A Distributed Task Scheduling Framework for Edge Computing and Cyber Physical Systems
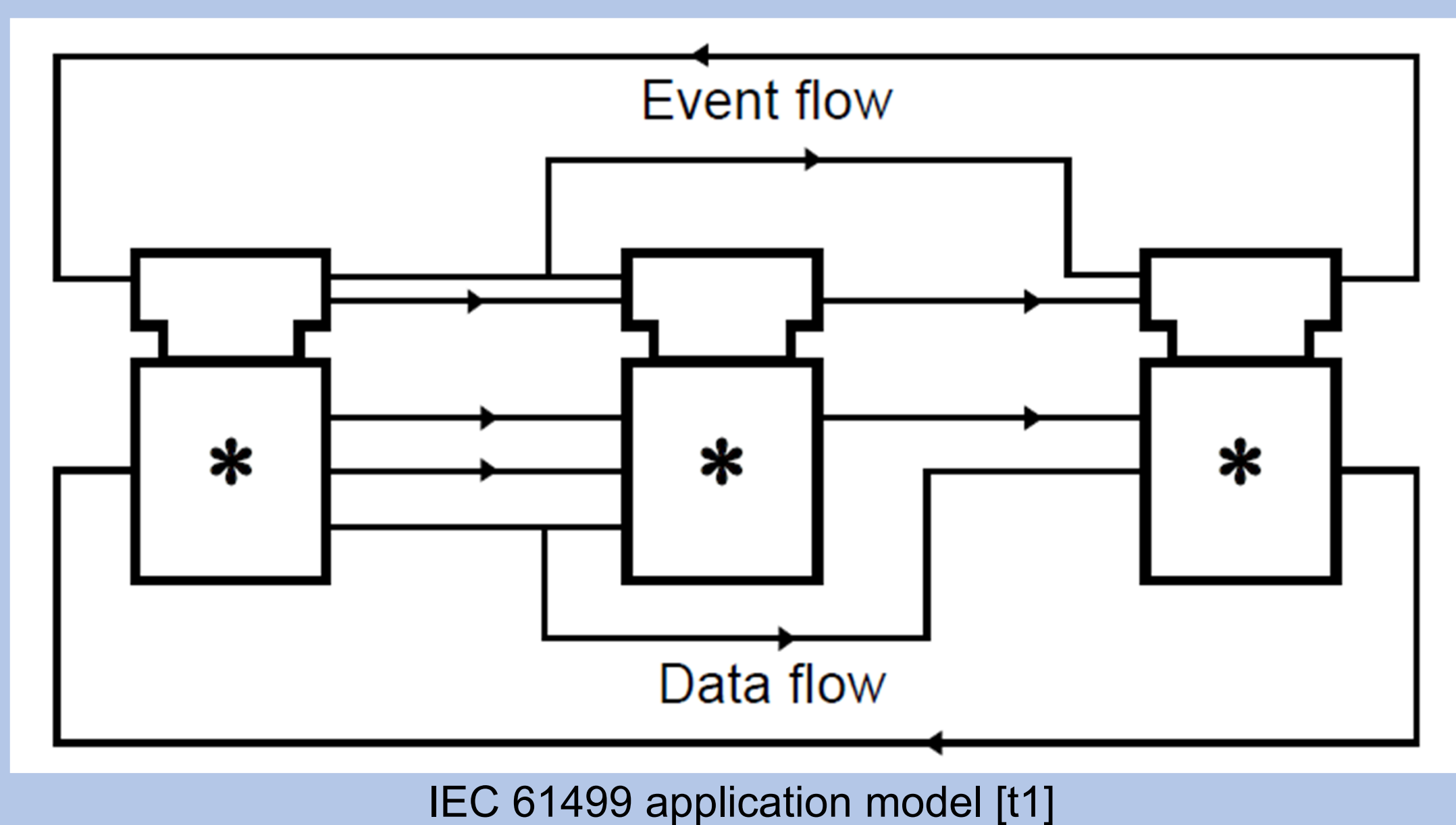