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Analysis of HLFET and MCP Task Scheduling Algorithms

Samriti[1], Sandeep Gill[2], Ankur Bharadwaj[2], Navpreet Singh[3], Harsimran Singh[4], Jashwinder Singh[5]

[1](Assistant Professor, DCSE, SSIET Patti, Punjab, India)

[2] (Assistant Professor Department of Computer Science, Sewa Devi SD College Tarn Taran, India)

[3]Technical Head, IT, MINT, Ajmer, Rajhasthan

[4] (PHP Developer, Kochhar Inoftech, Amritsar, Punjab)

[4] (Senior Technical Assistant, Punjab Technical University, Kapurthala)

ABSTRACT

Scheduling tasks on multiprocessor system is an imperative and computationally intricate problem. Multiprocessors are used for running real-time applications that a uniprocessor system would not be competent to execute. It requires an resourceful algorithm to determine when and on which processor a given task should execute. The scheduling problem is represented by an edge-directed acyclic graph (DAG) based on homogenous processors. The objective of scheduling is to minimize the execution time, evaluate and compare the performance of the individual algorithms. Different algorithms are analyzed and classified into four groups. The algorithm in first group schedule the DAG to bounded number of processor (BNP). Algorithms in second group schedule the DAG to unbounded number of clusters (UNC). The algorithm in third group schedule the DAG to task duplication based (TDB). The algorithms in the fourth group perform allocation and mapping on arbitrary processor network topologies (APN). In this study the focus is given on two major BNP algorithm based upon homogenous environment i.e. HLFET Highest Level First with Estimated Time and Modified Critical Path commonly abbreviated as MCP.

Keywords **- Parallel Environment, Directed Acyclic Graph, HLFET, MCP, Task Scheduling**

I. INTRODUCTION

Parallel computing, one of the emerging concept in the field of Information Technology [4] that is used to execute number of tasks on different computers of workstations.

Parallel processing plays a significant role in solving complex and computation intensive problems in a minimum time with efficiency. The homogenous environment of parallel computing uses the similar power computers for task execution on the other hand in the heterogeneous environment of parallel computing the tasks are allocated on different capacity of computers. The major aspect of parallel environment Independent of the environment is to improve the execution speed and to minimize the makespan [2] of task execution.

BNP uses b-level and t-level for assigning priority to different nodes for its execution. HLFET [1][2][3][4] (Highest Level First with Estimated Times) is one of the important static list scheduling algorithm that compute the sum of computation cost of call the nodes available in a DAG.

II. OBJECTIVE OF STUDY

The objective of this paper is to compare and contrast the various parallel environment metrics of HLFET and MCP task scheduling algorithms. Both HLFET and MCP are BNP Task scheduling algorithms. Here BNP stands for Bounded Number of processors. These algorithms schedule the DAG to a bounded number of processors directly. The processors are assumed to be fully connected. Most BNP scheduling algorithms are based on the list scheduling technique. List scheduling is a class of scheduling heuristics in which the nodes are assigned priorities and placed in a list arranged in a descending order of priority. The node with a higher priority will be examined for scheduling before a node with a lower priority. If more than one node has the same priority, ties are broken using some method. The Highest Level First with Estimated Time (HLFET) algorithm [4][6][7] is one of the simplest list-scheduling algorithms. It uses Static level as node priority. On the other hand the Modified Critical Path algorithm commonly abbreviated as MCP algorithm [5][6] utilizes the ALAP attribute of a node as for priority scheduling. Modified Critical Path algorithm initially calculate the value of ALAPs of all nodes and after that erects the list of nodes in increasing order of nodes ALAP. When the ALAP values of two nodes become same, the ALAPs of the children are taken into concern. It should be noted that the MCP algorithm schedules the nodes on the list taking one by one such that a node is scheduled to the processor or work-station that allows the earliest execution start time.

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III. ANALYSIS

In this section the performance of two major BNP algorithms is compared by taking two different cases consisting of 5 nodes and 10 nodes.
All the tasks are allocated and executed on three processors P1, P2, P3. HLFET and MCP algorithms are used to compute various parallel environment metrics like makespan, speedup, Scheduled Length Ratio, processor utilization, complexity etc.

Case1: Consider a DAG consisting of 5 task nodes as shown in the following figure. The 5 task nodes used are T1, T2, T3, T4 and T5.

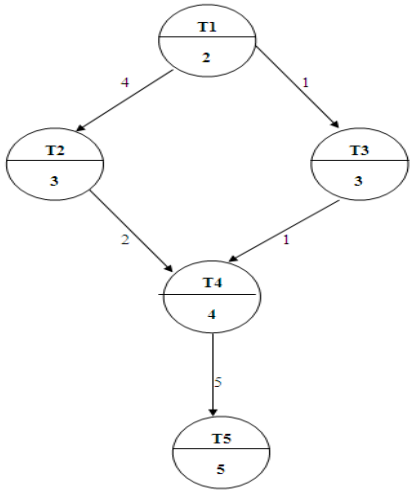

Figure1: DAG with 5 Nodes

The following table shows the various scheduling attributes used to find the performance of algorithms.

