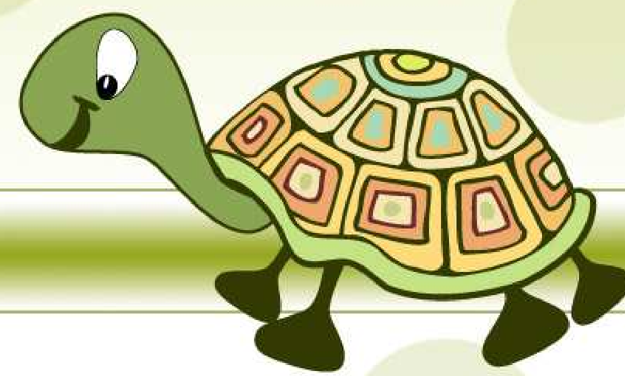
Resource Management

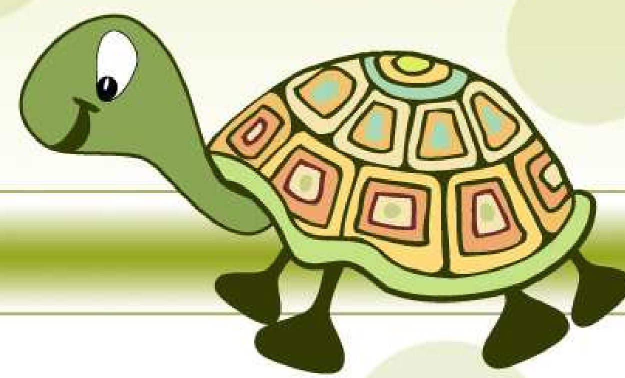
Reference: Pradeep K Sinha,

"Distributed Operating Systems: Concepts and Design", Prentice Hall of India, 2007



Overview

- Resource Management Techniques
- Desirable features of Scheduling Algorithms
- Task Assignment



Introduction

- A resource can be logical, such as a shared file or physical such as CPU.
- The set of available resources in a distributed system acts like a single virtual system.

Introduction

- Resource manager:
  - Controls the assignment of resources to processes.
  - Routes the processes to suitable nodes of the system in such a manner that resource usage, response time, network congestion, and scheduling overhead are optimized.

Resource Management Techniques

Task assignment approach:

- Each process submitted by a user for processing is viewed as a collection of related tasks.

- Tasks are scheduled to suitable nodes to improve performance.

Resource Management Techniques

Load-balancing approach:

- All the processes submitted by the users are distributed among the nodes of the system.

- Equalizes the workload among the nodes.

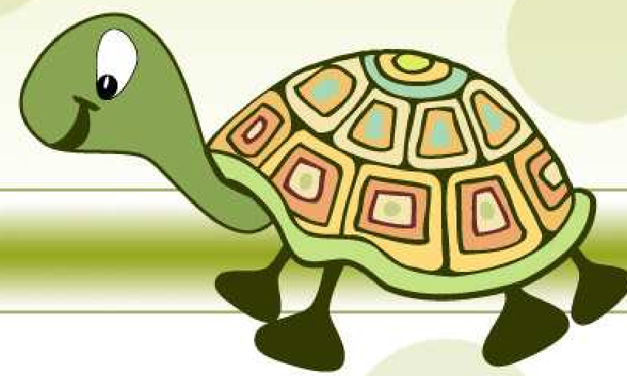
Resource Management Techniques

Load-sharing approach:

- Attempts to conserve the ability of the system, assuring that no node is idle while processes wait for being processed.

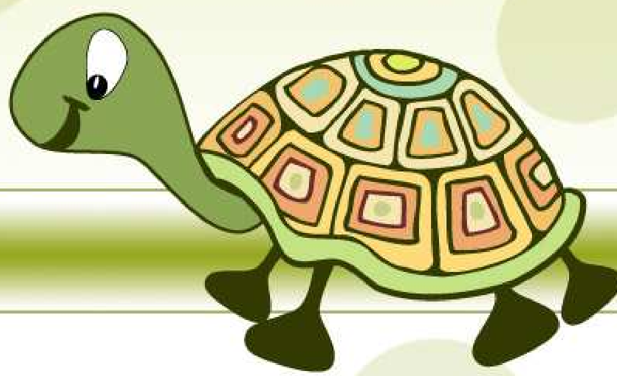
Desirable features of a good Scheduling Algorithms

- No a priori knowledge about the processes.
- Dynamic in nature.
- Quick decision-making capability.
- Balanced system performance.
- Stability.
- Scalability.
- Fault tolerance.
- Fairness of service.



