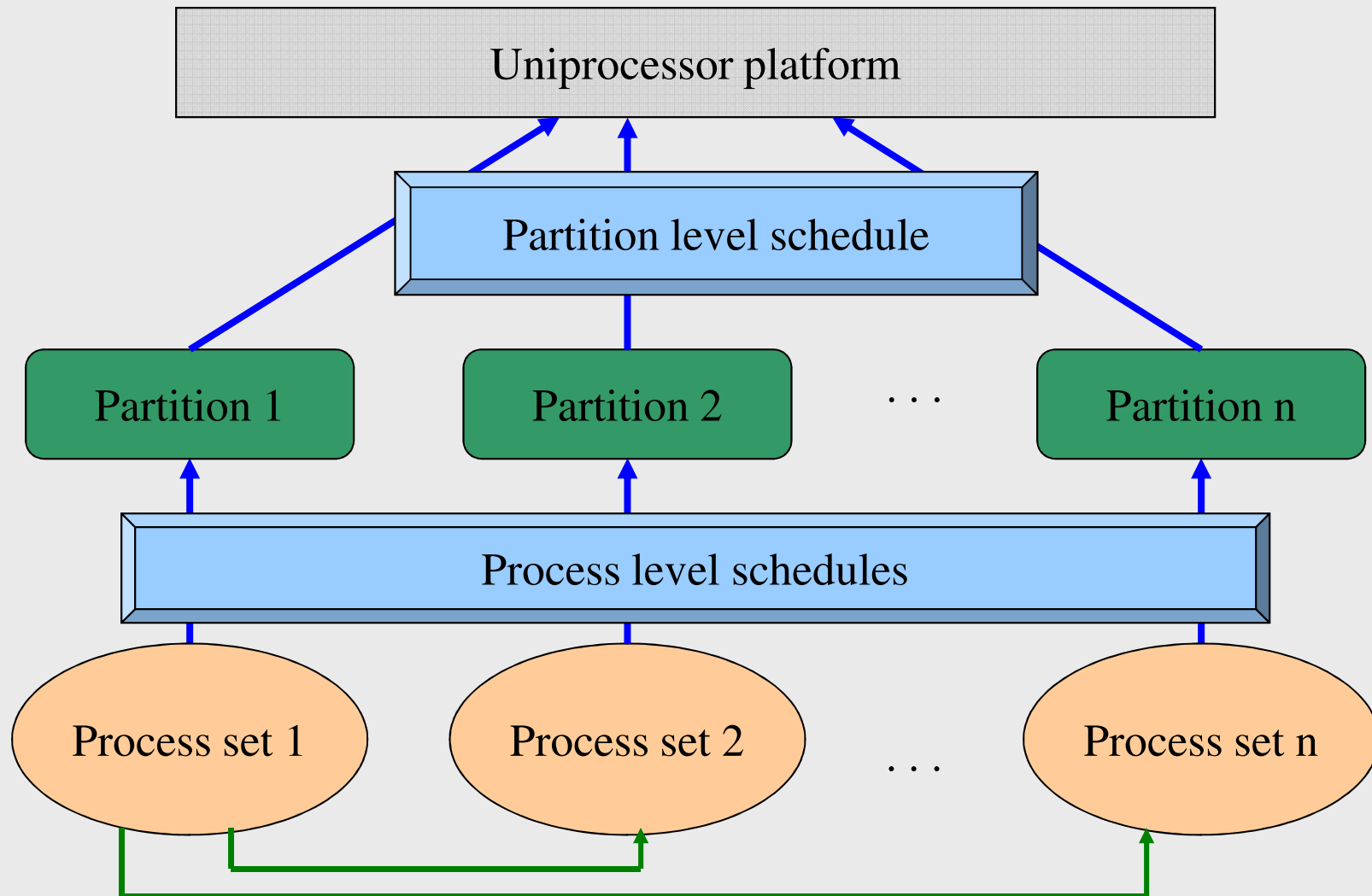


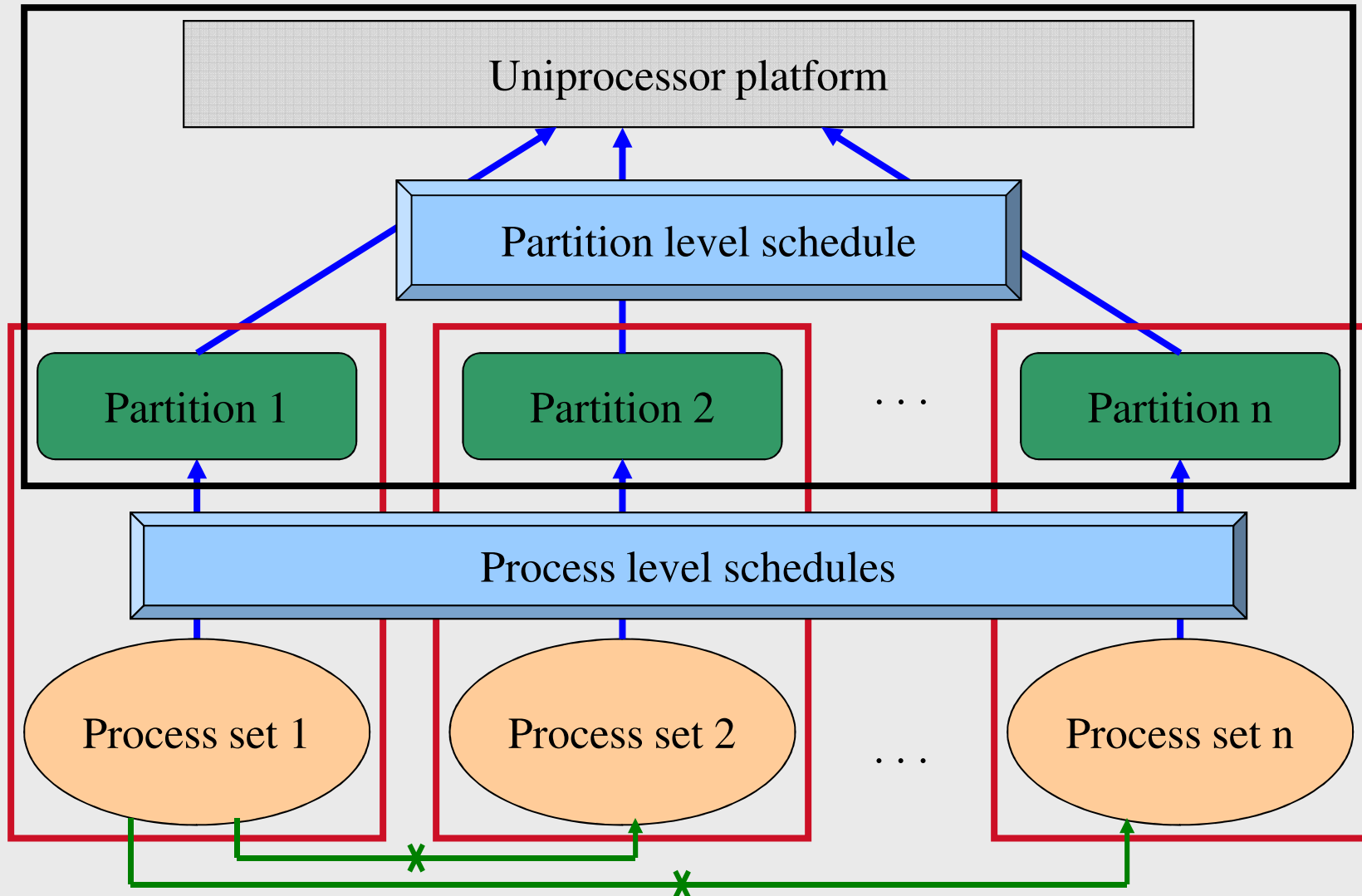
Compositional analysis of ARINC 653 systems

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ARINC-653 Avionics OS



ARINC-653: Schedulability



Main steps

- Extract partition workloads from AADL
- Abstract away inter-partition communication
 - Well-known methods based on offsets, jitter, and constrained deadlines
- Compute partition interfaces
 - Use periodic or EDP resource models
 - Assume DM scheduler (can be adjusted to other schedulers)
 - Each partition appears to the top-level as a single task
- Generate DM partition schedule

Resource Satisfiability Analysis

- Given a component and a resource model, **resource satisfiability analysis** is to determine if, for every time interval,

