed embedded systems for hard-real time applications
  - Static cyclic scheduling of processes and messages,
  - Bus access scheme: time-division multiple-access.
- Incremental design process
  - Already existing system,
  - Implement new functionality,
  - a) Existing system modified as little as possible,
    b) new functionality can be easily added to the system.
- Mapping strategy
  - a) Subset selection to minimize modification time,
  - b) Two design criteria, objective function.



Problem Formulation

- Input
  - A set of *existing* applications.
  - A *current* application to be mapped.
  - The system architecture.
- Output
  - A **mapping and scheduling of the *current* application**, so that the incremental design requirements are satisfied.
- Requirements
  - a) constraints of the *current* application are satisfied and minimal modifications are performed to the *existing* applications.
  - b) new *future* applications can be mapped on the resulted system.

Characterizing existing applications:



Characterizing future applications:
- Typical WCETs
- Typical message sizes
- Smallest expected period T_{min}
- Expected necessary processor time t_{need}
- Expected necessary bandwidth b_{need}

Mapping Strategy

- Initial mapping and scheduling
- Requirement a)
  Subset selection problem
  Select that subset Ω of existing applications so that the current application fits and the modification cost $R(\Omega)$ is minimized:

$$R(\Omega) = \sum_{\forall i \in \Omega} R_i$$

Three approaches to the subset selection problem
- Exhaustive Search (**ES**)
- Ad-Hoc Solution (**AH**)
- Subset Selection Heuristic (**SH**)

- Requirement b)
  Objective function minimization:

$$C = w_1^P(C_1^P) + w_1^m(C_1^m) + w_2^P \max(0, t_{need} - C_2^P) + w_2^m \max(0, b_{need} - C_2^m)$$