Task assignment approach

- A process is considered to be composed of multiple task.
- Goal is to find an optimal assignment policy for the task of an individual process.



Task assignment approach

Assumptions:

1. A process has already been split into pieces called tasks.

2. Amount of **computation required** by each task and speed of each processor are known.

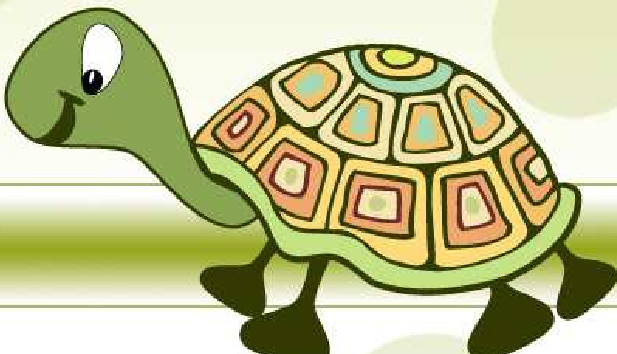
3. The **cost of processing** each task on every node of the system is known.

4. The **IPC costs** between every pair of task is known.

Task assignment approach

5. Other constraints, like Resource requirements of the tasks and the available resources at each node are also known.

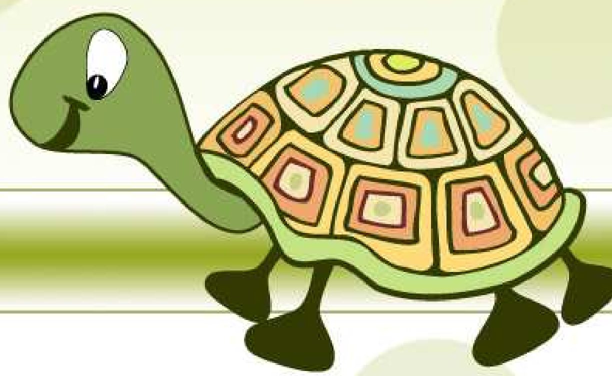
6. Reassignment of the tasks is generally not possible.



Task assignment approach

- Goals:
  - Minimization of IPC costs
  - Quick turnaround time for the complete process
  - A high degree of parallelism
  - Efficient utilization of system resources in general

- These goals often conflict with each other.



Task assignment approach

- Two task assignment parameters
  - –Task execution cost &
  - –Inter-task communication cost

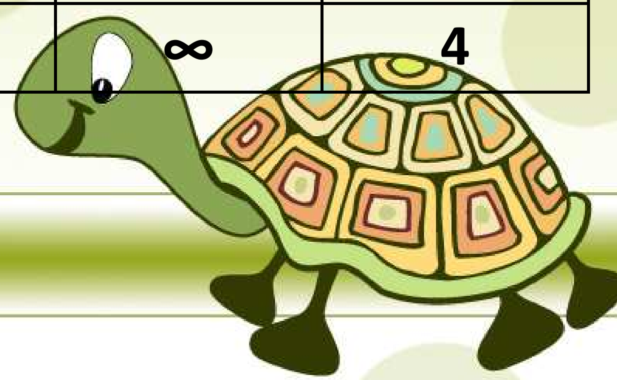
Example

- Total tasks = 6
- Total nodes = 2

Example

Inter task communications cost						
	t 1	t 2	t 3	t 4	t 5	t 6
t 1	0	6	4	0	0	12
t 2	6	0	8	12	3	0
t 3	4	8	0	0	11	0
t 4	0	12	0	0	5	0
t 5	0	3	11	5	0	0
t 6	12	0	0	0	0	0