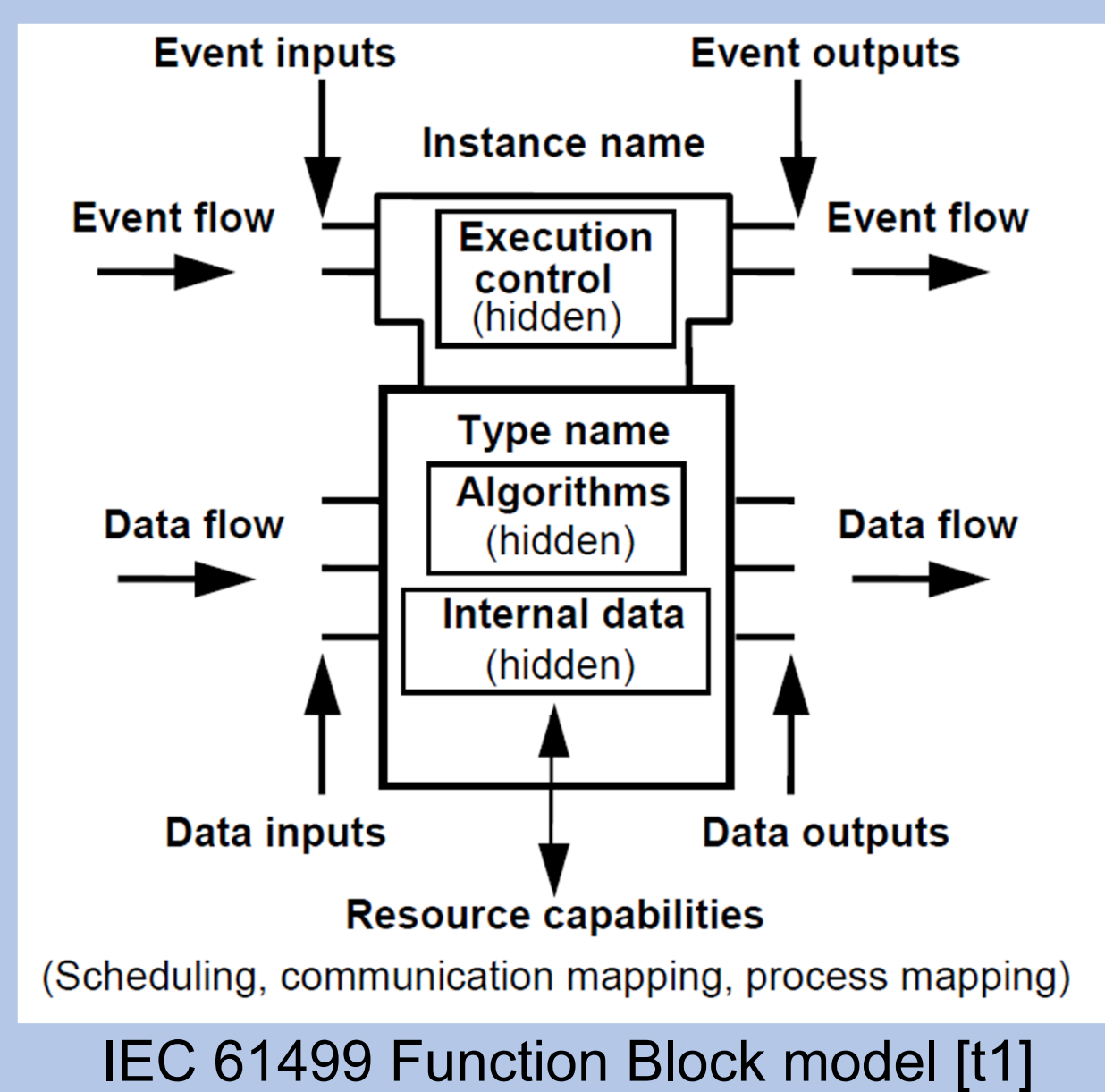
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