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EFFICIENT QOS WITH MULTIPLE CONSTRAINTS FOR EPIGENOMIC SCIENTIFIC WORKFLOW MODEL IN SAAS CLOUD

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ABSTRACT

In cloud computing, Service Level Agreement (SLA) will be executed between the user and the cloud provider before the start of the application or using the cloud. SLA defines user's essential Quality of Service (QoS) parameter in terms of execution cost and time. The QoS can be measured by many factors viz. Execution time, User deadline, Cost and Reliability etc. SC-PCP algorithm is used to improve the QoS, by using cost and time for satisfying user defined deadline. In this paper, an attempt has been made to enhance the SC-PCP algorithm and thereby to improve the QoS by including the several other parameters viz. Reliability, Scalability and Throughput. The user requirement is obtained with higher efficiency in short duration for considering of multiple parameters as QoS contrain. The performance of the enhanced SC-PCP algorithm has been simulated and analyzed using CloudSim to validate the results.

Keywords: *Throughput, Stability, Reliability, CloudSim, SAAS(Software as a Service), QoS(Quality of Service), Cloud Computing, Distributed Computing*

1. INTRODUCTION

A part of distributed computing is referred as cloud computing [1], has more benefits for scientific applications and provides a wide range of service. In Clouds, services are provided based on Service Level Agreements (SLA). The services are utilized by the consumers through SLA. The three major categories of cloud computing include Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS). The user can opt for a service based on their requirements. The Quality of service is considered as an important criteria and the user has to provide their QoS constrains along with the workflow.

Workflow depicts a sequence of operation which includes Planning, Scheduling and execution. These operations are necessary to evaluate the performance of any scientific workflow implementation [2]. The scientific workflows have been used frequently to compute complex model in heterogeneous atmosphere, to analysis, instrumental data and to merge the information with distributed environment. The workflows have been considered in various application domains like astronomy, biology, gravitational physics and earthquake science [3]. These workflows, access the resources in on-demand basis for computation [4]. Scheduling is the phenomenon by which processes or data flows are given access to system resources in order to load balance the system and to achieve the target QoS. Multitasking gives rise to the necessity for scheduling. In cloud computing, scheduling has been developed for multiple workflows with different QoS requirements. A multiple QoS constrained scheduling strategy has been proposed for achieving quality of service with multiple constraints [3]. As a result of difficulties in the development process of general multi- Objective Scheduling algorithm [5], the researcher proposed bi-Criteria Scheduling algorithm. The user requirement is obtained with higher efficiency in short duration [6].

The QoS act as a metric in workflow scheduling. The various factors that affect the QoS of an application include deadline, budget, time, cost, trust, reliability and efficiency. Deadline and budget distribution workflow scheduling algorithm [7] has been developed, considering deadline and budget as QoS parameter. In cloud, computational time and cost are the most important factors, as the users are being charged on pay-per-usage technique. For the effective utilization of resources and to compute the results within a short duration, a Particle Swarm Optimization (PSO)-based Heuristic for Scheduling [8] algorithm has been developed. This algorithm saves the 3 times cost compared to Best Resource Selection (BRS) algorithm. A Compromised-Time-Cost Scheduling Algorithm [9] has been proposed to meet the user deadline, cost effective and time efficiency. SaaS cloud Partial Critical Path algorithm (SC-PCP) [10] has been proposed to meet the user requirement with effective cost and shorter duration.

In this paper, an enhanced SC-PCP algorithm has been proposed in order to improve the QoS attributes viz. Reliability, Scalability and Throughput along with the time and cost functions. It is attempted to consider multiple parameters to get better efficiency of user desired QoS, because in existing algorithm all these parameters are not considered as QoS Constrain. This paper is organized as follows: Section 2 depicts the algorithms used in cloud computing, which includes the SC-PCP algorithm; Section 3 elaborates the proposed algorithm Enhanced SC-PCP algorithm. Section 4 gives the proposed model and Analysis and Section 5 Concludes the paper with a summary of our contribution.

