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Fault Tolerant Scheduling Methods in Cloud Based 5G Networks

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Abstract*: Cloud computing is one of the emerging technology in the field of business and also in the research field. High performance and high efficiency for 5G systems can be provided by the cloud radio access networks(C-RAN). There is also requirement of higher efficiency and also for the low latency for the 5G mobile networks. Sometimes there is probability of entire system failure due to the fault in some part of the hardware or the software. Hence by developing some of the fault tolerant methods these kind of issues can be avoided. Fault tolerance methods can also increase the use of cloud based services. The main idea of fault tolerant scheduling methods is to involve redundancy , so that all the tasks can be performed even when the system fails. But this may cause overhead for the cloud service providers. Hence various scheduling algorithms can be used to overcome this problem. In this paper, the different kinds of fault tolerant scheduling algorithms are discussed. Hence the suitable methods can be used according to the requirement of the user. This should also lead to increase in the efficiency, performance of the tasks and avoid the system failure in case of minute faults in the system.

***Index Terms*: Fault tolerance, Redundancy, Cloud computing, Quality-of-service.**

I. INTRODUCTION

The cloud computing domain has grown up in the business sector and also in the research community from past many years. The cloud computing provides services for the users who are in need for the resources. Several services are provided by the cloud service providers based on pay-per-use basis. Cloud computing is an emerging technique. It is attracting many number of applications that can run in the remote data centres. Recently the researchers are willing to use cloud platform for building scientific applications and also the big organizations are willing to use the cloud platforms. Several computer applications require parallel processing capabilities, so there is also proper requirements for scheduling the jobs properly[1]. Therefore several scheduling algorithms are used to allocate the specific task to the suitable machines. Since the 5G networks is one of the blooming technology in the mobile computing field. The need for evolution of the 5G networks as increased due to the increase in the need for quality of communication. Also there is requirement for higher energy efficiency and also for the low latency. Also the services for the real time tasks are expected. In the future five plus years, there is requirement for mobile data, thousand times compared to the year 2018. The expected connected devices over the few years would be fifty billion. The energy efficiency is also expected. So for all these cloud radio access networks must be used[2]. These are useful for the signal processing. High performance and high availability for 5G systems are provided by C-RAN. In many cases, the failure in the hardware and the software also leads to failure in providing services for real time tasks. To solve these type of problems, the fault tolerant scheduling algorithms are used. Cloud computing as become more popular due to the advancement in the virtualization technologies. Many applications will be sent to the data centres to get the services from them. But scheduling the workload would be the major task , due to availability of the limited resources. Task scheduling should also meet the requirements of the user and also must be profitable for the cloud service providers. In cloud technology the virtual machines[3] plays an important role in the task scheduling. Virtual machines are the most required service resources. The performance of the computer is also impacted by the task scheduling. Task scheduling must also meet the quality of service requirements of the user tasks.

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II. FAULT TOLERANT SCHEDULING METHODS:

J. Angela jennifa sujana, J. Soniya [4] The author here discusses on how to dynamically tolerate the faults that may occur during the execution or scheduling of the tasks. This study proposes a dynamic fault tolerant scheduling algorithm that helps in allocating the resources dynamically. It mainly performs two different techniques known as Resource expansion and Resource contraction. Resource Expansion is a process where the one resource cannot be scheduled in the another existing resource. The new virtual machine will be created whenever a new task will be provided, and the existing resource which is idle will be deleted. Hence increases the resource utilization of the system. This is called as Resource contraction. The main intention of this study is to utilize the maximum resource and also incorporating fault tolerance. The efficiency of the work is evaluated using the Google cloud trace logs.
Year: 2016
Advantage: This technique uses both resource expansion and resource contraction. This improves the utilization of the resources.
Disadvantage: This technique creates a new virtual machine, every time a new task is assigned from the user. This will create a overhead to the system. Also security level for the resources must be improved.

