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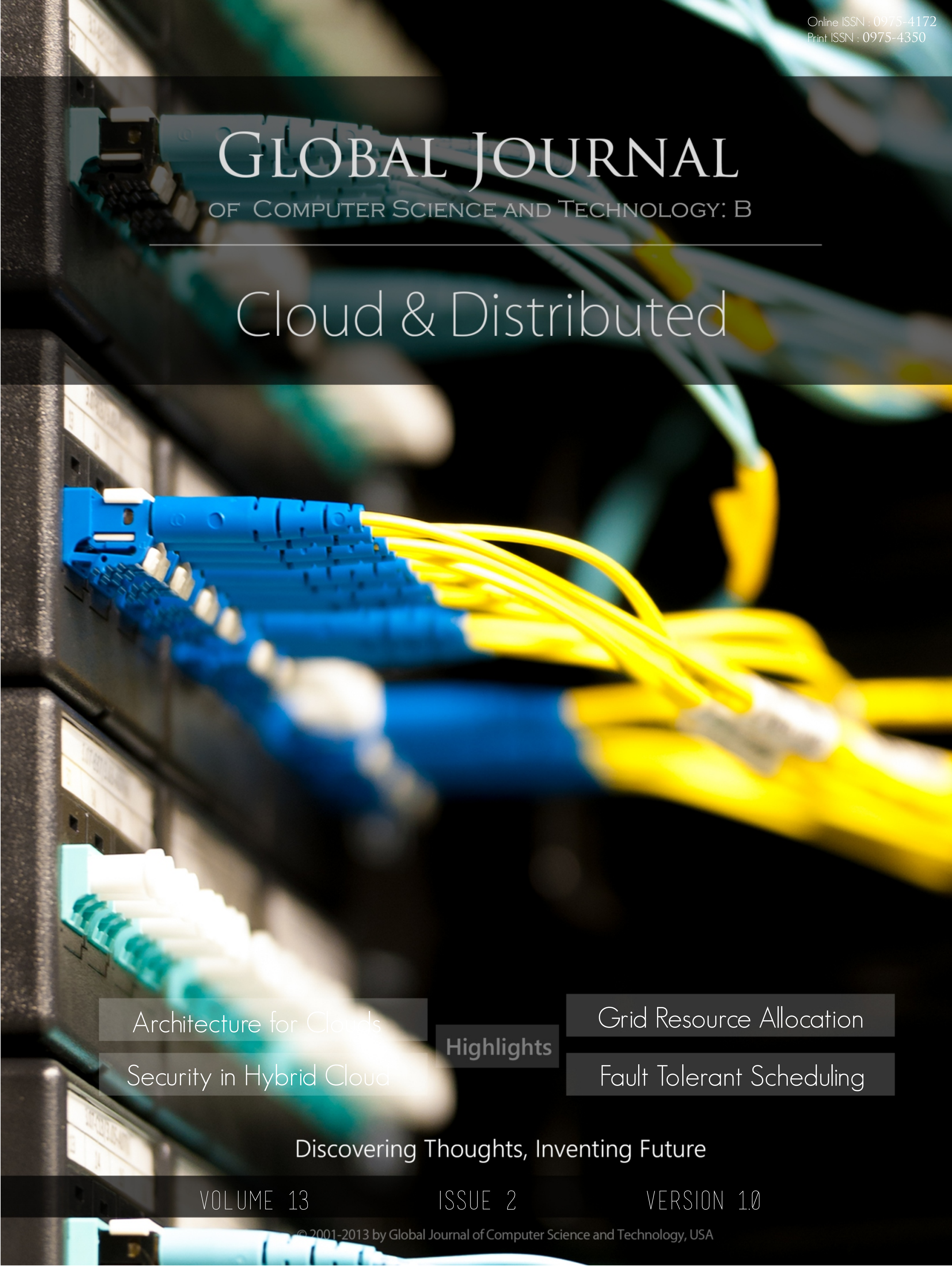

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Cloud & Distributed

Architecture for Clouds

Security in Hybrid Cloud

Highlights

Grid Resource Allocation

Fault Tolerant Scheduling

Discovering Thoughts, Inventing Future

VOLUME 13 ISSUE 2 VERSION 1.0

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Security in Hybrid Cloud

By Anukrati Dubey, Gunjita Shrivastava & Sandeep Sahu
University of RGPV, India

Abstract - As the cloud computing is spreading around the world, need of inter cloud communication is becoming a growing in the organizations. It is causing the researchers to focus on first, making it possible to communicate between two or more clouds and second security of communication is to considered up to utmost level. With emergence of cloud computing, the term "Hybrid Topology" or "Hybrid Deployment" is becoming more and more common. Definition of "Hybrid Topology" is when you join different cloud deployments into one connected cluster. Another area of research is to focus on communication between a cloud and non cloud computing system. Hybrid Cloud computing mainly deals with working of data centers where different software are installed with huge of growing data to provide information to the users of the system.

The techniques which can be used in hybrid cloud securities can be built around the encryption and decryption of data, key based security algorithms which are mainly oriented on authentication and authorization techniques as in wired and wireless networks. One such mechanism is to share the challenge text between the clouds before actual communication should start for authentication. The various works done in this area till date are oriented on other techniques of security between the two or more clouds in a hybrid cloud.

Keywords : cloud computing; hybrid cloud; challenge text; security.

GJCST-B Classification : C.1.3

SECURITY IN HYBRID CLOUD

Strictly as per the compliance and regulations of:

Security in Hybrid Cloud

Anukrati Dubey [α], Gunjita Shrivastava [σ] & Sandeep Sahu [ρ]

Abstract - As the cloud computing is spreading around the world, need of inter cloud communication is becoming a growing in the organizations. It is causing the researchers to focus on first, making it possible to communicate between two or more clouds and second security of communication is to considered up to utmost level. With emergence of cloud computing, the term "Hybrid Topology" or "Hybrid Deployment" is becoming more and more common. Definition of "Hybrid Topology" is when you join different cloud deployments into one connected cluster. Another area of research is to focus on communication between a cloud and non cloud computing system. Hybrid Cloud computing mainly deals with working of data centers where different software are installed with huge of growing data to provide information to the users of the system.

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Keywords : cloud computing; hybrid cloud; challenge text; security.

I. Introduction

Cloud computing is becoming a buzz word in computer industry and everyone is looking to associate in one way or other with this brand new concept. Cloud computing is a very current topic and the term has gained a lot of traction being sported on advertisements all over the Internet from web space hosting providers, through data centers to virtualization software providers.

Such complex technology and business models setting entails an extensive research and provides the motivation towards writing this paper. The main goal is to "clear the air on hybrid cloud computing security" and provide an unbiased and independent, albeit critical outlook of the technology.

Special emphasis is put on the critical examination of each strategy as now more than ever in the face of the global economic crisis, companies face higher refinancing and investment costs and as any company thinking about adopting or moving to cloud computing technology would do in practice; short-to-medium term disadvantages of the technology have to be pragmatically and carefully weighted out against any hyped long-term potential efficiency achievements, be it strategic, technical or cost related. [1]

In order to understand the vision, goals and strategy behind cloud computing, two key concepts that form its foundations need to be explained first.

1. Autonomic Computing.
2. Utility Computing.

Autonomic computing, the term initially being introduced by IBM's Senior Vice President Paul Horn to the National Academy of Engineers at Harvard University in 2001, represents a research aim towards achieving self-managing computing systems, whose components integrate effortlessly.

Utility computing is the second key concept that one encounters in all cloud computing models. It is by no means a new concept as articulated in one form or another as early as the 1960s and implies that it is only natural that at some point computing power will be offered as a standardized service billed on actual usage with very limited or no upfront set-up charges.

a) Cloud Computing – Definitions

A scientific definition is proposed by the GRIDS Lab at the University of Melbourne:

"A Cloud is a type of parallel and distributed system consisting of a collection of interconnected and virtualized computers that are dynamically provisioned and presented as one or more unified computing resources based on service-level agreements established through negotiation between the service provider and consumers."

Berkeley's defines it as:

"Cloud Computing refers to both the applications delivered as services over the Internet and the hardware and systems software in the datacenters that provide those services (Software as a Service - SaaS). The datacenter hardware and software is what we will call a Cloud. When a Cloud is made available in a pay-as-you-go manner to the public, we call it a Public Cloud; the service being sold is Utility Computing." [1]

Building blocks of cloud computing:

- Storage-as-a-Service
- Database-as-a-Service
- Information-as-a-Service
- Process-as-a-Service
- Application-as-a-Service

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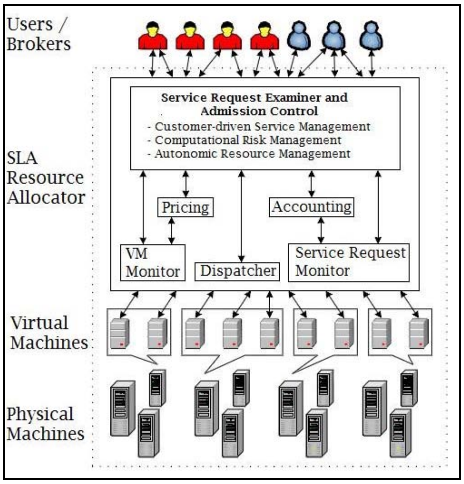
- Integration-as-a-Service
- Security-as-a-Service
- Management/Governance-as-a-Service
- Testing-as-a-Service



b) Hybrid Cloud Computing

1. A hybrid cloud is a composition of at least one private cloud and at least one public cloud. A hybrid cloud is typically offered in one of two ways: a vendor has a private cloud and forms a partnership with a public cloud provider, or a public cloud provider forms a partnership with a vendor that provides private cloud platforms.
2. A hybrid cloud is a cloud computing environment in which an organization provides and manages some resources in-house and has others provided externally. For example, an organization might use a public cloud service, such as Amazon Simple Storage Service (Amazon S3) for archived data but continue to maintain in-house storage for operational customer data. Ideally, the hybrid approach allows a business to take advantage of the scalability and cost-effectiveness that a public cloud computing environment offers without exposing mission-critical applications and data to third-party vulnerabilities. This type of hybrid cloud is also referred to as hybrid IT.

c) Challenges in Hybrid Cloud Computing

Here are some challenges to consider when setting up hybrid clouds:

i. *On Demand Startup and Shutdown*

Your infrastructure must be able to start up and shutdown cloud nodes on demand. Usually you should have some policy implemented which listens to some of your application characteristics and reacts to them by starting or stopping cloud nodes. In simplest case, you can react to CPU utilization and start up new nodes if main cloud gets overloaded and stop nodes if it gets under loaded.

ii. *Cloud-based Node Discovery*

The main challenge in setting up regular discovery protocols on clouds is that IP Multicast is not enabled on most of the cloud vendors (including Amazon and Go Grid). Your node discovery protocol would have to work over TCP. However, you do not know the IP addresses of the new nodes started on the cloud either. To mitigate that, you should utilize some of the cloud storage infrastructure, like S3 or Simple DB on Amazon, to store IP addresses of new nodes for automatic node detection.

iii. *One-Directional Communication*

One of the challenges in big enterprises is opening up new ports in Firewalls for connectivity with clouds. Quite often you will only be allowed to make only outgoing connections to a cloud. Your middleware should support such cases. On top of that, sometimes you may run into scenario of disconnected clouds, where cloud A can talk to cloud B, and cloud B can talk to cloud C, however cloud A cannot talk to cloud C directly. Ideally in such case cloud A should be allowed to talk to cloud C through cloud B.

iv. *Latency*

Communication between clouds may take longer than communication between nodes within the same cloud. Often, communication within the same cloud is significantly slower than communication within local data center. Your middleware layer should properly react to and handle such delays without breaking up the cluster into pieces.

v. *Reliability and Atomicity*

Many operations on the cloud are unreliable and non-transactional. For example, if you store something on Amazon S3 storage, there is no guarantee that another application can read the stored data right away. There is also no way to ensure that data is not overwritten or implement some sort of file locking. The only way to provide such functionality is at application or middleware layers.