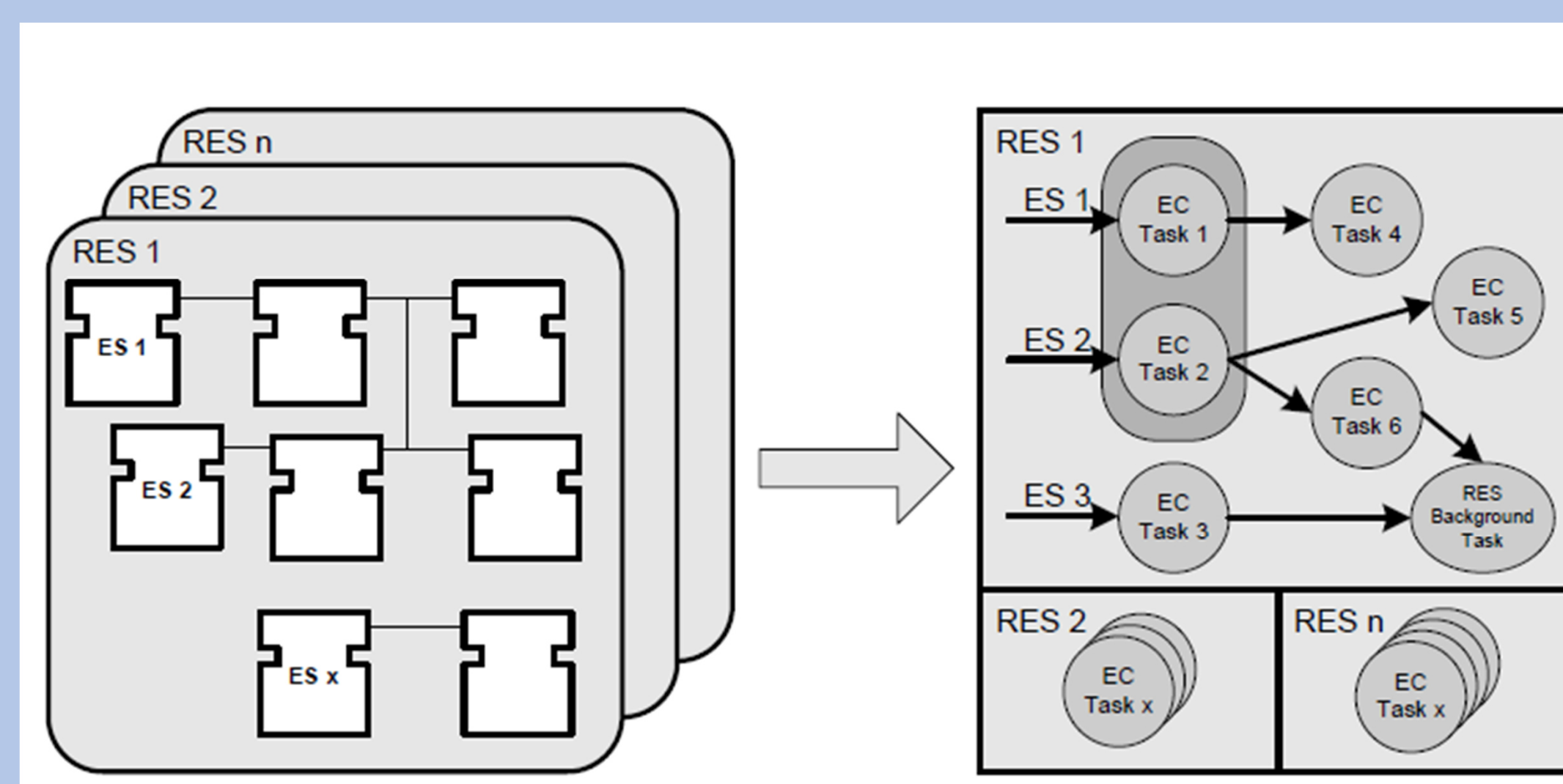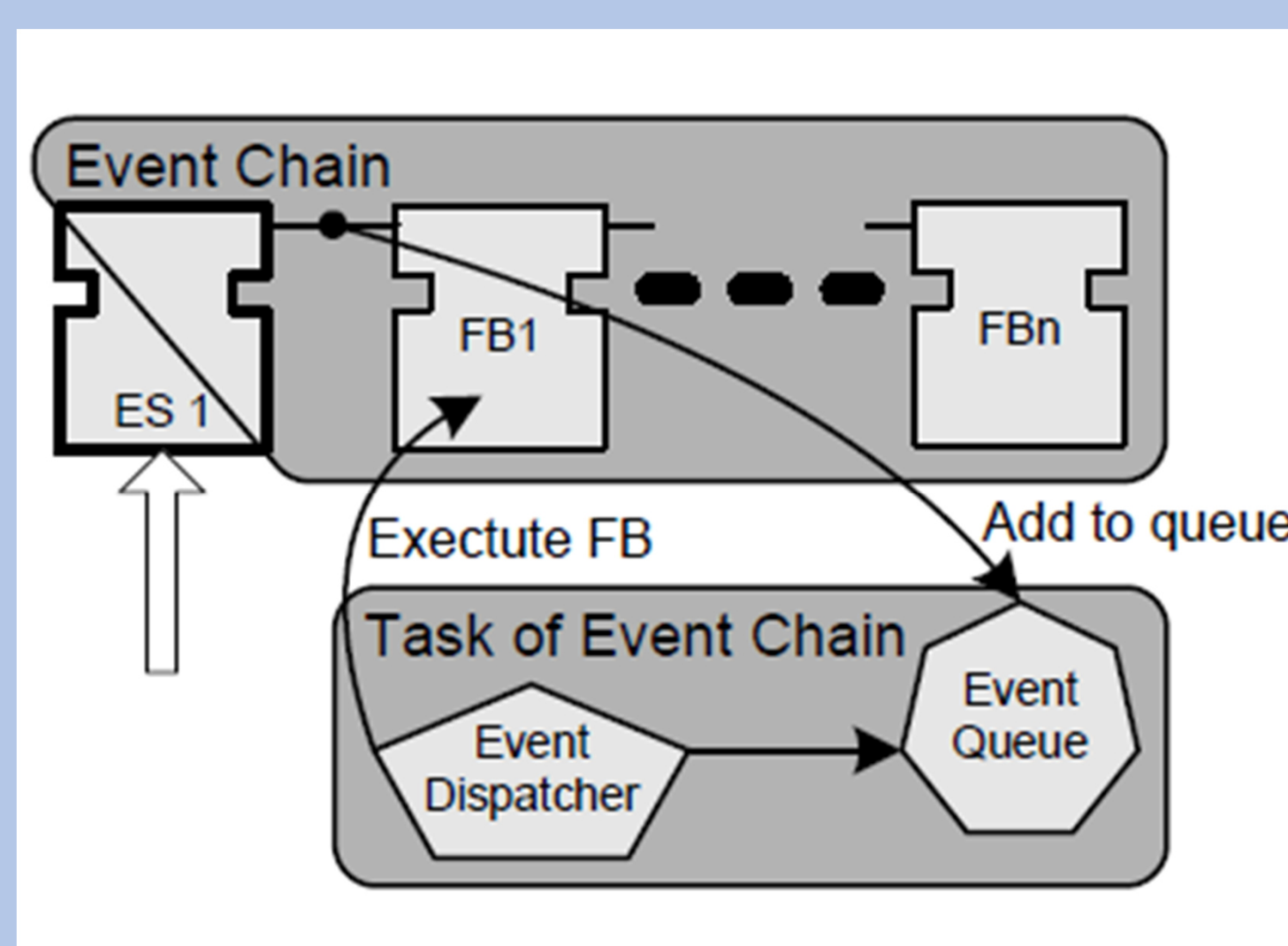Software and Embedded Systems Engineering
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Function Block Execution based on IEC 61499