2. SC-PCP ALGORITHM

In SC-PCP algorithm [10], execution time and cost has been considered as QoS factors. The algorithm determines scheduling, cost and time functions in consecutive manner. Thereby an effecting critical (fair) path will be selected for completing the task with reduced cost and time values.

The critical path is created based on the EST (Earliest starting Time) Starting time of the task (T_i) for computation, EFT (Earliest Finishing Time) the time on task to complete the performance and it is calculated before the computation starts and LFT (Latest Finishing Time) the time to complete the task, it is calculated during the computation time of each tie in the workflow. In-order to determine the end result, the algorithm executes the

1. Parent Schedule algorithm for critical path creation and scheduling of the task.
2. A path scheduling algorithm for reducing the cost of the scheduled path, i.e. considering the execution cost in QoS parameter.
3. A fair path algorithm for reducing the time of the scheduled path, by considering the execution time in QoS parameter.

3. ENHANCED SC-PCP ALGORITHM

In General, QoS requirements can be classified as functional and non-functional parameters. Some of the parameter viz., security and user experience cannot be measured easily [11]. In this enhanced SC-PCP algorithm has been modified by taking into account of other factors viz., reliability, stability and throughput in addition to the time and cost factors of SC-PCP. The aforesaid factors have been considered, because addition of multiple parameters may result in improved QoS [3].

Execution Time $ET(T_i,S_j)$ and Execution Cost $EC(T_i,S_j)$ are considered for processing T_i tasks on S_j service respectively. A task may consist of a number of services SJ and a service may include a number of applications, M_k. In workflow, T_i can be processed by M_k applications in a service which is given by S_j, $S_j = \{S_1, S_2, \ldots, S_{mj}\}$, with different QoS attributes.

3.1 Characterization of Parameters

The SC-PCP algorithm has been enhanced considering the parameters viz., reliability, scalability and throughput.

Reliability **(R)** is referred as, how many numbers of tasks have been completed successfully in a given time. It is measured by the mean time failure assured by the cloud supplier and previous failures practiced by the users.

$$R(T_i,S_j) = \max\{ (1- (\text{no. of failure in } S_j) / T_i)^* P_{mtf}\} \quad (1)$$

Where,

$R(T_i,S_j)$= Reliability of Task (T_i) in Service (S_j)
P_{mft} = Probability of Mean Time Failure

Stability **(ST)** is referred as variability in the performance of a service. For computational resources, it is the deviation from the performance specified in the SLA.

$$ST(T_i,S_j) = \max \{(\alpha_{avg,I} - \alpha_{sla,i}) / ET(T_i,S_j)\} \quad (2)$$

Where,

$ST(T_i,S_j)$ = Stability of Task (T_i) in Service (S_j)
$\alpha_{avg,I}$ = average performance of user I
$\alpha_{sla,\ I}$ = promised value in SLA for the user

Throughput **(TP)** is measured to evaluate the performance of the cloud. It depends on the several factors that affect the task execution. The total throughput of a cloud service is measured by, the number of successfully completed task by the cloud services in a unit of time.

$$TP(T_i,S_j) = \max\{(T_i/(ET(T_i,S_j)+T_o)\} \tag{3}$$

Where,

$TP(T_i,S_j)$ = Throughput of Task (T_i) in Service (S_j)

T_o = Time overhead due to infrastructure delay and task communication delay

The cost (C) and time factors could be computed by the following equation [10].

$$C(T_i,S_j)= \min\{C_{k-1}(d-ET((T_i,S_j) - TFT(ek-1,k)) + EC(T_i,S_j),\ EST(T_i) + ET(T_i,S_j) <= d\} \tag{4}$$

Where,

$d= EFT(T_i),\ldots\ldots LFT(T_i)$
TFT = Transfer time
$C(T_i,S_j)$ = cost of Task (T_i) in Service (S_j)

In the enhanced SC-PCP algorithm, the weighted sum method has been used in-order to maximize the Reliability, Stability and Throughput parameters and minimize the cost and time factors [12-14]. By combining these two objective functions, more accurate QoS results can be arrived. The optimized path that provides Enhanced QoS (EQoS) is given by Equ. 5.