Tasks	Execution Time	Static b-level	t-level	b-level	ALAP Time	Dynamic Level
T1	2	14	0	25	0	14
T2	3	12	6	19	6	6
T3	3	12	3	18	7	9
T4	4	9	11	14	11	-2
T5	5	5	20	5	20	-15

The following chart shows the schedule generated by HLFET task scheduling algorithm, when the tasks are scheduled over three processors.

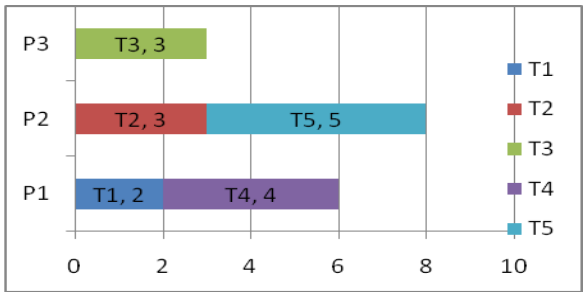

Figure 2 : HLFET Task Schedule

The following chart shows the schedule generated by MCP algorithm, when the tasks are scheduled over three processors.

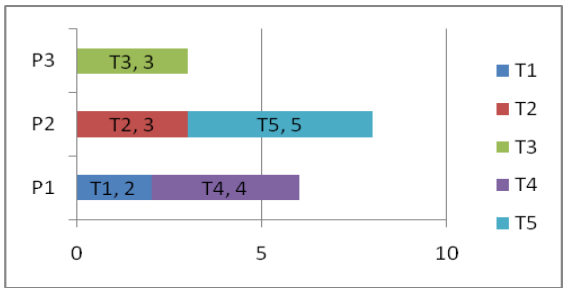

Figure 3: MCP Tasks Schedule

The following table shows how HLFET task scheduling algorithm is different from MCP task scheduling algorithm in term of various parallel environment metrics.

	HLFET	MCP
Makespan	8	7
SLR	0.32	0.28
Speed Up	2.12	2.42
Processor Utilization (P1)	75%	75%

The following table shows the nature of relation between HLFET makespan and MCP makespan for 5 nodes with their relative mathematical equations.

S.No.	Nature of Relation	Mathematical Equation
1.	Logarithmic	y = -1.4427Ln(x) + 8

IV.	Linear	y = -x + 9
V.	Exponential	y = 9.1429e-0.1335x

Case II: Consider a DAG consisting of 10 task nodes as shown in the following figure. The 10 task nodes used are T1, T2, T3, T4,T5,T6,T7,T8,T9 and T10. In the DAG there are two types of weight associated, one is execution time

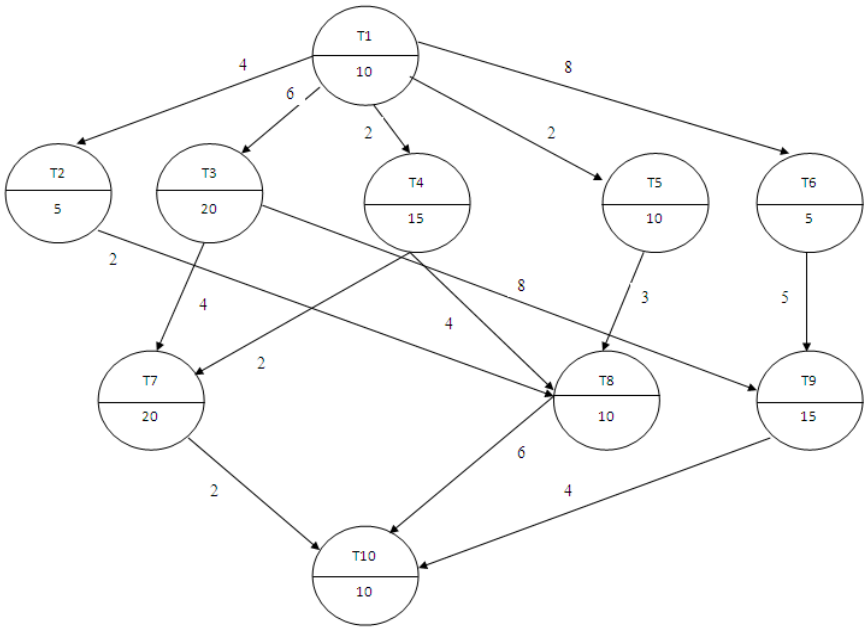

Figure1: DAG with 5 Nodes

shown in the node and other is communication cost shown by edges. By using the DAG shown in the figure, one is able to compute various parallel environment metrics like makespan, b-level, t-level, ALAP etc. By using these parameter further performance metrics are computer as shown in the following table. The following table gives information of various computed attributes required for task scheduling.