Simulator used: Google cloud trace logs

Y. Ding and G. Yao [5] the author discusses that the increase in the complexity of the cloud system and also increasing functionalities of the tasks execution in the cloud, requires fault tolerance as well.

It is mainly require when there is dependency among the tasks. In many of the situations the main features like elasticity and the virtualization of the systems must be taken care. And for all these the appropriate algorithms as to be used. Here, considering both the fault tolerance and increase in utilizing the resource allocation. The author proposes a Fault tolerance elastic task scheduling algorithm to tolerate the fault as well as utilizing maximum resources that are provided. Using the resource migration technique , the tasks are allocated to the system based on the request from the users. Later many simulations experiments are done to check the performance of the tasks using the cloud sim simulator. The results were better than the existing methods.

Year: 2017

Advantage: It helps in scheduling the resources for task which are dependent on each other.

Disadvantage: It uses resource migration technique which is an overhead for the system.

Simulator used: Cloud sim simulator

Pengze Guo and Zhi Xue [6] The author discusses on the cost effective scheduling algorithms along with the fault tolerance in the cloud system. This method mainly concentrates on the effectiveness of cost as well as on meeting the deadline. The scheduling algorithms mainly concentrates on assigning tasks to the suitable host. But it is also important for the result to be produced at the right time. The result from executing the task not only depend on the logic used, but also important to execute on the suitable time constraint. Hence , the accurate results will be produced and tasks can be executed within the deadline. Here the tasks does not follow any precedence order, and they are independent of each other. This approach is also useful for 5G based networks. This approach mainly concentrates on minimizing the cost of execution along with meeting the deadlines as well. It follows the iterative approach for optimizing the method of assigning the resources. In every iteration a particle swarm optimization is used to select virtual machine for the task. The iteration method is used to reduce the cost of executing the task.

Year: 2017

Advantage: Since it uses the iterative approach, the cost for executing the task will be reduced.

Disadvantage: The iterative approach may cause overhead for the system. Since it follows the iterative approach it may also require high utilization of the 5G systems.

Simulator used: Cloud sim simulator

Pengze Guo and Zhi Xue [7] the author says that most of the fault tolerant scheduling methods mainly considers service level agreement and other metrics. But they will ignore quality of service, which is an important parameter to be considered. The quality-of-service aware fault-tolerant rate monotonic first-fit scheduling algorithm(QFTRMFF) algorithm is used to provide high quality of service to the users. This method uses two different processes, initially the tasks are assigned to the suitable virtual machine using the existing fault tolerant methods, later a unique method is used to increase the quality of service of the tasks. When this approach is compared with the other algorithms , it will show better performance compared to the existing once in terms of resource utilization and in terms of providing quality of service.

Year: 2017

Advantage: It provides improvement in the quality of levels of service quality as well as achieves fault tolerance.

Disadvantage: It uses static scheduling method which may be reason for faults during the scheduling of task which uses 5G networks.

Simulator used: Cloud sim simulator

Ming Liu and Pengse guo [8] In this study the author proposes a energy efficient fault tolerant scheduling algorithm for tasks that are real time and which works on 5G networks. This approach performs the scheduling of tasks by increasing the processing capacity of the system. It uses the most useful technique to improve the processing capacity of the system. Also uses mechanism of rearrangement to improve the resource utilization. Consumption of energy is calculated based on the power consumption.

Year: 2018

Advantage: The frequent tracking of energy consumption for a period of time improve the system processing capacity.

Disadvantage: The energy consumption is calculated based on the power consumption , this may lead to time consumption in evaluating the system.

