Processor Allocation and Scheduling in Distributed Systems

Part III

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Allocation of Parallel Applications: Problem Definition

- Given a set of tasks with certain precedence constraints, computation, and communication requirements,
- Given a set of processors connected by a communication network,
- Find: the assignment of tasks to processors and the order of their execution that minimizes the total execution time.
Problem Definition

![Task Graph](image)

**Scheduler**

**Processors**

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Problem Complexity

- General problem is NP-complete
- Polynomial time algorithms can be found in some very special situations:
  - tree-structured task graphs and all tasks execute in unit time
  - when there are only two processors
- Heuristics have to be used in the general case.
Assessing Schedulers

• Schedulers are assessed by two metrics:

  – the performance of the schedule generated (schedule length).
  – the efficiency of the scheduler: time taken by the scheduler to generate a schedule.

Additional Scheduling Characteristics

• Single Application versus Multiple Applications

  – multiple parallel applications: objective is to minimize response time and average completion time per application.
  – multiple independent jobs: load balancing.
Additional Scheduling Characteristics

• Nonpreemptive versus Preemptive:

- Non-adaptive versus adaptive:
  - adaptive schedulers may change their behavior based on information received from the system.
  - information gathering implies in overhead.
Task Allocation Criteria

- If two communicating tasks are allocated to the same node, the communication time between them is zero and the total response time is reduced.
- Allocating tasks to different nodes increases parallelism and reduces total execution time.
Clustering Algorithms

- Process of mapping nodes of a task graph into labeled clusters.
- All nodes in the same cluster are allocated to the same processor.
- Optimal clustering is NP-complete.
- \( \{T_1, ..., T_n\} \Rightarrow \{C_1, ..., C_k\} \)

Example of Clustering

Linear Clustering
Example of Clustering

Non-linear Clustering