II. Existing System

Paper [4] states that Cloud computing is setting off great changes in the IT industry. There are more and more researches on cloud computing. And this paper focuses on cloud computing too. At the beginning this paper describes the characteristics and definitions of cloud computing, and then introduced its services patterns (including SaaS, PaaS and IaaS) and deployment patterns (including public cloud, private cloud and hybrid cloud), at the end lists the cloud security challenges that cloud computing faces.

Security problems faced by the cloud system about in the following five aspects:

- First, face more security attacks: due to the vast amounts of user data stored in the cloud system, for attackers there has greater allure. If the attacker in some way successfully attack cloud systems, it will bring devastating disaster for both cloud providers and users; On the other hand, in order to ensure flexibility and versatility services of the cloud, cloud systems provide users with more open access interfaces, which also bring greater security threats.

- Second, virtualization technology: it not only brings cloud computing platform flexibly resources configured, but also brings new security challenges. There is a need to solve the problem that secure deployment of cloud platform based on the virtual machine architecture. In a virtualized environment, the server is like a file which is taken away easily, so the risk of disclosure increases. The introduction of the virtualization platform has become new security vulnerabilities. Once be hacked, all the virtual machines running on the virtualization platform will be under control of attackers. By that time, the cloud providers and users will suffer huge loss.
- Third, ensure continuity of the cloud platform services and high availability of user data and business: Amazon data center downtime event, Google's Gmail failing to use event and so on are associated with cloud computing availability. To a certain extent, the events above discourage the enthusiasm of the enterprise to use public cloud. Cloud computing service need to provide a fault tolerant mechanism to backup user data to reduce the impact in application when the original data is destroyed. In addition, the software itself may have loopholes and a large number of malicious attacks happen, all these above greatly increase the possibility of service interruption. How to protect the high availability of software services and user application and how to provide convenience security management to the thin-client user have become one of the biggest challenges of cloud security.
- Fourth, ensure the safety and privacy of user data: user data stored in the cloud system, for malicious attacks, the primary purpose is to get user privacy, and then to obtain economic benefits. In this case, laws, regulations and processes are the problems that are the most urgent to be solved, and relevant laws and regulations should be established and improved to protect third-party security, to meet requirements listed by companies, especially to clear responsibility division when problems arise and to provide protection mechanisms as cloud service providers exit.
- Fifth, perfect the cloud standards: Interest-oriented IT development process leads to cloud standards exist everywhere. Many manufacturers have defined their own application standards and data formats, forcing the user deploying IT system and their own business in accordance with the framework set by different service provider. Ultimately, all of this leads to business fragmented and chaotic system which are adverse to users' application. In cloud computing, cloud computing security standards and evaluation system provides an important technical and management support. And interoperability between varieties of cloud services is essential to ensure the cloud not to fall into isolated development situation and then promote common progress. To a certain extent, the establishment of cloud standards decides the future evolution of cloud computing. [4]

In the conclusion the authors say that as a new technology is expected to significantly reduce the cost of existing technologies, cloud computing is the development trend of IT industry. For information security, there are both favorable factors and negative factors brought by cloud computing. The final effect depends on whether we can develop its strengths and avoid its disadvantages. Only in this way, the cloud can become a real cost savings, improving productivity efficiency and secure platform.

Not much of the work has been done in the field of security of the hybrid cloud computing and sharing between them. Various research are done but are focused on how to achieve the hybrid clouds working together. Some of researches done by the researchers are listed herewith for references.

With the advance of cloud computing, hybrid cloud that integrate private and public cloud is increasingly becoming an important research issue. Migrating cloud applications from a busy host to an idle host needs an efficient way to guarantee the performance in the geographical heterogeneous cloud environment. This paper we propose an automatic, intelligent service migration framework on a hybrid cloud based on agent technology. We build a prototype that integrated our private cloud with public cloud. In the prototype, mobile agent technique is exploited to manage all resources, monitor system behavior, and negotiate all actions in the hybrid cloud, in order to achieve automatic, intelligent service migration between the clouds. We demonstrate the service migration mechanism on Hadoop platform between our platform and ITRI public cloud [1].

In the recent era, cloud computing has evolved as a net centric, service oriented computing model. Consumers purchase computing resources as on-demand basis and get worry free with the underlying technologies used. Cloud computing model is composed of three service models Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS) and four deployment models Public, Private, Community and Hybrid. A third party service provider, stores & maintains data, application or infrastructure of Cloud user. Relinquishing the control over data and application poses challenges of security, performance, availability and privacy. Security issues in Cloud computing are most significant among all others. Information Technology (IT) auditing mechanisms and framework in cloud can play an important role in compliance of Cloud IT security policies. In this paper, we focus on cloud security audit mechanisms and models [1].

It is found that the research into the use of multi-cloud providers to maintain security has received less attention from the research community than has the use of single clouds. This work aims to promote the use of multi-clouds due to its ability to reduce security risks that affect the cloud computing user.

For data security and privacy protection issues, the fundamental challenges are separation of sensitive data and access control. Our objective is to design a set of unified identity management and privacy protection frameworks across applications or cloud computing services. From the studies of various research papers and works done by various researchers it has been found that following are the major areas of focus in the field of cloud computing:

1. Defining Architecture: on the basis of the application areas.
2. Security of communication over the cloud.
3. Integration of services on various layers.
4. Inclusion of Various network and communication devices being developed rapidly. [1]

III. Proposed Algorithm

Cloud computing is a buzz word today and it allows to provide interruption free services to the customers. In one hand public clouds, provides services for external customers, on the other hand private clouds provide services for specific group of customers who are interconnected with one another.

Hybrid cloud, in this way is more useful as they are combination of public and private clouds. Such a system is obviously going to very less secured and will face more and more security challenges. Primary security goal found in hybrid clouds is to provide secured sharing of data between the public and private clouds i.e. secured intra cloud communication.

This work proposes a secured intra cloud communication mechanism in which it is being tried to keep the data more secured over the intra cloud communication using a challenge text based communication. Various Steps involved are as follows:

Step 1: Cloud ‘A’ has to communicate with Cloud ‘B’. (Both ‘A’ and ‘B’ may be public, private or combination). Both have a trusted environment already created between them using SLA.

Step 2: Cloud ‘A’ sends a data request (DRQ) to Cloud ‘B’.

Step 3: Cloud ‘B’ receives the DRQ and sends a challenge text (RID) encrypted using RSA algorithm, to Cloud ‘A’.

Step 4: Cloud ‘A’ receives the RID and decrypts the same using its public key. The decrypted text (VID) is sent to the Cloud ‘B’.

Step 5: Cloud ‘B’ if founds that the key is matching, it will send the encrypted data to Cloud ‘A’ as desired by the Cloud ‘A’.

Step 6: Cloud ‘B’ if founds that the key is not matching, it will reject the request instantly.

DRQ- Data Request
RID-Reveal Identification
VID – Verify Identity

IV. Results

The algorithm is expected to perform better in all situations such as a cloud is performing mal activities, cloud become malicious after a while or a cloud is not at all malicious. Algorithm will also give good results even in case of the infecting clouds found in the network.

The proposed work in implementation and it is being found to be secured and useful for processing of hybrid cloud computing.

V. Conclusion and Future Work

Since cloud connects to thousand and thousand people over internet or intranet on pay per basis, therefore security of the cloud is a focused are for researchers and with the growth of the cloud computing and hybrid computing, requirements for security are increasing heavily. The proposed work is expected to provide a good security infrastructure over cloud.

One mechanism is to share the challenge text between the clouds before actual communication should start for authentication. The various works done in this area till date are oriented on other techniques of security between the two or more clouds in a hybrid cloud.

Cloud Computing is facilitating users around the world for the best of the services available across the world on their machines through web. It is beneficial for both the service providers (they get huge clientele) and clients (they get all available services).

For data security and privacy protection issues, the fundamental challenges are separation of sensitive data and access control. Our objective is to design a set of unified identity management and privacy protection frameworks across applications or cloud computing services. As mobility of employees in organizations is relatively large, identity management system should achieve more automatic and fast user account provisioning and de-provisioning in order to ensure no un-authorized access to organizations’ cloud resources by some employees who has left the organizations.

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Maximizing Computational Profit in Grid Resource Allocation using Dynamic Algorithm

By K. Sathish & A. Rama Mohan Reddy
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Abstract - Grid computing, one of the most trendy phrase used in IT, is emerging vastly distributed computational paradigm. A computational grid provides a collaborative environment of the hefty number of resources capable to do high computing performance to reach the common goal. Grid computing can be called as super virtual computer, it ensemble large scale geographically distributed hetero- geneous resources. Resource allocation is a key element in the grid computing and grid resource may leave at anytime from grid environment. Despite a number of benefits in grid computing, still resource allocation is a challenging task in the grid. This work investigates to maximize the profits by analyzing how the tasks are allocated to grid resources effectively according to quality of service parameter and gratifying user requisition. A fusion of SS-GA algorithm has introduced to answer the above raised question about the resource allocation problem based on grid user requisition. The swift uses genetic algorithms heuristic functions and makes an effective resource allocation process in grid environment. The result of proposed fusion of SS-GA algorithm ameliorates the grid resource allocation.

Keywords : grid computing, heterogeneous resources, resource allocation, QoS parameter, swift scheduler (SS), genetic algorithm (GA), fusion of SS-GA.

GJCST-B Classification : C.1.4

MAXIMIZING COMPUTATIONAL PROFIT IN GRID RESOURCE ALLOCATION USING DYNAMIC ALGORITHM

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K. Sathish [α] & A. Rama Mohan Reddy [σ]

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Keywords : grid computing, heterogeneous resources, resource allocation, QoS parameter, swift scheduler (SS), genetic algorithm (GA), fusion of SS-GA.

I. Introduction

The grid is the term defines based on the infrastructure of the distributed computing and offer the resources based on the client requirement. Grid technology can largely improve the virtual society's effectiveness and usefulness and supports the productivity. When going with improvement in grid technology, the grid facing many challenges by shared networking and collaboration and the main challenges by resource optimization and processes optimization. Grid computing technology is coordinated with the use of several numbers of servers; the grid server toil based on many applied techniques and methods. And these specialized gird servers in the network which acts together as a single logic integrated server system [1]. In 1969, Leonard Kleinrock was first visualized the concept of Grid in computing, he wrote: "We will probably see the spread of computer utilities, which, like present electric and telephone utilities, will service individual homes and offices across the country". In 1998, the redefinition of grid computing is evolved by Carl Kesselman and Ian Foster they wrote: "A computational grid is a hardware and software infrastructure that provides dependable, consistent, pervasive, and inexpensive access to high-end computational capabilities" [2]. The large-scale computation of the grid computing is the collection of heterogeneous autonomous system; systems are distributed throughout geographically, and the large number of heterogeneous networks is interconnected in the grid [3]. Fewer years back grid computing is formally defined as a technology that allows accessing, managing and strengthening the resources of IT in the environment of distributed computing. Grid computing is an advanced technology of distributed computing, that brings all databases, servers, infrastructures, applications and resources into a massive single system. The grid technology partnership among different enterprise organizations comprises the same organization and in addition external enterprise companies [1]. There are three reasons, which ensure grid computing is a promising technology [4]:

The availability of the number of efficient computer resources which brings time-consuming and cost-effective to all clients, Grid computing can solve what normal system doesn't have the capability to solve some problem that can be solved by the available cooperative resources with massive computing power in the grid and Grid system directs the job to the proper resources of numerous computers can be run cooperatively and it works towards common goal with the usefulness of available resource collaboration which results the less time consumption and cost effective.