Simulator used: Cloud Sim Platform

K.Wang ,Y. Cen [9] In this study the author mainly discusses on the scheduling the tasks which are having deadline constraints. Having the pool of centralized baseband unit , the joint process signals are supported with highly useful capability of computation. This requires to meet the deadlines. Hence , the author proposes a partitioned scheduling algorithm for the real time tasks called as Wi-EDF. This process takes place in two methods: the first method includes scheduling of tasks by reducing the power consumption. Then based on the control of admission , the scheduling algorithm which is based on preemptive deadline first is used. The results after the experiments shows that this methods provides high utilization of CPU and less consumption of power.

Year: 2017

Advantage: Since it is based on the deadline , it will perform more efficiently compared to other algorithms.

Disadvantage: The tasks are statistically assigned to each processor individually.

Simulator used: Cloud sim simulator

L. Zhang and K. Wang [10] The author discusses on increasing demand for the user equipment generated big data, due to increase in use of user equipments such as mobile phones and other devices. It has become difficult to process the data and its application , to overcome this problem , the author has given near far computing architecture. Here the near edge computing and far edge computing is experimented. Simulation results are effective compared to other methods.

Year: 2018

Advantage: This covers both near and far edges which very useful.

Disadvantage: For some tasks it will depend on the user equipments which may not show accurate results.

Simulator used: NFC-RAN (Near Far cloud radio access network).

Pengze Guo [11] This approach mainly concentrate on minimizing the resource utilization and providing fault tolerant method. Most of the fault tolerant scheduling techniques will use the primary-backup approach.
Where the user tasks will be assigned to the suitable virtual machine. Here, initially all the tasks will be waiting in the queue, the tasks in the queue can be rearranged. In most of the scheduling methods the order of executing the tasks will be settled in the queue. But it can be rearranged to utilize the related resources and can complete the task. The tasks waiting in the virtual machine will be rearranged according to the utilization of the resources. Each and every primary copy of the task will be scanned entirely and will be checked whether it can utilize the interval of time left by its backup copy. Hence this approach will improve the utilization of the resources.
Year: 2017
Advantage: This approach helps improving the utilization of the resource. Also the time left over by the backup copies will be used by the new primary copies of tasks to be executed.
Disadvantage: Rearranging of tasks in the queue may cause overhead for the system since time interval must be managed.
Simulator used: Cloud sim simulator
W. Dai and Y. Li [12] The author here discusses on energy aware scheduling method. The mobile phones are cyberphysical systems. It should always consume low energy and it must always be reliable to interact with the cloud repeatedly. Power consumption or the management of low energy is done by dynamic voltage scaling(DVS). In this study the author proposes, Energy aware dynamic voltage task scheduling(EDTS) method used to reduce the energy consumption for all the smart devices. And also satisfies the timelines given by the users. The result will indicate that it is comparatively better than the other algorithms used for scheduling.
Year: 2015
Advantage: Since it is integrated with the cloud system, frequent interaction can be made by using dynamic voltage scaling.
Disadvantage: This study is tested on smart phones, it could have been tested for other android devices.
Simulator used: Android Emulator
K. Li and G. Xiao [13] Author here discusses on the heterogeneous computing. The heterogeneous computing is better than the homogenous computing. And hence there will be more chances of network failure. The study proposes a new replication based scheduling algorithm used to increase the system reliability. Also optimal reliability communication algorithms are also used.
Year: 2017
Advantage: It considers both reliability and high performance aspect as the main factors.
Disadvantage: Replications of the tasks may cause overhead in the system.
Simulator used: CloudSim Simulator
Ji.wang and Xiaomin Zhu [14] The virtualization plays an important role in cloud computing. Here the author mainly considers two main features like elasticity and virtualization of the system. To improve the usage of all the resources and to avoid the fault tolerance the author proposes the elastic fault tolerant scheduling algorithm. Results are compared with the other algorithms and shows efficient results.
Year: 2015
Advantage: The cloud is provided with elastic scaling feature.
Disadvantage: This technology splits the system into two layers, which might increase the cause of faults.
Simulator used: Cloud Sim conducts the google trace logs.
Xiaomin Zhu, Hui Guo[15] here the author discusses mainly on avoiding the faults. Also on resource utilization. When there are huge number of tasks to be completed in particular time constraints, it is difficult to execute all the tasks within the given time. The author proposes a elastic fault tolerant scheduling algorithm to avoid the faults, and also implements vertical scaling up to allocate the resources for the tasks. The backward shifting method is used to use the idle resources as well.
Year: 2016
Advantage: It uses the backward shifting method which increases the use of idle resources.
Disadvantage: Tasks are overlapped due to primary backup model in some cases.
Simulator used: Google trace logs are conducted in cloud sim simulator.
Liu Huai, Huang Jianxin [16] The author discusses about the fault tolerance for the distributed system. Now-a-days the distributed controlled system are widely used in the various fields. It may cause failure of hardware and software due to increase in the usage of multiple processors and also increase in the complexity. Here, the author proposes a fault tolerance scheduling algorithm that can tolerate hardware as well as software failures. To decrease the preemptions that are made , the Earliest deadline first algorithm is used. The results shows that , this method reduces the runtime overhead of the system.
Year: 2016
Advantage: The process of calculating the notification time allocated by the task help in avoiding the tasks.
Disadvantage: These algorithms does not help to tolerate temporary faults in the software.
Simulator used: CloudSim simulator
Haoran Han and Weidong Bao [17] Now-a-days due to the faster development of the mobile technology , there is also development in the real time applications. Hence there is necessary of fault tolerance of the system . The data must also should be handled and processed. To maintain the usage of cloud resources , the learning based fault tolerant scheduling algorithms are used. The results of this method maintains both resource utilization as well as protect the system from the faults.
Year: 2016
Advantage: Nebula works better for the distributed system
Disadvantage: Based on the features of the cloud system, the nebula is designed.
Simulator used: CloudSim simulator
Weidong Bao, Xiaomin Zhu [18] The author is concerned about maintaining the fault tolerance and increase the proper utilization of the cloud based resources. The algorithm for the hybrid tasks , called as ARCHER is proposed to improve the performance of the system. The newly used technology of checkpoint is used to identify the time taken for execution by the backup copies. Hence many tasks gets executed at a time in turn improving the performance of the system. The results are compared with the other algorithms and this method will show the very good impact on the system.
Year: 2017