.Tasks	Execution Time	Static b-level	t-level	b-level	ALAP Time
T1	10	60	0	73	0
T2	5	25	14	33	4
T3	20	50	16	57	16
T4	15	45	12	49	24
T5	10	30	12	39	34
T6	5	30	18	39	34
T7	20	30	40	32	41
T8	10	20	31	26	47
T9	15	25	44	29	44
T10	10	10	63	10	63

The following chart shows how various 10 tasks are scheduled over three processor P1, P2 and P3 by using one of the list scheduling algorithm i.e. HLFET.

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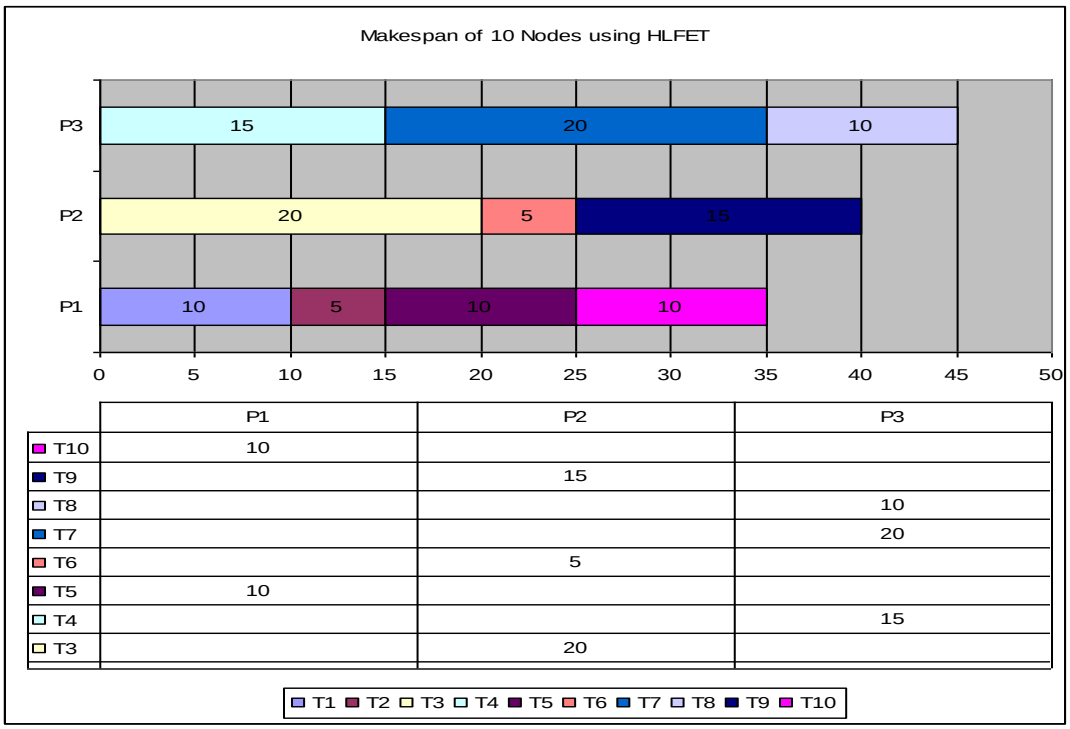
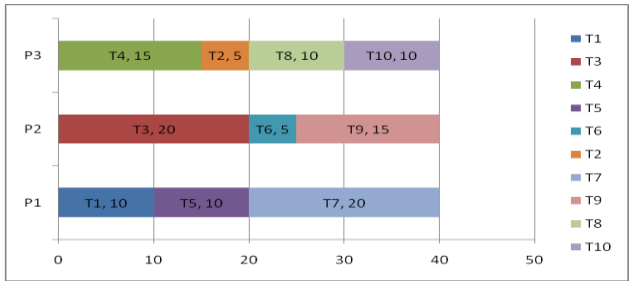


Figure: Analysis of 10 nodes DAG

The following chart shows how MCP differs in allocating above said 10 tasks to three processors.



The following table shows how HLFET task scheduling algorithm is different from MCP task scheduling algorithm in term of various parallel environment metrics.

	HLFET	MCP
Makespan	45	40
SLR	0.32	0.28
Speed Up	51.42857	62.2%
Processor Utilization (P1)	100	100%
Processor Utilization (P2)	88.88889	100%
Processor Utilization (P1)	77.77778	100%

IV. CONCLUSION

From the above data it is very clear that both HLFET and MCP task scheduling algorithms are used to reduce the processing time of task as compare to serial task scheduling. Further it is clear that MCP task scheduling algorithm has smaller makespan as well as SLR in both of cases as compare to HLFET task scheduling algorithm. And MCP task scheduling algorithm has high speed up as compare to HLFET task scheduling algorithm. So in regard to above said case of 5 nodes and 10 nodes one comes to conclude that MCP task scheduling algorithm is better than HLFET task scheduling algorithm. Although both are superior when compared with serial task scheduling algorithms.

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