(maximum possible)
resource demand

that the component's task set needs
under its scheduling algorithm



(minimum possible)
resource supply

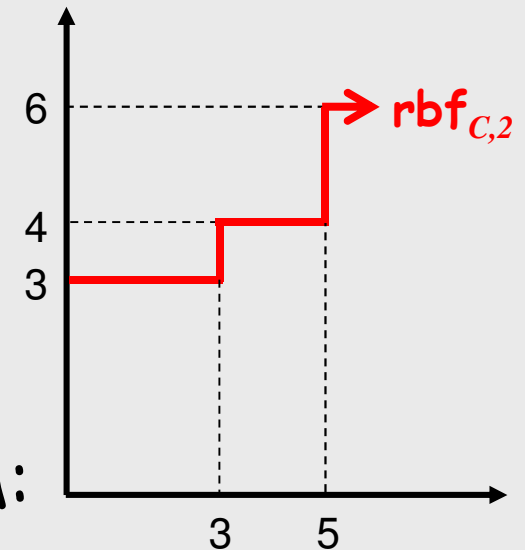
that resource model
provides

Component Resource Demand (DM)

- $rbf_{C,i}(t)$: The maximum resource request with priority at least i of component C over all intervals of length t
- C has workload $\tau_i = (T_i, C_i, D_i)$, $i = 1, \dots, n$, with $D_1 \leq D_2 \dots \leq D_n$ and uses DM scheduler
- No offset/jitter:

$$rbf_{C,i}(t) = \sum_{j=1}^i \left\lceil \frac{t}{T_j} \right\rceil C_j$$

- Extensions to offsets/jitter exist
- E.g., $C = \{(3,1,3), (5,2,5)\}$ under DM:



Resource supply

- Periodic resource model: $\Phi=(\Pi,\Theta)$
- Supply Bound Function:

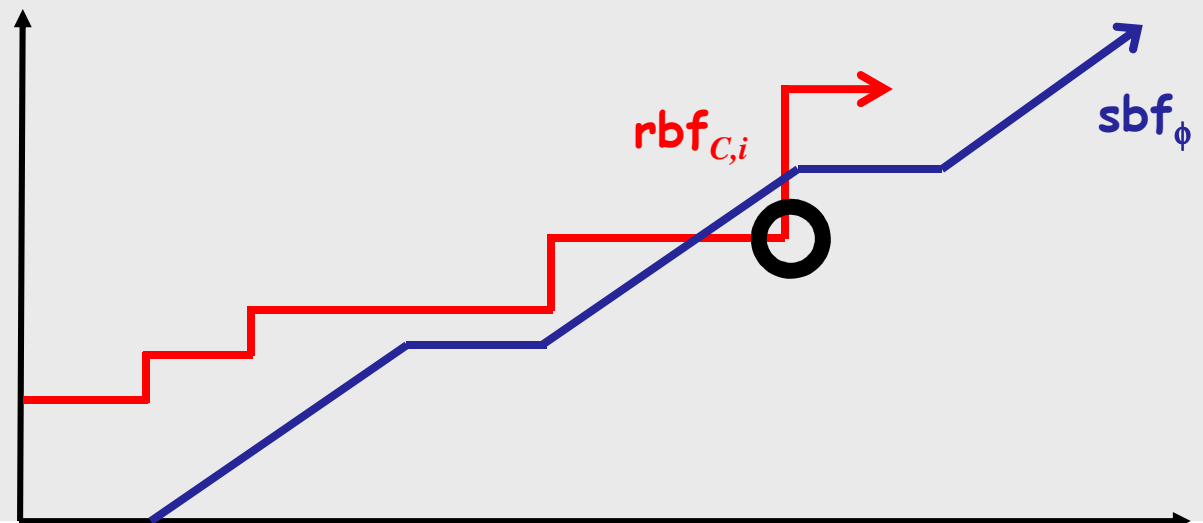
$$sbf_{\Phi}(t) = \left\lfloor \frac{t}{\Pi} \right\rfloor \Theta + \max \{ 0, t - (\Pi - \Theta) - \left\lfloor \frac{t}{\Pi} \right\rfloor \Pi \}$$

- Improved for harmonic periods

Resource Satisfiability Analysis

- Component \mathcal{C} is schedulable under DM using periodic resource model $\Phi=(\Pi,\Theta)$ iff, for all $i: 1 \leq i \leq n$, there exists t_i s.t., $\text{rbf}_{\mathcal{C},i}(t_i) \leq \text{sbf}_{\Phi}(t_i)$
- Set Π to be the partition period
- Find smallest Θ_i that satisfies the condition, for each i
- Take Θ to be the largest Θ_i

(Π, Θ) is the partition interface



Partition schedule generation

- Each partition is now represented as a single periodic task
- Determine schedulability of this task set under DM
 - Using the same resource satisfiability analysis
- Simulate execution of the task set under DM to the hyperperiod
 - Yields a static partition schedule

CARTS tool

- Performs middle steps:
 - Interface generation and sched. analysis
- Does not abstract out connections or generate partition schedule