In grid computing, there are lots of computers connected to grid to execute the jobs assigned by the clients, and among available computers at least a computer will perform as a server, this server takes all responsibility to allocate the client's jobs to the appropriate resource that are ready to execute [5]. Generally, grid resources can be divided into two types; one is software resources, and another one is hardware resources. In the category of the software resources which includes source of application pack, component services and data resources and the hardware resources which includes network resources, storage resources and computational resources [7]. The resources are distributed as grid geographically, unlike management policies are applied, heterogeneous

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resources are interconnected and all heterogeneous resources belong to various administrative domains. In grid computing, the term resource is defined as the capability that can be shared and utilized heterogeneous networked grid environment [6].

The pros of grid computing are

- Grid performance in processing data integration.
- Gird takes less time to solve more complex problems.
- Process the huge date sets into smaller one for faster execution.
- Put to good use the available heterogeneous hardware in the grid.
- Collaboration between the different organizations becomes easier.
- The cons of grid computing are
- Grid standards and software are still evolving one.
- The job submissions in grid network are non-interactive.
- Grid resource administrations are not properly controlled.
- No proper allocation of jobs to the appropriate resources.
- Due to the improper resource allocation leads to long execution time and added cost.

In grid computing, large scale powerful resource allocation is a main challenge in a grid that may be critical to task performance. In general, the resource allocation in the grid faces many challenges in adaptability, load balancing, scalability and reliability [7]. The resources in the grid network are not controlled centrally and the resources can enter grid network and may leave anytime from the network autonomously. The autonomous property of the grid resources in the network leads to vagueness. The competence of the grid system is totally dependent on the proficiency of the resource allocation. As per the grid network, there is a substantial change in availability of the resource which varies the computational performance of the network and so there is a need for scheduling and allocation algorithm to survive from the changing environment for this network. To gear up the grid resource allocation, there is a need to overcome the challenges to speed up the processing power and resource memory in order to process the job in minimal computational cost as well as minimal computational time [8]. The First Come First Serve (FCFS) based resource allocation [19] that allocates the jobs which comes first. The other jobs in the job pool may wait longer due to the job size and resource availability for that particular size of job, and so this leads to very high time and cost consumption. The Shortest Job First (SJF) also named as Shortest Job Next (SJN) or Shortest Process Next (SPN) based resource allocation [19] that allocates the job which has shorter length on the fastest resource. When the continuous arrival of shorter length job pushes the job with the longest length leads to longer waiting time in the job pool.

The Swift Scheduler (SS) based resource allocations [18] collects the job from the different users and swift the job using either by length or priority assigned. The resources are allocated based on the job swift by their priority in the job pool. The Genetic Algorithm (GA) based resource allocation is a population-based technique that allocates the jobs according to the fitness function evolved. The Genetic Algorithm (GA) performs crossover and mutation each in order to find the optimal solution. The Ant Colony Optimization (ACO) based resource allocation is a population-based technique which found the optimization problem solution using the pheromone values. Initially, the jobs are assigned to the resources randomly and each job verifies all the available resource using probability rule by assigning initial pheromone value and visibility value (i.e. simple heuristic value finds dividing one by distance between the job and the resource). After analyzing each job with each resource using probability rule, the process finds the reasonable solutions and stores values in the pheromone trails. The small amounts of pheromone trials are evaporated evaporation constant (ρ) and density of pheromone ($\Delta\tau_{ij}$). Finally the jobs are allocated to the resources which have the strong pheromone value and which found the optimal resource with less time consumption and low cost.

In this paper, the above all algorithms are compared with proposed fusion of Swift Scheduler and Genetic Algorithm (SS-GA) based resource allocation as shown in fig.1. The Swift Scheduler and Genetic Algorithm (SS-GA) based resource allocation algorithm fuses prioritized jobs in the job pool using Swift Scheduler (SS), with the Genetic Algorithm (GA) based resource allocation, so it makes full use of advantages of the Swift Scheduler, estimated with a Genetic Algorithm, as well as ability provided the effective resource allocation. The swift scheduler arranges/schedules the jobs by the user's urgency (i.e. assigned as priority) or length of the job. And the arranged/scheduled jobs are allocated to the appropriate resources using Genetic Algorithm to obtain time-consuming and cost-effective as best. The Quality of Service (QoS) [14] parameter includes job execution time and cost efficiency are compared in First Come First Serve (FCFS) based resource allocation, Shortest Job First (SJF) based resource allocation, Swift Scheduler (SS) based resource allocation, Ant Colony Optimization (ACO) based resource allocation and AWOPF & AWPF Constraint checked Genetic Algorithm (GA) based Resource Allocation with the proposed fusion of Swift Scheduler and Genetic Algorithm (SS-GA) based resource allocation algorithm. The performance of the proposed fusion of Swift Scheduler and Genetic Algorithm (SS-GA) based resource allocation algorithm compared with the above mentioned other algorithms by using simulation.

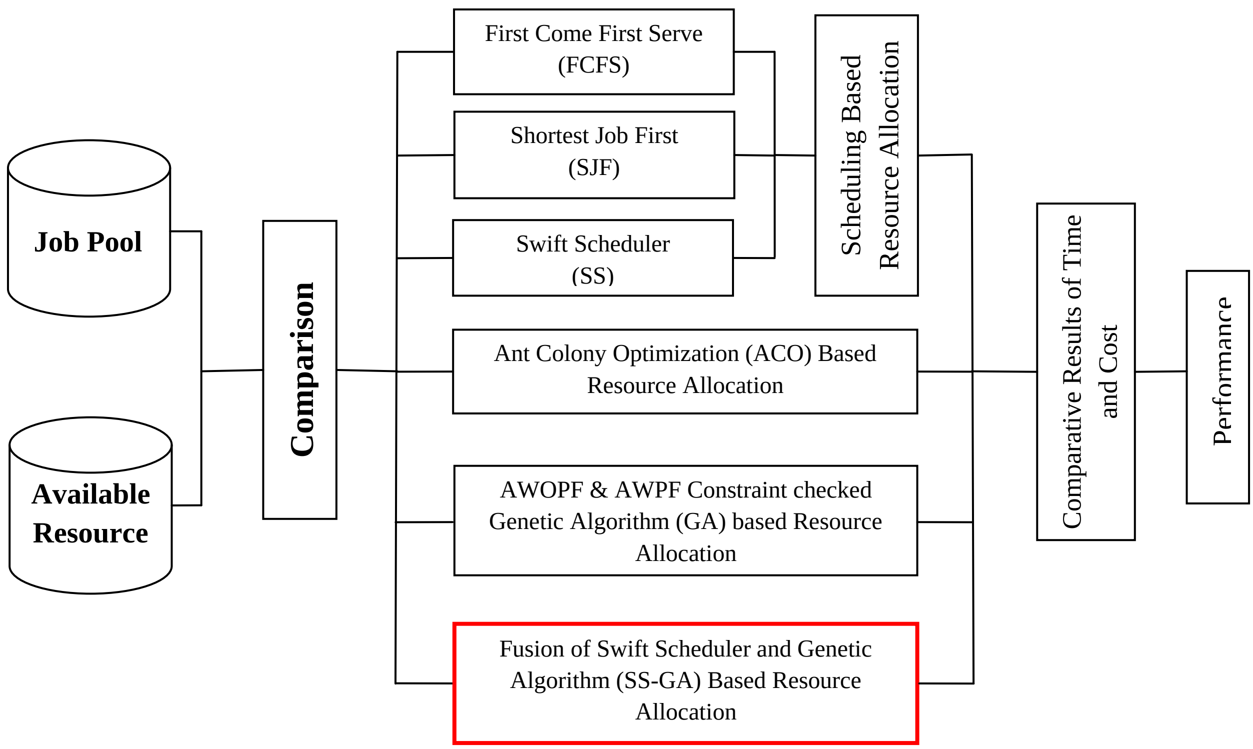

Figure 1 : The comparative model of various algorithms with proposed fusion of Swift Scheduler and Genetic Algorithm (SS-GA) based Resource Allocation

The paper is structured as follows: The related works are declared in Section 2. The proposed fusion of Swift Scheduler and Genetic Algorithm (SS-GA) based resource allocation algorithm and its architecture are derived in Section 3. The experimental simulated resource allocation results are showed in Section 4. And Section 5 concludes the paper.

II. Related Works

A number of methods are being addressed by various researchers in the past; in this section some of the methods related to resource allocation are provided in this section.

Fatos Xhafa et al. [3] have presented for the minimization of makespan and flowtime by designing the efficient Grid Scheduler with the usefulness of Genetic Algorithm (GA). Along with Genetic Algorithm two encoding schemes are used separately with GA, empirically studied and implemented. The pervious works are based only with the makespan estimation of the resource and this experimental study in the Grid Schedulers surpasses than the previous one by adding flowtime minimization with makespan minimization in a contemporaneous optimization mode. Furthermore, this encoding based Genetic Algorithms versions can able to discover the best and useful in real grids, which gives the best grid characteristics. This GA based grid scheduler can schedule the job arriving in the grid system dynamically and very fast by executing the work in the short time.

Mayank Kumar Maheshwari et al. [9] have proposed the load balancing technique for proper distribution of the jobs. In general, Decision making, Information Collection and Data Migration are the three types of phases in Load Balancing. Load balancing algorithm which improves parallelism of work, proper distribution of task need to reduce the response time and resource utilization increases throughput management. Load balancing algorithm has two types of nature, static and dynamic. In this paper, they have proposed the optimal scheduling using Load balancing. This algorithm schedules the task by their minimum work completion time and to obtain load balance, it reschedules the waiting time of the works. This paper was based on the dynamic nature of the load balancing algorithm. By rescheduling the works according to the waiting time of the task tries to provide the best solution. It reduces the execution time of the job and with effective cost for the processing of all the jobs in the grid system.

Karthick Kumar [10] have proposed fair scheduling using Load balancing, and this fair

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scheduling is compared with existing scheduling algorithms includes Adjusted Fair Task Order, Earliest Deadline First, Max Min Fair Scheduling and Simple Fair Task Order in the operational grids. It concentrated mainly the fairness issues by using mean waiting time. This algorithm schedules the task by their fair completion time and to obtain load balance, it reschedules using mean waiting time of the works. This fair scheduling algorithm scheme tries to reduce the execution time and minimization of cost for all jobs provides best solution in the computational grid. Adjusted Fair Task Order, Earliest Deadline First, Max Min Fair Scheduling and Simple Fair Task Order algorithms are compared with the proposed algorithm by using simulation.

Murugesan et al. [11] have proposed a resource allocation framework in a grid computing environment for heterogeneous workloads, subject to a set of conditions. The resource allocation approach can manage and assign the task to the available grid resources with the minimization of cost from user side. They proposed a mathematical model to allocate the user task in the job pool to the accurate resources in the grid resources pool with the purpose to reducing the grid user's costs with reference to the time limit and budget denoted by the grid user. In this paper, they presented a reasonable model to consider the Quality of Service (QoS) parameter requirements to complete the user task, and at the same time they examine the performance of this proposed algorithm.