EQoS (T_i€ path) =

$$\sum_{i=1}^{n} \sum_{j=1}^{k} W_1 R(T_i,S_j) * W_2 ST(T_i,S_j) * W_3 TT(T_i,S_j) * W_4 C(T_i,S_j) \tag{5}$$

Where, $\sum_{m=1}^{r} W_m$ and $0 \leq W_m \leq 1$

3.2 Procedural Steps For Enhanced SC-PCP

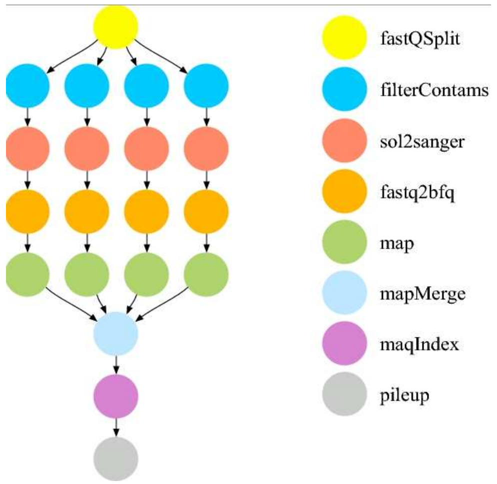
```
1.  Procedure schedule path_ additional parameter (path)
2.   For all tasks $T_i$€ path do
3.   If($T_i$ is completed the services successfully)
     then
4.   Compute reliability using Equ. 1
5.   Compute stability using Equ. 2
6.   Compute throughput using Equ. 3
7.   Total Reliability ($T_i$ € path) += R($T_i$,$S_j$)
8.   Total Stability ($T_i$ € path)+=SS($T_i$,$S_j$)
9.   Total Throughput ($T_i$ path)+=TP($T_i$,$S_j$)
10. End if
11. End for
12. For all tasks ($T_i$€ path) do
13. For all services ($S_j$€$T_i$) do
14.   Compute QoS performance using Equ. 5.
15. End for
16. End for
17. Mark the QoS performance is computed.
18. End procedure.
```

In this algorithm, the tasks are scheduled based on the fair path algorithm [10]. The Reliability, Stability and Throughput of (successfully completed service S_i) the tasks are calculated using the equation 1, 2, 3 respectively. The total Reliability, Stability, Throughput of the path is computed in step7-9. These values should be calculated along with the SC-PCP algorithm parameter like Execution cost and time, that can be achieved by the equation 5 in step14 of the algorithm.

4. SIMULATION MODEL AND ANALYSIS

4.1 Simulation Model

The epigenomic workflow model has been used to simulate the enhanced SC-PCP algorithm using Cloudsim simulator. This workflow model is simple and easy to design as it can be generated with the help of coding techniques.

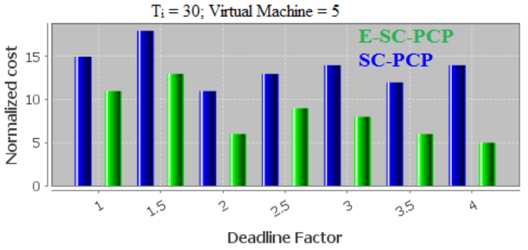


` *Figure 1. Epigenomic workflow model*

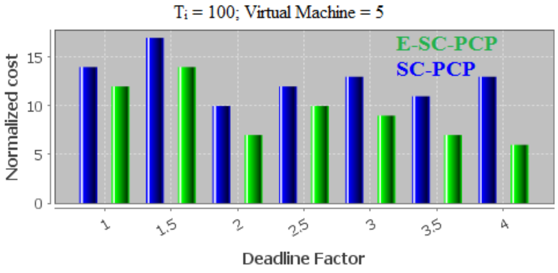
The work flow model has been considered for a various tasks and these tasks have been assigned to the various virtual machines. The reliability, stability and throughput factors have been taken into account in the simulation model to obtain the optimized path with enhanced QoS values. The simulation results arrive at the normalized cost in the optimized path. To evaluate this workflow model has been considered with three sizes of task values viz., small (Ti = 30), medium (T_i = 100) and large (T_i = 1000) for a deadline factor [16] of the range 1 to 4 has been set.