Advantage: This method uses exploiting of time slot mechanism which has a greater effect on the system.
Disadvantage: The CPB model can be improved to provide tolerance against multiple host failure.
Simulator used: Suitable simulators can be used.

Talwana Jonathan Charity, Gu Chun Hua [19] The author here discusses on the reliability of the resources in the cloud system. Most of the time , several request will be sent at a time to the server , this may lead to increase in the cause of faults. Also losses the reliability of the server. In this study the author is mainly concerned about the parameters like network, power of processing and also the memory usage. This system will also increase the stability of the system and results in effective manner.
Year: 2016
Advantage: This method mainly concerned about network system which is most required.
Disadvantage: Since it controls the power of processor , it is overhead for the entire system.
Simulator used: CloudSim 3.0.3

Xiangru Meng, Yakun Zhang[20] This study include the awareness created on the survivability of the tasks in the system. Due to increasing demand for the fault tolerance , it is also equally important to take care the other required parameters by the system. The tasks are executed by scheduling it to the suitable virtual machines .a). In the first step , the node where the task to be executed is selected. b). Then it will provided with the scheduling path that is suitable. c). Finally the task will be allocated to the suitable virtual machine. This methods comparing with other algorithm , shows better performance.
Year: 2016
Advantage: The tasks are given the priority based on the requirements.
Disadvantage: The tasks are executed in the elongated process, this would be an overhead for the system.
Simulator used: Suitable simulator can be used.