Manavalasundaram et al. [12] have proposed Grid association states the method for synchronized sharing of distributed clusters based on the computational economy, permits the grid users to use the local resources from the grids association but doesn't satisfies the users requirement. The computational economy methodology used here as organizing the resource which not only satisfying the Quality of Service (QoS) parameters, but also the best performance of the resources. The entire self-provisioning for the each user's as autonomous world in Grid Association. The proposed efficient methodology for resource management can use by grid user effectively. The local resources in the grid association doesn't met the requirement of the grid user, so it the job migrate remote resources according to the user's condition in Quality of Service (QoS) requirements. The global scheduler manages and schedules the user job in the Virtual Organization (VO) and that imposes Virtual Organization (VO) - wide policies. The agents used in the grid association to access and maintain the shared directory of the association of the grid resources. The experimental results of this work shows that the resource which have high capability to execute the job in low mean time and cost effective, and so there is a very huge competitions from all other jobs in the association to that particular resource to satisfy their Quality of Service (QoS) requirements, the resource association provides a increased ability to satisfy Quality of service requirement, in general the resource allocation methodology provides an increased ability to satisfy Quality of service (QoS) parameter needs overall the grid users.

Navjeet Kaur et al. [13] have proposed managing the resource using inter-intra fairness scheduler in grid environment. In grid computing environment an essential role is resource allocation management. The grid system responsibility is to make sure weather the client's jobs/applications request are getting the best resources in cost effective and timely manner. In grid computing technology, there are many resource allocation algorithm are there making jobs allocate to the resources allocation decisions. In this paper, they describes the resource management with different proportional share scheduler with O(1) precision in grid environment. While allocating the resource to the job, the resource allocation's fairness and efficiency that ensure by proportional/fair share scheduler. The proposed inter - intra fairness scheduler is the integration efficient fair share scheduler features as well as managing resources and job scheduling issues in a soft way.

Rajkumar Buyya et al. [14] have identified challenges in grid resource management in the grid computing environment and proposed an effective resource allocation management and job scheduling as metaphor in the computational grid environment. Their projected algorithm analyzes the challenges and requirements in the distributed resource allocation of economy based grid system. The various agent economy based system considering both promising and historical. The CPU cycles, storage, and network bandwidth of the resources are considered by the various economy based system. It presented an extensible and leverage of existing resource management technology and service oriented grid architecture in the grid system. And it also presented auction models and merchandise for the resource management in the grid technologies. The use job scheduling and merchandise economy model for resource management in both data grids and operational is also presented.

Zne Jung Lee et al. [15] have proposed cost effective resource allocation process by allocating the job to optimal resources in the grid environment. In this paper, they proposed the hybrid search algorithm heuristics approach for the resource allocation problem is encountered in grid system. The proposed algorithm can explore the search space and exploit the best solution with the dual advantages of Genetic Algorithm (GA) and Ant Colony Optimization (ACO) of population algorithms. The well designed GA and ACO are implemented for resource allocation problem. In addition, heuristics in Ant Colony Optimization are used to amend the search performance of the resource allocation problem. While testing this proposed algorithm by simulation, the results showed attractive performance for resource allocation problem.

Devaki et al. [16] have proposed population based Genetic Algorithm considering Quality of Service parameters for Job scheduling. The utilization of an idle resource and distributed resources present global grid system to solve the challenges which are computational was greatly encouraged in grid computing. The problems are either in two sides one in scheduling the job or another was executing jobs in available resource in the grid system. Here the main issue was scheduling the jobs in correct resource is considered as NP complete problem, and so it was essential to have an efficient job scheduling to be effective utilization of the resource in the grid system. Various heuristic algorithms are used to solve the issues which bring a nearby optimal solution. In this paper, they proposed an offline mode Genetic Algorithm evolution using Quality of Service (QoS) parameter satisfaction for scheduling the job to heterogeneous resources. The proposed algorithm mainly focused in makespan and Quality of Service (QoS) satisfaction, when selecting the optimal resource.

Prabhu et al. [17] have proposed the resources scheduling approach based on the multi-objective Genetic Algorithm (GA). This proposed multi-objective Genetic Algorithm (GA) focused on the mean waiting time, flow time and optimal resource allocation and batch mode methods used for the allocation of jobs to the favorable resource. They evaluate the performance using the methods with multi-objective parameters based on their computational results. The overall execution time is minimized by Genetic Algorithm (GA) based scheduling. This proposed algorithm was tested with up to 1000 generation, and the experimental performance shows the results achieved near optimal efficiency.

III. The Proposed Algorithm

a) The basics of Swift Scheduler and Genetic Algorithm

The swift algorithm and genetic algorithm is the key algorithm in problem solving methods. The swift focus and works according the users requirement and the genetic algorithm is a population based search algorithm which found the optimal solution to the problem.

i. *Swift Scheduler*

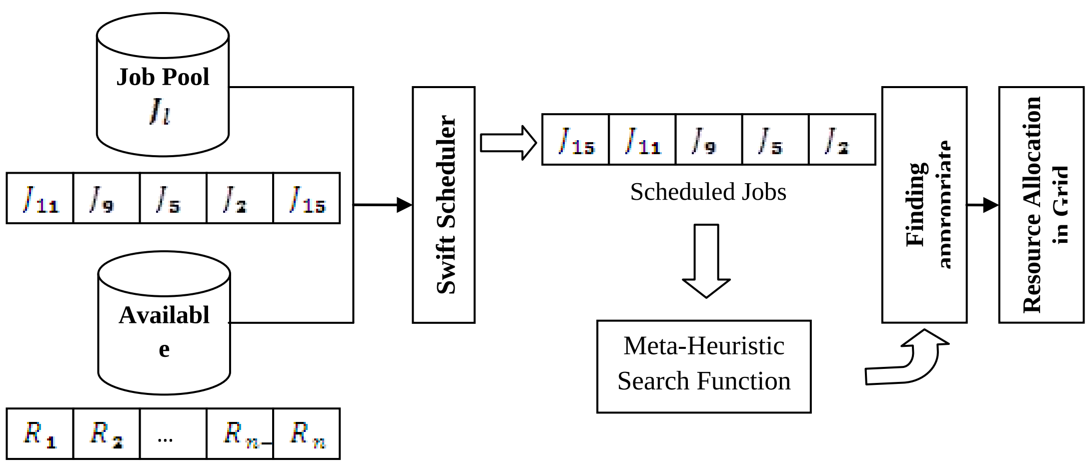

Figure 2 : Swift Scheduling based Resource Allocation

Swift scheduler based resource allocation defines the resource allocation process in the fast resource scheduling manner. Swift scheduler based resource allocation is the combination of the shortest job first and local meta-heuristic search function. Fig.2. shows the processing of swift scheduler based resource allocation. Swift scheduler gives the importance to the jobs, which schedules the jobs according to its length in ascending order (i.e. Shortest Job First (SJF) order). The resource allocation takes the advantage of meta-heuristic search function. The heuristic function searches the resource which has the capability to execute the job in minimal job computational time.

a. *Basic Structure*

The Swift Scheduler based Resource Allocation works as follows:

```
Begin
        Step 1: Initialize the N jobs in job pool;
        Step 2: Initialize the available M resource in Grid
                system;
        Step 3: Schedules the N jobs in ascending order based
                on the job's length;
        Step 4: Search the resource using meta-heuristic
                function based on less computational time;
        Step 5: Allocate the jobs to the appropriate resources;
End
```

Figure 3 : Swift Scheduler based Resource Allocation Structure

ii. *Genetic Algorithm*

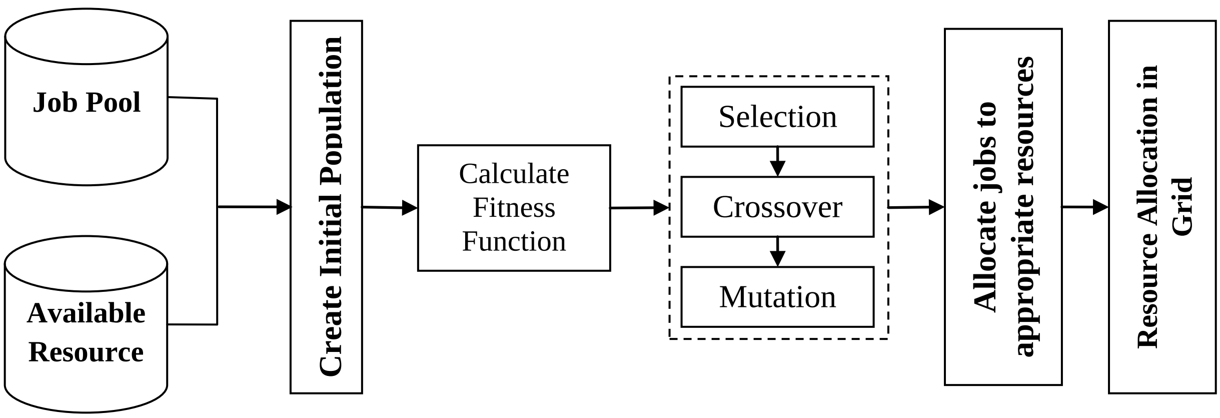

Figure 4 : Genetic Algorithm-based Resource Allocation

The Genetic Algorithm based Resource Allocation defines the resource allocation process by analyzing the compatibilities between jobs and available resources in the Grid system. The compatibility was analyzed by the job's computational time and if the expected computational time was satisfied, the jobs will be allocated to the available grid resources. Fig.3. shows the processing of genetic algorithm based resource allocation. The genetic algorithm can search the available resources in polynomial time by its meta-heuristic search technique. The algorithm initializes the population by random selection of chromosomes. It can explore the appropriate resource by calculating fitness function for each chromosome and selecting the chromosomes for mating for next generation. Crossover was done between randomly selected chromosomes with fixed probability rate, and mutation was also done in the random manner with some fixed probability rate. These operations are repeated every iteration while it satisfies the job with expected computational time in available resources.

a. *Basic Structure*

Begin

Step 1: Initialize the population with randomly generated N chromosomes;
Step 2: Initialize the available M resource in Grid system;
Step 3: Start the loop for finding appropriate resources;
Step 4: Fitness function evaluation for each chromosomes;
Step 5: For next generation - selecting the chromosomes for mating;
Step 6: Crossover between the chromosomes with random pairs;
Step 7: Changing the chromosome with new chromosome i.e. mutation;
Step 8: Stop the loop while the chromosome finds the best resource;

End

Figure 5 : GA based Resource Allocation Structure

b) *Fusion of Swift Scheduler and Genetic Algorithm (Ss-Ga) Based Resource Allocation*

The main objective of this resource allocation model is to allocate the proper jobs to the fittest resources in order to meet the Quality of Service (QoS) parameters like minimum job completion time, cost efficient, economy, and resource utilization. Our proposed grid resource allocation model combines the swift scheduling mechanism and genetic algorithm to make the resource allocation process as more proficient when compare with other methods. In our methodology, we take the input data set which contains jobs and resources to be processed. A job pool consists of the number of jobs having its id, length of the job and job priority while the resource pool has resource id, its capacity and cost to execute the particular job.