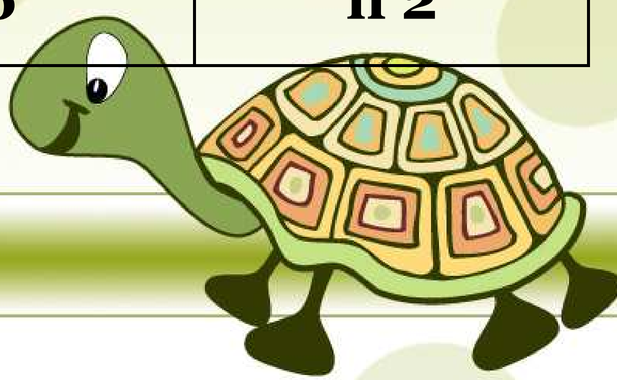
Execution costs		
Task	Nodes	
	n 1	n 2
t 1	5	10
t 2	2	∞
t 3	4	4
t 4	6	3
t 5	5	2
t 6	∞	4



Example

Serial assignment	
Task	Node
t 1	n 1
t 2	n 1
t 3	n 1
t 4	n 2
t 5	n 2
t 6	n 2

Optimal assignment	
Task	Node
t 1	n 1
t 2	n 1
t 3	n 1
t 4	n 1
t 5	n 1
t 6	n 2



Example

Serial assignment execution cost (x)

$= x11+x21+x31+x42+x52+x62$

$= 5+2+4+3+2+4 = 20$

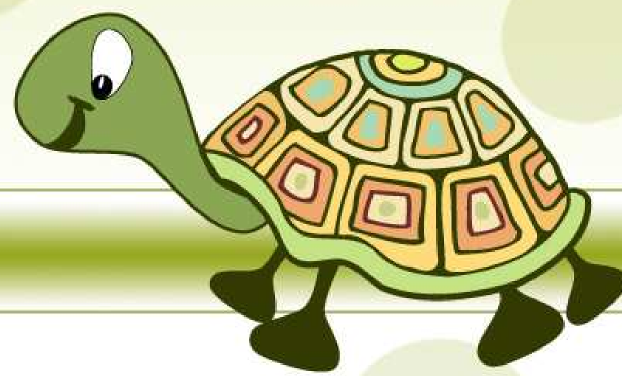
Serial assignment communication cost (c)

$= c14+c15+c16+c24+c25+c26+c34+c35+c36$

$= 0+0+12+12+3+0+0+11+0 = 38$

Total Serial assignment cost

$= x + c = 20 + 38 = 58$



Example

Optimal assignment execution cost (x)

$= x11+x21+x31+x41+x51+x62$

$= 5+2+4+6+5+4 = 26$

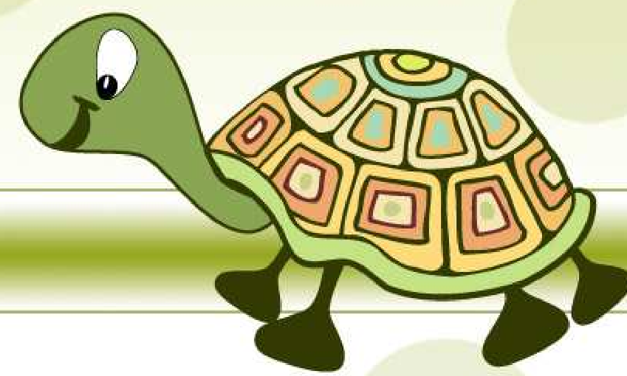
Optimal assignment communication cost (c)