Arabi E. Keshk,Medhat A. Tawfeek [21] This study is mainly concerned about fault tolerance along with load balancing. Even though cloud computing has huge benefits, it will face some challenges. The major reason for fault occurrence may be overload to the system. Hence, the workload among the various virtual machines must be appropriately distributed. The author proposes hill climbing scheduling algorithm to overcome this issue. This helps to balance both resource allocation as well as balance of load among the virtual machines. The experiment is conducted and the results are compared with other algorithms and is beneficial.
Year: 2018
Advantage: The use of mechanism of positive feedback helps in performance evaluation.
Disadvantage: Using hill climbing method all the tasks may get the common solution and meet at the local minima
Simulator used: Cloud Sim Tool kit

Kai Huang, Xiaowen Jiang, Xiameng Zhang, Rongjie Yan [22] During the scheduling of tasks the saving of the energy and the reliability of the system are two important features to be maintained. This study is concerned on energy saving and maintaining the reliability of the system. The author proposes a energy efficient fault tolerant scheduling algorithm with management of the power mode to overcome the issues caused by the dynamic scaling of the voltage frequency. Also uses a List based Particle swarm optimization algorithm which helps in scheduling of the real time faults. Comparatively this method produces higher results than the other algorithm.
Year: 2018
Advantage: Various factors related to the power consumption are evaluated , so system performance will automatically gets increased.
Disadvantage: Multiple number of tasks are considered at a time , hence may lead to fault tolerance.
Simulator used: Discrete event simulator

Marcel Neumann, Felix Wolf [23] Here in this study, the author mainly depends on avoiding the faults by reducing the node failures. Sometimes executing the interrupted tasks in the newly created node , may cause failure of the nodes. The use of new node each time cause wastage of the resources. Hence the author proposes a dynamic way of replacing the node. Also uses the on the fly replacement technique. Thus the system get stronger and avoids the system failure. In turn improves the performance of the system and also helps the multi level checking method.
Year: 2018
Advantage: Dynamic method of handling the node failure is very useful and it also provide on the fly node to replace.
Disadvantage: Adding of non-negligible measure of overhead is considered and also the usage of checkpoint in various levels is restricted.
Simulator used: Simulating the cluster computer with 125 nodes.

Guangshun Yao, Yongsheng Ding[24], The resubmission and also the replication of the tasks are the important things. The resubmission helps in utilization of resources in the appropriate manner. Also the
replication method is used to reduce the execution time of the tasks. Here the tasks are executed based on the deadline given. The soft deadline of the system are divided among the group of tasks. Later based on the requirement , the tasks are divided into sub soft deadlines and are executed. The performance is evaluated and is compared with the other methods to overcome this problem.
Year: 2017
Advantage: This method is a combination of both resubmission and replication of the tasks.
Disadvantage: It will reserve the resources for each and every task , hence difficult.
Simulator used: DAG Generatable Tool, Randomly generated workflows.

Felix Muhlbauer, Lukas Schroder, Mario Scholzel [25], In this study the author mainly speaks on avoiding fault tolerance of the system. The tomasulo architecture used here, helps in covering all the networking data paths. Even though all the data paths are covered and checked for the faults. Some of the data paths may be on the network which may lead to faults. To overcome this problem, re execution of those already executed tasks will be made to detect the errors. Then the faults will detected and it will be solved using the suitable methods.
Year: 2018
Advantage: Re execution of the already executed tasks are made if it gets fails or some fault may be occurred.

Disadvantage: The repeated execution of the same task may cause overhead to the system
Simulator used: Suitable simulator can be used.

III. CONCLUSION

The scheduling of tasks is one of the important technique. In case of hardware or the software failure , the fault tolerance technique is also important criteria to be maintained. As discussed in the paper , there are several algorithms which helps in avoiding the faults in the system. In the future 5G based networks needs high efficient, high performing and efficient performance from the system, in order to meet the user requirements. Hence these kind of various methods will be useful in order to get the accurate results and also provide quality of service to the user and complete the execution of tasks within the deadline.

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