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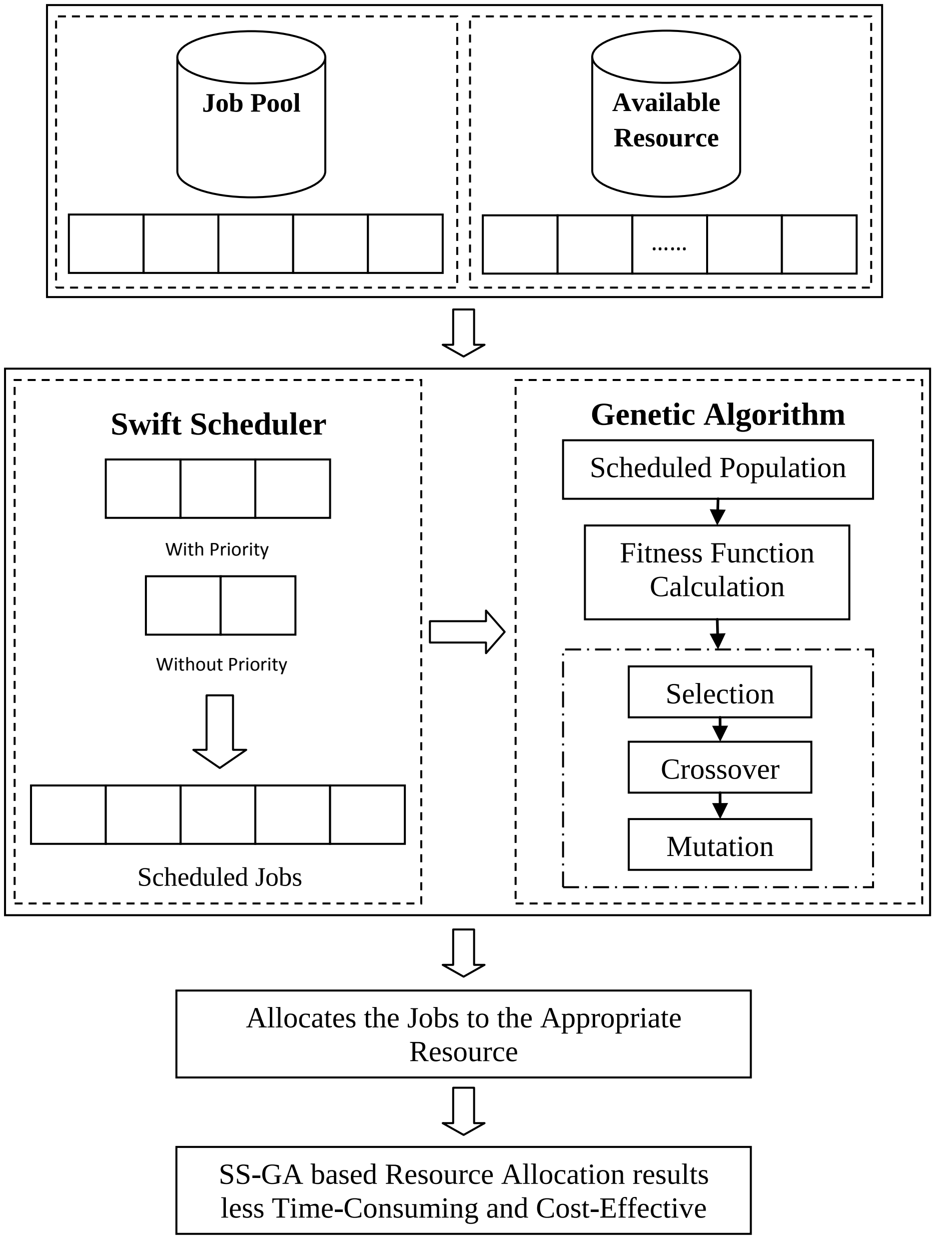

Figure 6 : Proposed SS-GA algorithm for Resource Allocation

i. *Basic Assumptions*

Let us consider that there are n jobs to be processed by m resources or machines where n>m. The following assumptions can be made to achieve the resource allocation as the finest one.

- Every single job is autonomous of each other and there is a priority among them.
- Every resource and jobs is simultaneously available at the early stage of time.
- A resource can only process one job at a time and this procedure cannot be interrupted before completed.
- For every resource and job has its unique id to differentiate each other and avoid conflicts while processing jobs in the resources.
- The migration of jobs is not permitted.
- In job and resources, we need to specify the job length, job priority, resource capacity and resource cost to allocate effectively.

In the proposed SS-GA algorithm, it fuses the swift scheduler with the population based Genetic Algorithm. So it makes full use of advantages of the priority based job scheduling offered by swift scheduler, as well as the powerful accurateness finder ability provided by the Genetic Algorithm. Fig.4. shows the proposed Fusion of Swift Scheduler and Genetic Algorithm (SS-GA) Based Resource Allocation.

ii. *Basic Structure*

Fig. 7 illustrates the algorithmic structure of proposed fusion of Swift Scheduler and Genetic Algorithm (SS-GA) based resource allocation. The

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proposed algorithm accepts the dynamic nature of grid resource availability and users' task.

Begin

Step 1: Initialize the jobs in the job pool;
Step 2: Initialize the available resources in resource pool;
Step 3: Schedule the job with high priority in ascending order;
Step 4: If the job with no priority, schedules the job in shortest job first order;
Step 5: Initialize the scheduled Population size P(s) based on the number of jobs;
Step 6: Perform a Fitness function to minimize the following objective function;
Step 6.1: Job Completion Time (J_C);
Step 6.2: Job Completion Cost (C_F);
Step 7: Selecting half of the individuals among the population P(s) having best fitness values;
Step 8: Apply One-Point Crossover for the selected individuals with a crossover rate C_r;
Step 9: Mutation to be carried out at the rate of M_r to obtain the new better chromosomes;
Step 10: Terminate the above process after 'n' iterations to achieve best results in case of objective function in resource allocation;

End

Figure 7 : Proposed SS-GA Algorithm Structure

iii. *Flow Chart*

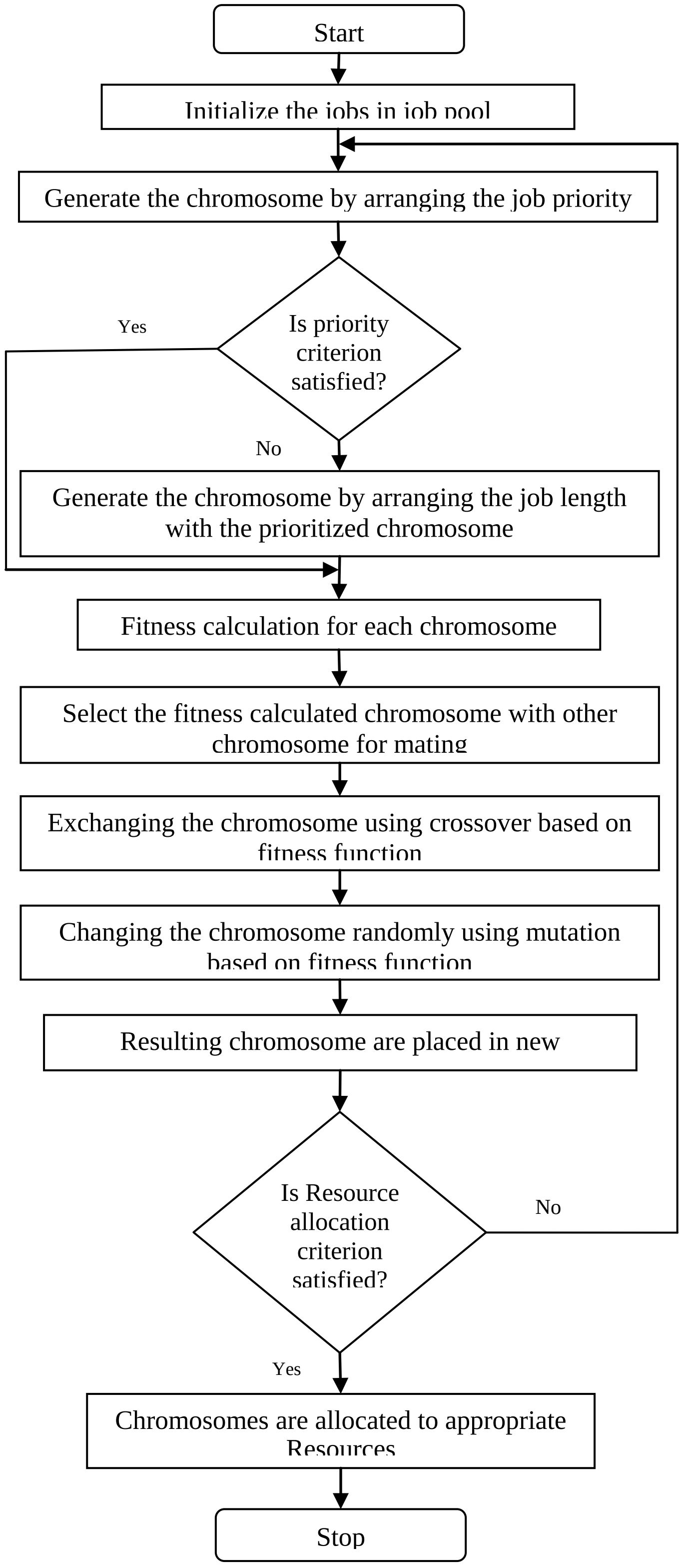

Figure 8 : Flowchart for proposed SS-GA algorithm

Nomenclature

Job length in million instructions

Job priority (0 to 5)

Unique id of each job

Job cost

Capacity of a resource in MIPS

Resource cost per minute of execution

Resource id

Crossover rate

Mutation rate

Makespan or Overall completion time

Total job completion cost

Position of the chromosome

Mathematical Steps
BEGIN
Step 1:

Initialize Job length ($\mathbf{J_l}$), Job Id ($\mathbf{R_{id}}$), Job priority ($\mathbf{J_P}$), Resource Id ($\mathbf{R_{id}}$), Resource Capacity ($\mathbf{R_{Cap}}$), Resource Cost ($\mathbf{R_{Cos}}$), Chromosome length ($\mathbf{Ch_l}$), Population size;

Step 2:
Swift schedules the jobs in the job pool according to the user's importance i.e. priority;

Step 2.1: Priority of the jobs are randomly assigned between 0 to 5, 0 holds the high priority of the jobs and some jobs doesn't hold priority;

Step 2.2: Separate the jobs with ($\mathbf{J_L^P}$) and without ($\mathbf{J_L}$) priority in the job pool;

Step 2.3: With prioity jobs ($\mathbf{J_L^P}$):

If P =! Null;

For each $\mathbf{J_L^P}$

P[j] < P[Min]; Min = j; $\forall\ \mathbf{J_L^P}$

If P[i] == P[j];

Consider the length of the jobs

For each $\mathbf{J_L^P}$

L[j] < L[Min]; Min = j; $\forall\ \mathbf{J_L^P}$

Arrange the jobs according to the priority of the job;

Ptmp = P[i]; P[i] = P[j]; P[j] = Ptmp;

Step 2.4: Without priority jobs ($\mathbf{J_L}$):

If P == Null

For each $\mathbf{J_L}$

L[i] < L[Min]; Min = j; $\forall \mathbf{J_L}$

Arrange the jobs according to the length of the job;
Ltmp = L[i]; L[i] = L[j]; L[j] = Ltmp;

Generally, $$\text{Job} = \begin{cases} J_l^P, & \text{order the job by its priority} \\ J_l, & \text{otherwise order using length} \end{cases}$$

Step 2.5: Finally the chromosomes are arranged in the job pool by prioritized jobs followed by the without prioritized jobs;

Step 3:

Initialize the chromosomes scheduled by the swift scheduler;

Step 3.1: Evaluation of fitness function

Step 3.1.1: Time fitness

For each job's completion time: $J_C = \frac{J_L}{R_{Cap}}$

Overall completion time: $O_{J_C} = \sum_{i=1}^{n} J_C$

Step 3.1.2: Cost fitness

For each Job's cost: $C_F = R_{Cos} \cdot J_C$

Overall cost: $T_{C_F} = \sum_{i=1}^{n} C_F$

Step 3.2: Best chromosome selection

$$\text{Selection} = \frac{Pos_{c1} + Pos_{cL}}{2}$$

Here, c1 & cL are first chromosome and last chromosome respectively;

For each selection & total chromosome length

$Pos_{cN}[i,j] = Pos_c[Selection[i]]$;

Here, cN represents the intial best chromosomes;

Step 3.3: Chromosome Crossover

$Div = \frac{Chrom_L}{4}$, $Pnt_1 = Div * 2$, $Pnt_2 = Div * 3$;

For each $Chrom_L$

$Chrom_1[j] = IChrom[i,j]$;

$Chrom_2[j] = IChrom[i+1,j]$;

Applying crossover,

$L_V = Pnt_2 - Pnt_1$;

For each L_V

If $\{(L_V + i) \% 3\} \neq 0$

Crossover the chromosomes;

Step 3.4: Chromosome Mutation

$Mut_{pnts} = 2$;

For each Mut_{pnts}

$Tmp = \{Rand_{Mut_{Ind}}[j] - 1\} \% 3$;

If Tmp == 1

$BChrom\left[i, \{Rand_{Mut_{Ind}}[j] - 1\}\right] = Rand_{Chrom}(1,10)$;

If Tmp == 2

$BChrom\left[i, \{Rand_{Mut_{Ind}}[j] - 1\}\right] = Rand_{Chrom}(0,4)$;

Step 3.5: Termination

If cretiria satisfied

Return the results of time and cost;

Else Resturn to main;

Step 4:

Display the results of total best time and cost of the allocated job;

And find the resource utilization percentage and economy rate;

Finally, compare all the results with the existing resource allocation algorithm.