$= c16+c26+c36+c46+c56$

$= 12+0+0+0+0 = 12$

Total Optimal assignment cost

$= x + c = 26 + 12 = 38$



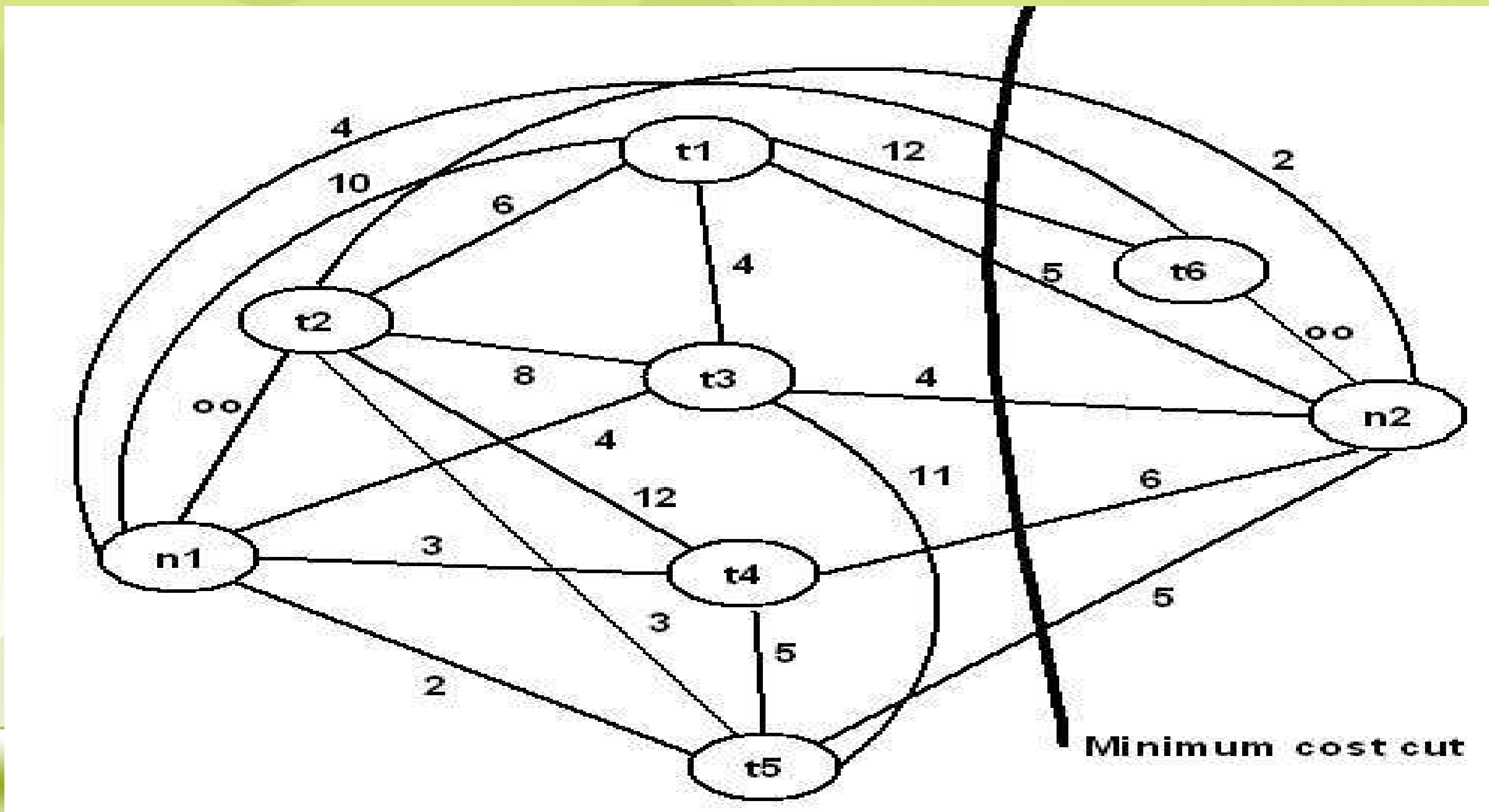
Finding an optimal assignment

- Problem : Finding an assignment of tasks to nodes that minimizes total execution and communication costs.

- An optimal assignment is found by creating a **static assignment graph.**

Finding an optimal assignment

Assignment graph:



Assignment graph for the assignment problem with minimum cost cut

Finding an optimal assignment

- Node n1 and node n2 represent the two nodes (processors).
- Nodes t1 through t6 represent the task of the process.
- Weight of the edge represent inter-task communication cost.
- Weight on the edge joining a task node to node n1 represent the execution cost of that task on node n2 and vice versa.

Finding an optimal assignment

A **cut-set** in this graph is defined to be a set of edges such that when these edges are removed, the nodes of the graph are partitioned into two disjoint subset.

Finding an optimal assignment

- The weight of a cut-set is the sum of the weight of the edge in the cut-set.
  - represents the cost of the corresponding task assignment.
- An optimal assignment may be obtained by **finding a minimum-weight cut-set.**

Finding an optimal assignment

- The bold line indicates a minimum weight cut-set that corresponds to the optimal assignment.

- In a two processor system, an optimal assignment can be found in polynomial time by utilizing max flow/ min cut algorithms.

Thank You