4.2 Simulation Results

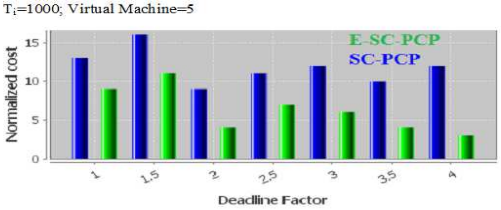
The simulation result of the epigenomic workflow model with 5 virtual machines and three sizes of task values has been depicted in Figure 2.1. The virtual machines have been varied and the results have been obtained and illustrated as in Figure 2.2 for the same T_i values.



(a) Small T_i

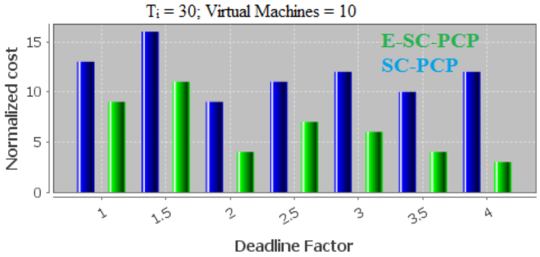


(b) Medium T_i

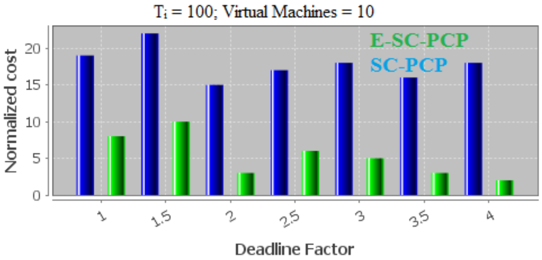


(c) Large T_i

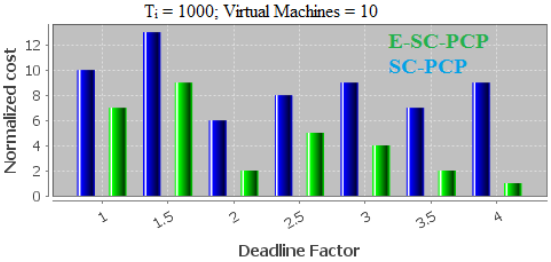
Figure 2 Simulation Results for 5 Virtual Machines



(a) Small T_i



(b) Medium T_i



(c) Large T_i

Figure 3 Simulation Results for 5 Virtual Machines

4.3 Results and Discussions

From the simulation results depicted in figures 2 and 3, of the proposed enhanced SC-PCP algorithm, it is clear that for a small range of T_i and with more number of virtual machines, the deviation in the normalized cost of the workflow model is very less. The reason behind the same is that some machines remain idle, when the task is of small range. For the medium and large range of T_i, the normalized cost is very less when the time of the number of virtual machines increases. In all the cases, the normalized cost value is decreased when compared with the previous algorithm. In user concern effective and efficient QoS means the tasks are computed in minimum value of time and cost. So all the parameter values are calculated in the base of cost and time.

5. CONCLUSION

The user needs to obtain their desired QoS by paying an amount for that. To attain this QoS in an efficient manner we proposed an enhanced SC-PCP algorithm. It considers Reliability, Scalability and Throughput in addition to execution time and cost functions, has been proposed in order to satisfy the QoS as per the user requirements in cloud systems. The proposed algorithm has been simulated and the results depict that the proposed algorithm provides better QoS with reduced normalized cost functions.

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