END

iv. *Swift Scheduler Process*

The fusion of swift scheduler and genetic algorithm (SS-GA) based resource allocation defines the resource allocation process in the fast resource scheduling manner. The word swift describes the capability of the work process to be done in high speed. The resource allocation algorithm uses the advantage of the swift algorithm by allocating the jobs in available resource according to user requirement. So the job with priority gives more importance for the resource allocation. The job assigned with priority denotes the urgency of job and '**0**' is considered as the highest priority among the jobs in job pool. The swift algorithm uses search algorithm to find the optimized available resource in the grid system. The search algorithm finds optimized available grid resource for the high-priority job; it makes an effective resource allocation. Here genetic algorithm used along with swift algorithm to find the optimized available resource in proposed grid system. Swift scheduler separates to the prioritized jobs, and non prioritized job in the job pool. And it arranges/schedules the prioritized job (i.e. priority numbered '**0**' is considered as high priority job) and the non-prioritized jobs are schedules the jobs according to its length in ascending order (i.e. Shortest Job First (SJF) order) as shown in the fig.4. The jobs are arranged/scheduled using the following formula.

$$Job = \begin{cases} J_l^P, & order\ the\ job\ by\ its\ priority \\ J_l, & otherwise\ order\ using\ length \end{cases} \quad (1)$$

Where, J_l^P denotes the job with priority, J_l denotes the non-priority job, *P* denotes the priority of the job and *l* denotes the job's length. The resource allocation takes the full advantage of swift scheduler for fast execution of high prioritized job first. Swift scheduler increases the scalability of memory and computational time. So the swift algorithm ameliorates the resource allocation process.

v. *Genetic Algorithm Process*

After performing the swift scheduling process, job tasks have scheduled according to its priority, and the procedure can be merged with genetic algorithm to achieve the objective function of less job completion time, cost-effective and its economy, and resource utilization. A Genetic Algorithm (GA) has four major steps: fitness, selection, crossover, and mutation. Genetic algorithm is capable of solve optimization problems by carrying out the genetic process. A possible solution to a definite problem may be represented as a chromosome containing a sequence of genes. Initially, the population size is a set of chromosomes is generated, and it undergoes many genetic processes. By using selection, crossover and mutation operations, GA is capable of progress towards the population to generate a best possible solution of resource allocation in grid environment.

a. *Initial Chromosome Representation*

The GA operates on a population of chromosomes, which is encoded according to the problem. The chromosome represents a complete solution to the problem. The chromosome is a collection of n number of jobs to be initialized randomly with resources from 1 to R_L where L = {1,2,3,……N}. Therefore, the number of chromosome sequence can be generated based on population size P(s).

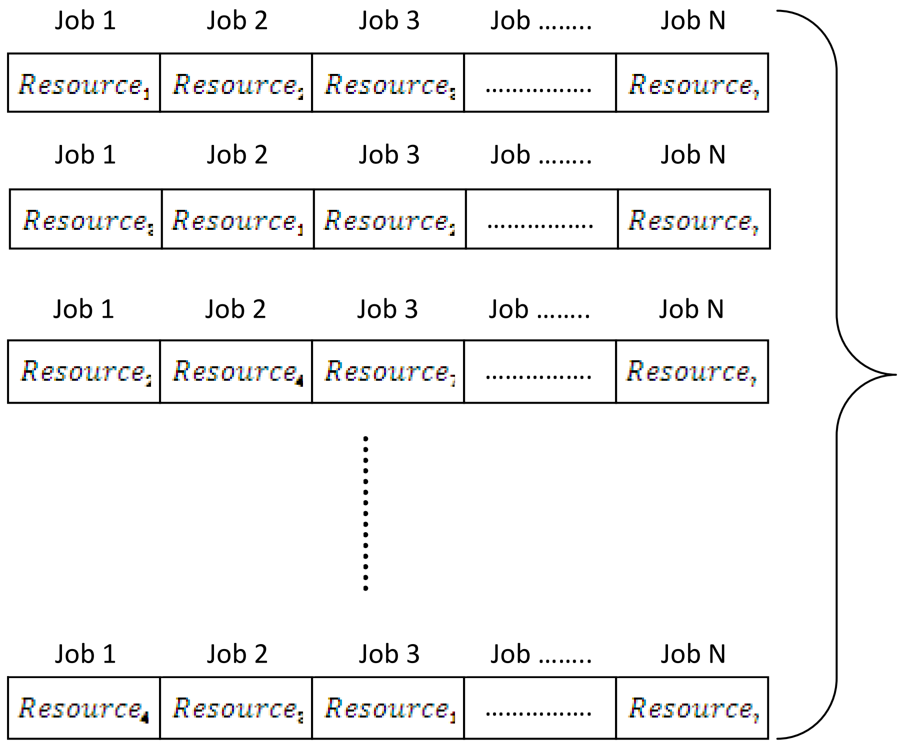

Figure 9 : Chromosome Representation of Jobs and Resources based on Population size

b. *Evaluation of Fitness Function*

In genetic algorithm, fitness function is the most important step for optimize the solutions in grid resource allocation. Fitness is initially resulted from the objective function and used in consecutive genetic operations. The objective function may be minimized or maximized based on the problem occurs in various domains. The purpose of a fitness function is to afford a significant, quantifiable, and equivalent value given a set of genes present in the chromosome. Here the objective function is cost efficient and minimum job completion time.

Fitness can be defined as the value assigned to an individual based on how far or close an individual is from the solution; greater the fitness value superior the solution it contains. It mainly considers two parameters those have to be optimized as follows

Job Completion Time (J_C)

It can be defined as the time taken by a job to be executed successfully in the given allocated resource,

$$J_C = {J_L}/{R_{Cap}} \qquad (2)$$

In this equation, J_L is the length of the job and R_{Cap} is the resource capacity to finish the certain job.

From this, the overall job completion time (O_{J_C}) can be calculated as it is the sum of execution of all the n jobs running on their corresponding allocated resources as,

$$O_{J_C} = \sum_{i=1}^{n} J_C \qquad (3)$$

Where i = {1,2,3,….n} denotes the number of jobs to be assigned for appropriate resource.

Job Completion Cost (C_F)

The cost of executing a job in specific resource is known by multiplying job execution time with its resource cost of the allocated resource as,

$$C_F = R_{Cos} \,.\, J_C \qquad (4)$$

Therefore, the total cost occurred to complete the grid resource allocation can be derived as,

$$T_{C_F} = \sum_{i=1}^{n} C_F \qquad (5)$$

The fitness function F_X can take these above parameters to evaluate the initial population of jobs and resources arranged in Chromosome representation. It guarantees that the resource allocation is optimized in case of time and cost by refining the population.

c. *Selection Process*

The selection of best individuals among the initial population size of chromosomes can be done after the fitness operation is performed. It is a genetic operator used in genetic algorithms for selecting potentially useful solutions for recombination. It plays the major role in well-organized allocation of resources because it only picks the best fitness chromosomes to undergo the genetic operations namely crossover and mutation. It selects the chromosomes having probability of best fitness values. If there are two or more chromosomes having the same best fitness, one of them is chosen randomly. Finally, there are n/2 chromosomes are selected for a genetic operation where n is the population size to produce new chromosomes.

d. *Crossover Operation*

Crossover is a genetic operator that combines or mates' two chromosomes (parents) derived from selection process to generate a new child chromosome (offspring). The two chromosomes (strings) take part in the crossover operation is known as parent and the ensuing chromosomes are known as child strings. This process takes place by fixing the crossover rate C_r as 60% to 70% for making this process a more effective. There are several types of crossover is carried out in genetic algorithm like one-point crossover, two-point crossover, arithmetic crossover, uniform crossover and heuristic crossover. Here the crossover function used is one-point crossover, because one-point crossover is suitable for task ordering problems.

One-Point Crossover

This crossover function selects a particular point randomly in the parent chromosomes to be induced, and then it interchanges the two-parent chromosomes at this point to create two new offspring. A point which selected randomly plays the significant role in one-point crossover. This process carried entirely depends on the crossover rate C_r. Let us consider that the two-parent chromosomes have been selected for undergone the crossover process as shown below.

Parent 1: 110010 | 00111010

Parent 2: 010110 | 10111001

The crossover point of both parent chromosomes is denoted by varying the colors in the chromosome. The offspring (child) chromosomes can be produced by interchanging their strings according to the crossover point as,

Child 1: 110010 | 10111001

Child 2: 010110 | 00111010

Figure 10 : One-Point Crossover

e. *Mutation*

If the chromosomes arrived after many steps of crossover, there is a chance of strings (chromosomes) having repeated or same one. In order to prevent the particular environment, the mutation is done to gather the best individuals among the parent chromosomes. The mutation has to be performed with the help of mutation rate M_r. This could make creating the completely new genes among the chromosomes in population by altering (changing) gene values. Flip Bit is one of the most common types of mutation used as it changes the bit values of genes from 0 to 1 or vice versa. This mechanism can be illustrated as follows.

Parent 1: 11000110101110010111

Parent 2: 01001001110110011010

The child can be produced by invert the gene values present in the above parent chromosomes. The pink color denotes the changed values which are done by Flip bit mutation.

Child 1: 11010110101010010111

Child 2: 01001011110110011010

Figure 11 : Flip Bit Mutation

f. *Termination*

After the swift scheduling and operators of genetic algorithm are executed over a certain number of iterations, the jobs stored in the job pool are ready to join their appropriate resource for executes the respective tasks in grid environment. The corresponding efficient resources in terms of flowtime (overall job completion time) and cost can already obtain by the fusion of SS-GA algorithmic methodology to carry out the jobs to finish simultaneously to meet the quality of service.