IEC 61499 Function Block model [t1]

IEC 61499 application model [t1]

Lack of determinism

No real-time capability

A. Zoitl's Real-time Execution Models for IEC 61499

Event dispatcher concept [p1]

Event Chain to task transformation [p1]

Deterministic execution of event chains

No real-time capability for <u>distributed</u> systems

How to assign timing semantics to these tasks in a distributed execution environment by considering <u>precedence</u> and <u>resource</u> <u>constraints</u>?

Approach

<u>Distributed system architecture</u> with different capability levels
- Edge clusters enable high scalability and modularity
- Cluster heads verify schedulability before a task is allocated, considering: precedence constraints, resource constraints, task buffer time, hyper period
- Containerization allows unrestricted allocation of specific functions to system devices

<u>Heuristic algorithm</u> to obtain feasible variable assignment
- Iterative variable assignment based on bounds with depth-first search
- <u>Complexity reduction</u> by making use of task set specific properties
  - Smart order for iterative variable assignments (fail fast, consider connected task cluster first)
  - Smart backtracking (identify and disregard unfeasible branches)
- Feasible variable assignment corresponds to feasible schedules including tasks with proper timing semantics

$$\mu = 2 : m_{\mu=1} | periodic, multi\ job, prec, res, dyn, conc, preem | \sum f_i$$
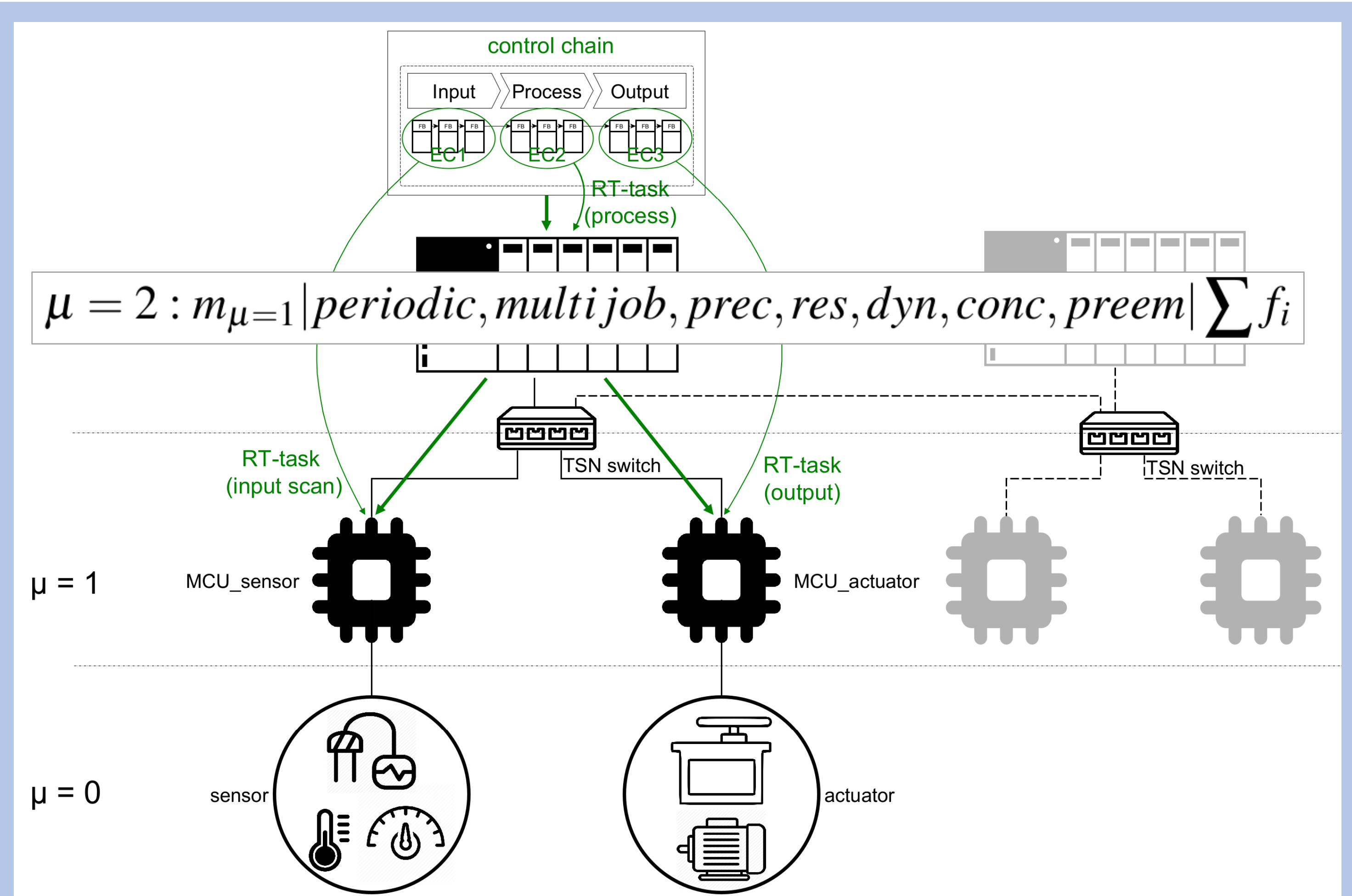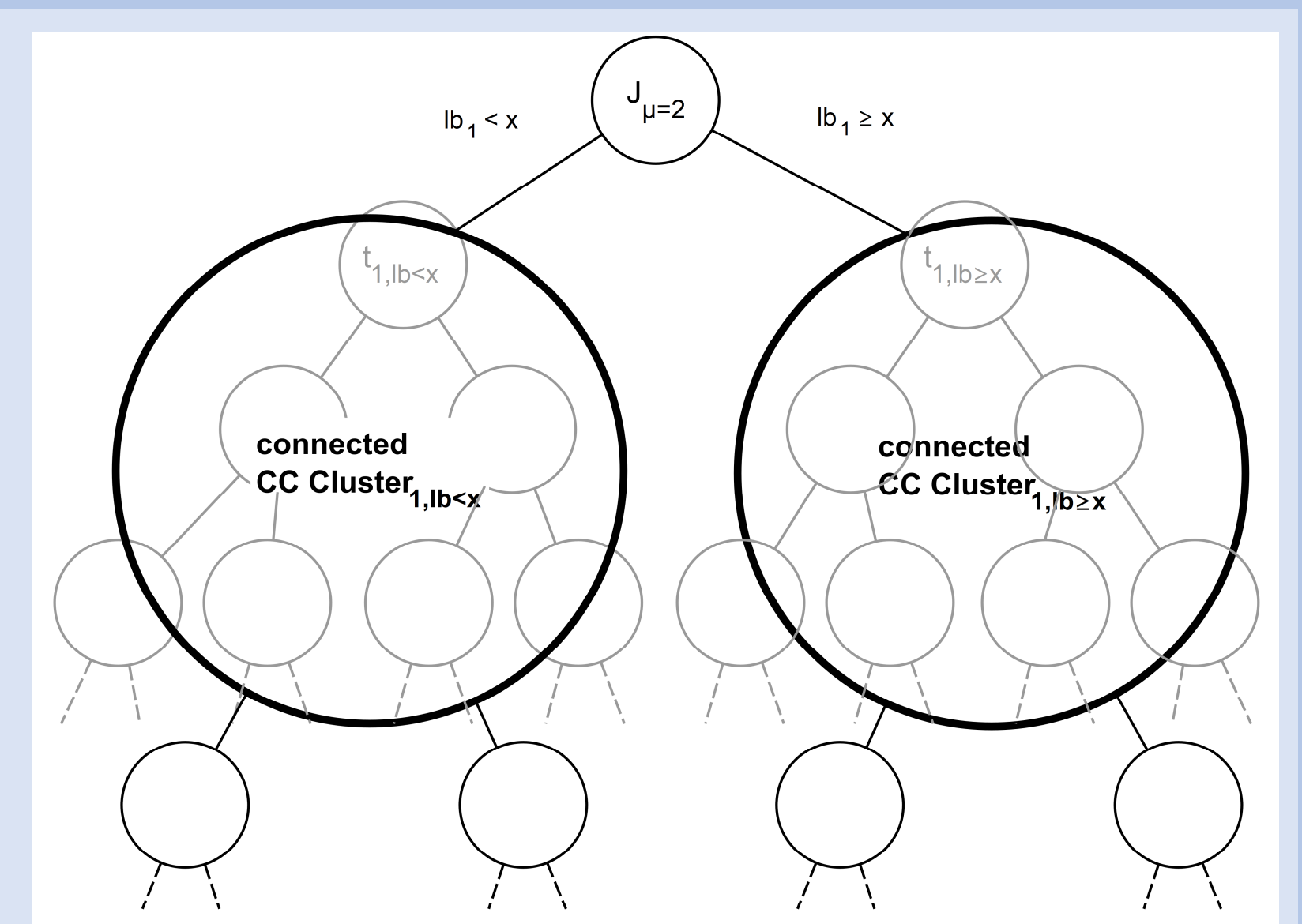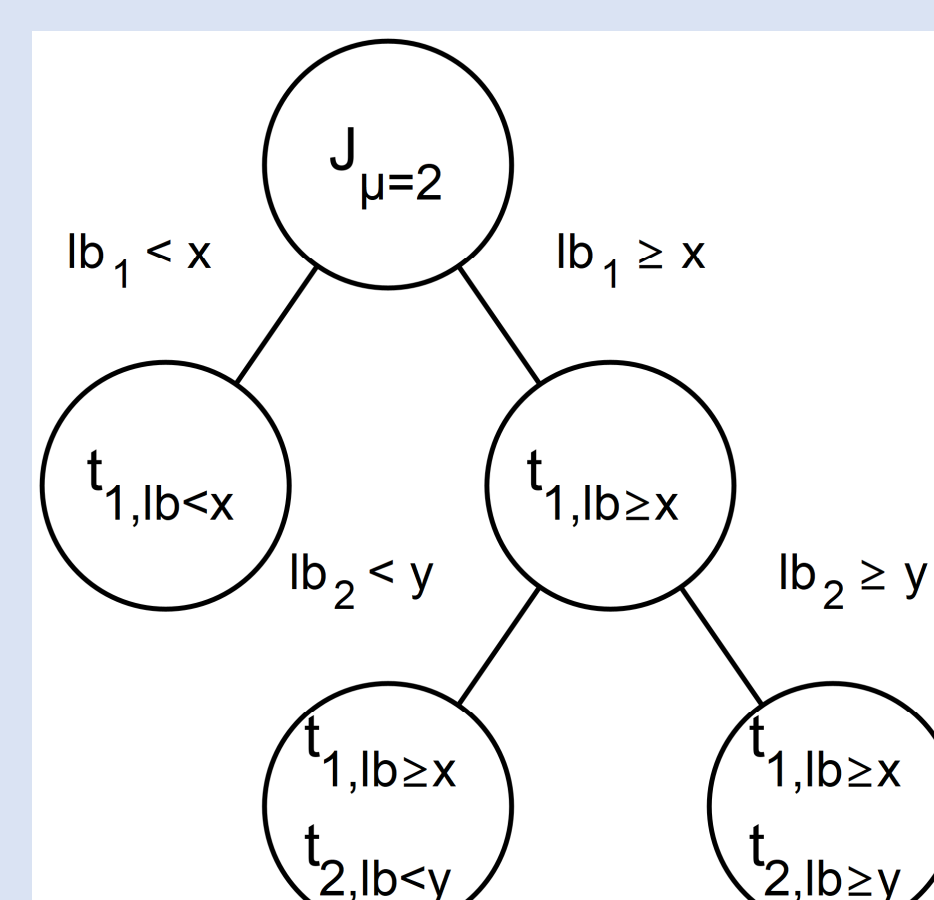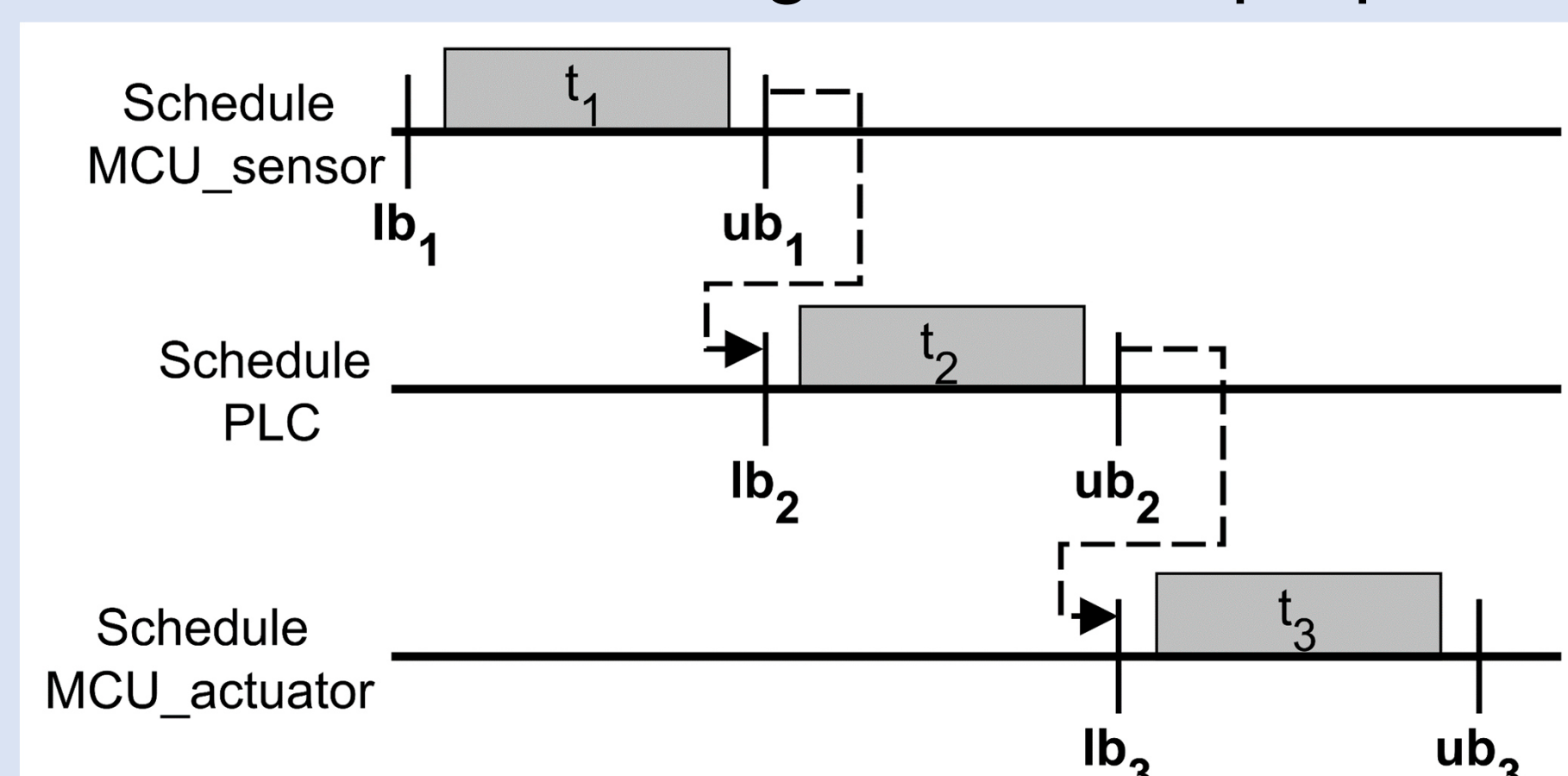
Containerized Implementation for a Proof of Concept
- Linear time complexity
- Optimal results (feasible schedules) for specific types of task sets

Future Work
- Identify determining task set classifiers
- Define performance more precisely based on classified task sets

References
- [t1] International Electrotechnical Commission, International Electrotechnical Commission, and Technical Committee 65. IEC 61499-1 Function blocks – Part 1:Architecture. English and French. OCLC: 820776327. Geneva: International Electrotechnical Commission, 2012.
- [p1] A. Zoitl. Real-time execution for IEC 61499. Research Triangle Park, NC: Instrumentation, Systems, and Automation Society, 2009.
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