IV. Experimental Results and Discussion

In this section, the experimental results are discussed in simulated grid network using dotNet framework platform. The proposed algorithm is compared and evaluated with existing algorithm using certain parameters like resource utilization, computational time, processing time, makespan, economy, time, cost etc. And these results are evaluated using separate line graphs. The results are taken in dynamic nature of grid environment. The dataset are simulated which contains job table and resource table separately. The job table contains its id, length and cost, similarly the resource table also contains its id, capacity and its cost.

a) Resource Utilization

The total resources consumed by the jobs against the expected amount of resources for a particular work. The utilization is normally calculated in percentage of time. Resource utilization is generally, the resource capability of the job execution in a period of time. Resource utilization will differ according to the resource processing speed. The idle resource should have very low utilization rate. The proposed algorithm boosts up all the resource in active stage in dynamic manner, the resources are utilized by the incoming tasks. The utilization formula is defined in equation 6.

$$Utilization = \left(\frac{\sum_{j=1}^{n} J_L(j)}{\sum_{j=1}^{n} R_{Cap}(j)}\right) \times 100 \qquad (6)$$

b) Economy

Economy is the word in grid resource allocation defines vigilant management and proficient or restrained use of resources in grid. "Maximum effect for the minimum effort" is the motto for economy. Economy purports the proficiency of larger resource allocation process with lower price. It will track the changes on the price level with the efficient use of resource price and can analyze and improve the performance of macroeconomic. The economy formula is defined in equation 7.

$$Economy = \left(\sum_{j=1}^{n} \frac{(1 - R_{Cos}(j))}{J_{Cos}}\right) \times 100 \qquad (7)$$

c) Processing Time

The processing time of the tasks are calculated by the following equation 8. It checks the first job with allocated resource and took its length of the job that which execute in the resources. And the upcoming jobs are checked with the all resources when the i^{th} resource id and j^{th} resource id are equal, this has to be done similar manner to all jobs allocated in the resources and so on.

$$Processing\ time = \sum_{i=1}^{n} \sum_{j=1\ \&\&\ i\neq 1\ \&\&\ R_{id}(i)==R_{id}(j)}^{i-1} J_L(i) \qquad (8)$$

The resource in the grid environment may connect and leave at anytime. So the results are taken in a dynamic way by varying job count and resource count in the simulated grid environment using dotNet framework. The proposed SS-GA algorithm with existing algorithms using utilization, economy, total resource cost, processing time and computational time parameters are evaluated.

The following results are compared between First Come First Serve (FCFS) based Resource Allocation, Shortest Job First (SJF) based Resource Allocation, Swift Scheduler (SS) based Resource Allocation, Ant Colony Optimization based Resource Allocation, AWPF Constraint checked Genetic Algorithm (GA) based Resource Allocation, AWOPF Constraint checked Genetic Algorithm (GA) based Resource Allocation with the proposed fusion of Swift Scheduler and Genetic Algorithm (SS-GA) based Resource Allocation.

These algorithms are compared using parameters like resource utilization, resource economy, total resource cost, processing time and computational time. The results are taken with different available resource pool size and in all cases of available resource the dynamic job inputs are compared in following table with proposed algorithm.

Table.1a – Table.1e with constant resource 10 with varying job size are analyzed with proposed algorithm

	FCFS	SJF	SS	ACO	AWPF	AWOPF	SS-GA
Utilization	101.13731	101.13731	101.13731	96.8543	104.0636	100.3295	94.96753
Economy	35.97241	35.97241	35.97241	39.2	44.2418	44.12	38.86897
Total Resource Cost	2321	2321	2321	2204	2048	2124	2116
Processing Time	7412	7412	7412	1502	1630	1534	2163
Computational Time	63.4956	41.0576	15.3729	7.2747	217.9281	487.5417	671.9201

Table 1.a : Resource - 10 Job - 40

	FCFS	SJF	SS	ACO	AWPF	AWOPF	SS-GA
Utilization	109.9085	125.1736	109.9085	106.0294	105.042	105.9474	102.7066
Economy	40.42171	42.21624	40.42171	39.88335	39.2986	39.4193	39.38986
Total Resource Cost	2656	2679	2656	2680	2700	2754	2652
Processing Time	11529	12214	11529	2210	2262	2320	2789
Computational Time	20.331	35.7789	23.1065	2.2418	285.6306	554.5056	723.9278

Table 1.b : Resource - 10 Job - 50

	FCFS	SJF	SS	ACO	AWPF	AWOPF	SS-GA
Utilization	88.96484	125.8287	125.8287	122.4462	91.9287	91.3758	118.7744
Economy	39.90874	45.17375	45.17375	44.82274	39.7398	39.7032	44.41909
Total Resource Cost	3424	3154	3154	3144	3242	3291	3137
Processing Time	19543	18990	18990	3214	3103	3221	3974
Computational Time	26.8791	19.9335	22.5993	3.7538	329.6535	614.6301	757.6617

Table 1.c : Resource - 10 Job - 60

	FCFS	SJF	SS	ACO	AWPF	AWOPF	SS-GA
Utilization	106.4024	106.4024	100.2874	103.869	97.8095	98.6705	97.30483
Economy	42.00766	42.00766	41.08812	41.63985	39.3844	39.376	40.5977
Total Resource Cost	3784	3784	3844	3808	3840	3886	3776
Processing Time	27525	27525	28899	4252	4090	4225	5186
Computational Time	43.6689	14.5231	25.3487	3.0638	433.0316	718.1304	830.0515

Table 1.d : Resource - 10 Job - 70

	FCFS	SJF	SS	ACO	AWPF	AWOPF	SS-GA
Utilization	99.72919	109.10143	99.72919	104.4964	105.5111	104.6957	97.89385
Economy	38.76685	39.75405	38.76685	39.74287	40.6181	40.6526	38.6948
Total Resource Cost	4389	4669	4389	4312	4304	4365	4297
Processing Time	36040	36703	36040	5333	5208	5332	6375
Computational Time	16.1187	16.3831	21.1927	3.2143	452.622	808.8489	879.7745

Table 1.e : Resource - 10 Job - 80

The above five tables are compared with constant 10 resources with dynamic job inputs. The result with different job inputs explains that the resource utilization is comes best compared to other algorithms, the resources are not fully occupied and it is used effectively. The proposed algorithm maintains the resources and avoiding the resources in idle stage. The economy rate using the resource cost shows proficient resource usage. The most important and expecting parameter should be the cost, the performance of the proposed algorithm bring the effective cost while comparing other existing algorithm. The processing time and computational time are totally depends implemented code.

Table.2a – Table.2e with constant resource 15 with varying job size are analyzed with proposed algorithm

	FCFS	SJF	SS	ACO	AWPF	AWOPF	SS-GA
Utilization	115.0763	115.0763	115.0763	99.17764	108.6022	104.8658	98.36868
Economy	43.76489	43.76489	43.76489	41.5409	43.6906	43.8856	41.40852
Total Resource Cost	2224	2224	2224	2208	2133	2198	2203
Processing Time	5399	5399	5399	1152	1162	1208	1242
Computational Time	26.5083	40.0634	24.3662	3.3151	230.8437	498.984	671.4895

Table 2.a : Resource - 15 Job - 40

	FCFS	SJF	SS	ACO	AWPF	AWOPF	SS-GA
Utilization	93.17889	93.17889	93.17889	100	102.8329	106.8017	95.01312
Economy	37.70749	37.70749	37.70749	38.89637	36.957	37.3555	38.04397
Total Resource Cost	2777	2777	2777	2724	2685	2710	2682
Processing Time	10018	10018	10018	1664	1620	1633	2056
Computational Time	32.1723	28.8015	28.069	4.2309	272.0314	543.2246	738.77

Table 2.b : Resource - 15 Job - 50

	FCFS	SJF	SS	ACO	AWPF	AWOPF	SS-GA
Utilization	99.10011	104.3839	99.10011	102.9206	102.8136	104.2056	97.45575
Economy	39.70669	40.53162	39.70669	40.31164	40.1455	40.6211	39.43172
Total Resource Cost	3289	3264	3289	3256	3292	3327	3254
Processing Time	16148	15478	16148	2203	2290	2385	2720
Computational Time	27.5003	31.5784	22.5031	4.0919	342.8629	632.962	787.1048

Table 2.c : Resource - 15 Job - 60

	FCFS	SJF	SS	ACO	AWPF	AWOPF	SS-GA
Utilization	123.5437	115.8134	115.8134	99.12366	93.3148	93.0657	97.32314
Economy	42.60374	41.73266	41.73266	39.38866	39.8867	39.7923	39.08774
Total Resource Cost	3824	3879	3879	3827	3819	3884	3811
Processing Time	22756	23503	23503	2975	2911	2949	3667
Computational Time	29.8284	29.1116	45.4337	5.0326	385.6059	658.5975	809.2128

Table 2.d : Resource - 15 Job – 70

	FCFS	SJF	SS	ACO	AWPF	AWOPF	SS-GA
Utilization	95.70403	111.8088	95.70403	100.2521	100.3407	101.2744	99.58263
Economy	38.21313	42.58612	38.21313	40.93111	38.6827	38.8788	38.62347
Total Resource Cost	4592	4267	4592	4390	4329	4372	4338
Processing Time	33765	32349	33765	3900	3842	3950	4436
Computational Time	35.7035	34.5346	33.2747	5.9805	467.8766	868.2343	876.4405

Table 2.e : Resource - 15 Job - 80

The above five tables are compared with constant 15 resources with dynamic job inputs. When the number of resources goes high, the rate of resource utilization maintains its proficiency with the use of proposed algorithm. The resource utilization and economy shows the good rate while using the proposed algorithm. The fusion of SS-GA algorithm gives the computational time is pretty high because the fused algorithm takes both the work of swift algorithm and genetic algorithm.

Table.3a – Table.3e with constant resource 20 with varying job size are analyzed with proposed algorithm

	FCFS	SJF	SS	ACO	AWPF	AWOPF	SS-GA
Utilization	117.2917	117.2917	117.2917	100.5357	87.6387	86.9029	93.05785
Economy	39.09224	39.09224	39.09224	36.74963	37.3456	36.8762	35.43192
Total Resource Cost	2180	2180	2180	2160	2181	2239	2155
Processing Time	3532	3532	3532	864	871	896	1256
Computational Time	40.6763	66.9054	35.3175	4.2761	241.6037	514.3924	705.319

Table 3.a : Resource - 20 Job – 40

	FCFS	SJF	SS	ACO	AWPF	AWOPF	SS-GA
Utilization	111.026	111.026	111.026	98.10555	103.9589	99.7241	93.06804
Economy	40.80768	40.80768	40.80768	38.88889	40.2273	39.5456	37.99643
Total Resource Cost	2753	2753	2753	2739	2682	2767	2679
Processing Time	7349	7349	7349	1338	1354	1321	1808
Computational Time	40.7577	32.6365	54.1946	6.7784	309.8983	595.1578	732.8609

Table 3.b : Resource - 20 Job - 50

	FCFS	SJF	SS	ACO	AWPF	AWOPF	SS-GA
Utilization	100.4372	100.4372	100.4372	97.24868	107.554	112.0098	94.25641
Economy	42.71643	42.71643	42.71643	42.19803	35.8771	36.5934	35.67963
Total Resource Cost	3315	3315	3315	3345	3235	3261	3237
Processing Time	13611	13611	13611	1864	1849	1906	2451
Computational Time	43.4866	34.0002	41.0565	6.0564	383.4802	661.8143	798.3901

Table 3.c : Resource - 20 Job - 60

	FCFS	SJF	SS	ACO	AWPF	AWOPF	SS-GA
Utilization	118.5099	118.5099	118.5099	93.65225	104.7856	108.6823	88.59878
Economy	41.86527	41.86527	41.86527	38.24277	39.753	40.184	37.25771
Total Resource Cost	3759	3759	3759	3887	3757	3772	3749
Processing Time	19330	19330	19330	2384	2441	2550	3063
Computational Time	48.9577	60.6802	44.1474	8.5887	415.6853	696.6445	850.4797

Table 3.d : Resource - 20 Job – 70

	FCFS	SJF	SS	ACO	AWPF	AWOPF	SS-GA
Utilization	90.8028	90.8028	90.8028	110.7414	98.0504	100.3276	95.5254
Economy	37.80522	37.80522	37.80522	41.00999	39.0302	39.7539	39.28857
Total Resource Cost	4483	4483	4483	4352	4338	4357	4304
Processing Time	28390	28390	28390	2914	3079	3153	3593
Computational Time	38.908	44.2368	40.7869	8.2141	502.8877	908.7781	856.5241

Table 3.e : Resource - 20 Job - 80

The above five tables are compared with constant 20 resources with dynamic job inputs. The economy results of SS-GA algorithm bring good rate, when increase in the number of available grid resources in the grid network. The total resource cost of proposed algorithm with varying resources results the effective cost. The performances of the resource allocation in the grid environment are boosted up by SS-GA algorithm. The processing time and computational time of the ACO based resource allocation algorithm is very low because it allocates the jobs by checking with the resources in first time itself. But the proposed algorithm takes the advantage of swift algorithm; it checks the job with priority brings higher order for allocation process. And so it takes more time for resource allocation computation. The available resources are dynamically checked by the proposed algorithm.

Table.4a – Table.4e with constant resource 25 with varying job size are analyzed with proposed algorithm

	FCFS	SJF	SS	ACO	AWPF	AWOPF	SS-GA
Utilization	114.3678	114.3678	114.3678	101.8771	102.0942	104.5534	98.84106
Economy	42.94165	42.94165	42.94165	41.22076	35.8982	35.8967	40.73676
Total Resource Cost	2232	2232	2232	2186	2191	2234	2184
Processing Time	2297	2297	2297	836	842	879	1139
Computational Time	52.7427	45.809	75.3122	8.6043	284.6685	568.168	710.2946

Table 4.a : Resource - 25 Job – 40

	FCFS	SJF	SS	ACO	AWPF	AWOPF	SS-GA
Utilization	115.3724	115.3724	87.60529	102.2472	106.1026	108.8235	95.41284
Economy	41.32471	41.32471	36.86441	39.51829	43.0998	43.1747	38.38091
Total Resource Cost	2731	2731	2831	2712	2680	2710	2663
Processing Time	5594	5594	5212	1111	1259	1257	1666
Computational Time	65.6896	47.8802	67.6473	7.7583	313.8459	593.0732	763.5657

Table 4.b : Resource - 25 Job - 50

	FCFS	SJF	SS	ACO	AWPF	AWOPF	SS-GA
Utilization	98.71899	99.54338	98.71899	102.9516	102.1378	97.3184	97.31663
Economy	38.54863	39.19822	38.54863	39.73645	37.8291	36.848	37.1611
Total Resource Cost	3311	3276	3311	3247	3282	3378	3238
Processing Time	10016	9418	10016	1555	1613	1627	1881
Computational Time	51.9269	56.5841	49.946	11.9545	319.5781	585.6896	775.5075

Table 4.c : Resource - 25 Job - 60

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	FCFS	SJF	SS	ACO	AWPF	AWOPF	SS-GA
Utilization	103.6847	103.6847	87.55402	102.5304	103.6585	101.4519	97.70473
Economy	39.68381	39.68381	36.80933	39.50814	39.2811	38.5519	38.061
Total Resource Cost	3777	3777	3957	3788	3733	3819	3726
Processing Time	15466	15466	14706	2007	2279	2345	2427
Computational Time	78.7174	52.712	52.2184	11.8828	385.6945	651.1487	854.7021

Table 4.d : Resource - 25 Job - 70

	FCFS	SJF	SS	ACO	AWPF	AWOPF	SS-GA
Utilization	91.76289	100.2523	100.2523	101.4468	99.2599	100.1643	98.6198
Economy	41.39925	42.88093	42.88093	41.0965	41.428	41.4092	41.09644
Total Resource Cost	4499	4389	4389	4375	4356	4399	4343
Processing Time	22542	23287	23287	2602	2672	2764	3185
Computational Time	37.1361	40.0114	50.1337	15.8017	444.0259	787.7263	904.6483

Table 4.e : Resource - 25 Job - 80

The above five tables are compared with constant 25 resources with dynamic job inputs. In the table.4a shows the slight change in economy rate of proposed algorithm with AWPF and AWOPF and resource cost also ACO based resource allocation algorithm's very nearest to the proposed one. When there is increase in number of job in resource allocation process, the resource utilization and economy rate are being fine. And the small scheduling based algorithm i.e. FCFS, SFJ, SS are maintaining good results but particularly in some cases because it only gives big concentration in scheduling the jobs to resources and it won't consider the cost of the resources while resource allocation.

Table.5a – Table.5e with constant resource 30 with varying job size are analyzed with proposed algorithm

	FCFS	SJF	SS	ACO	AWPF	AWOPF	SS-GA
Utilization	88.854	103.4735	103.4735	94.64883	105.5172	99.6795	90.56
Economy	35.81062	38.39311	38.39311	36.9297	41.4513	39.8808	36.15495
Total Resource Cost	2237	2147	2147	2198	2130	2219	2125
Processing Time	1180	1304	1304	724	801	880	914
Computational Time	60.8625	51.836	57.4498	14.2908	216.1684	481.3565	729.9444

Table 5.a : Resource - 30 Job - 40

	FCFS	SJF	SS	ACO	AWPF	AWOPF	SS-GA
Utilization	105.7991	102.8886	105.7991	97.26918	102.6243	101.7568	96.76585
Economy	42.20752	41.78053	42.20752	40.88386	40.305	39.7933	40.79846
Total Resource Cost	2727	2737	2727	2769	2740	2796	2723
Processing Time	4040	3586	4040	1057	1081	1100	1372
Computational Time	105.4399	82.6424	56.9463	13.9463	286.4863	602.7403	776.9802

Table 5.b : Resource - 30 Job – 50

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	FCFS	SJF	SS	ACO	AWPF	AWOPF	SS-GA
Utilization	90.24918	90.24918	82.231	88.05497	96.973	99.2366	85.87629
Economy	34.49635	34.49635	32.72226	34.04297	38.0134	38.1965	33.56988
Total Resource Cost	3423	3423	3413	3346	3245	3283	3340
Processing Time	6801	6801	7059	1277	1459	1557	1713
Computational Time	56.6984	60.839	53.8097	12.8454	353.1478	649.9953	807.4937

Table 5.c : Resource - 30 Job - 60

	FCFS	SJF	SS	ACO	AWPF	AWOPF	SS-GA
Utilization	123.7695	123.7695	123.7695	102.6892	96.4486	96.8692	97.63258
Economy	42.99388	42.99388	42.99388	40.31069	37.2644	37.7858	39.49474
Total Resource Cost	3733	3733	3733	3804	3761	3810	3756
Processing Time	12566	12566	13079	1799	1966	1934	2348
Computational Time	52.7387	45.2918	58.1812	20.3609	378.1919	647.6226	860.2208

Table 5.d : Resource - 30 Job - 70

	FCFS	SJF	SS	ACO	AWPF	AWOPF	SS-GA
Utilization	118.8993	113.0306	113.0306	91.67334	97.1264	95.8333	90.08655
Economy	40.81604	40.1052	40.1052	36.75007	39.8438	39.4922	36.43731
Total Resource Cost	4363	4313	4313	4349	4312	4385	4301
Processing Time	17925	18260	18260	2199	2282	2383	3013
Computational Time	76.1423	84.2506	68.7347	19.757	479.4874	843.1664	918.3843

Table 5.e : Resource - 30 Job – 80

The above five tables are compared with constant 30 resources with dynamic job inputs. The proficient resource allocation in grid computing and the raise in the performance show best result with the proposed fusion of SS-GA based resource allocation. And total resource cost while resource allocation process.

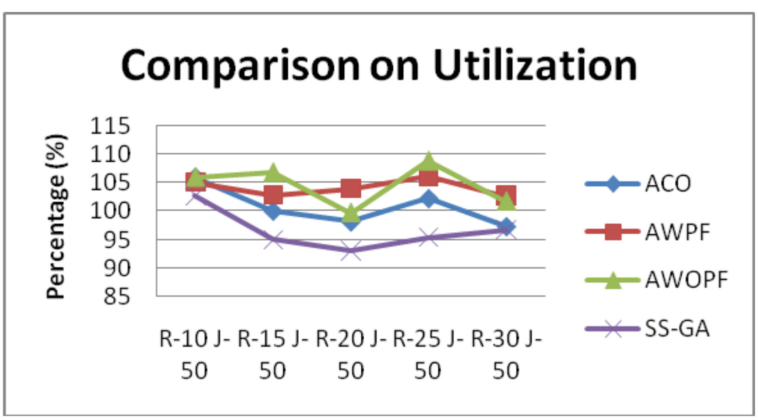

Figure 12 : Comparison on Utilization with constant Job 50

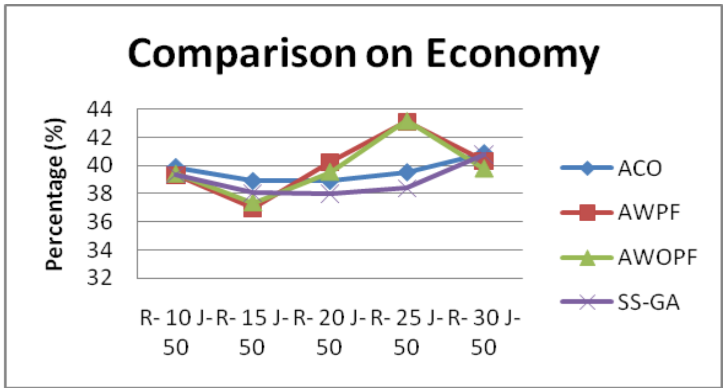

Figure 13 : Comparison on Economy with constant Job 50

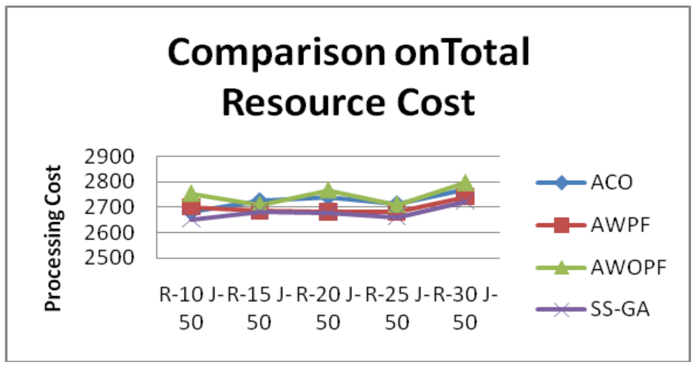

Figure 14 : Comparison on Total Resource Cost with constant Job 50

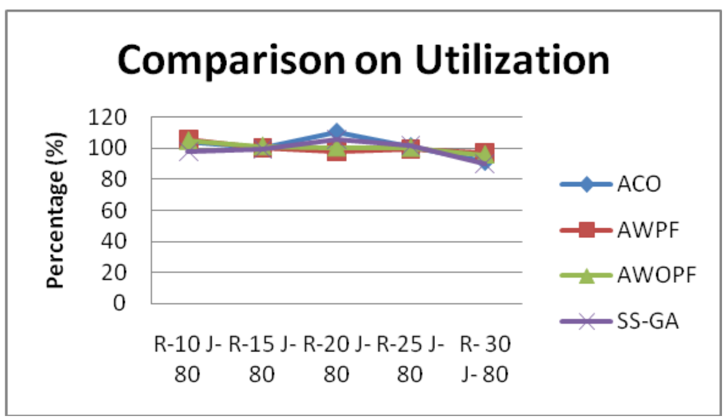

Figure 15 : Comparison on Utilization with constant Job 80

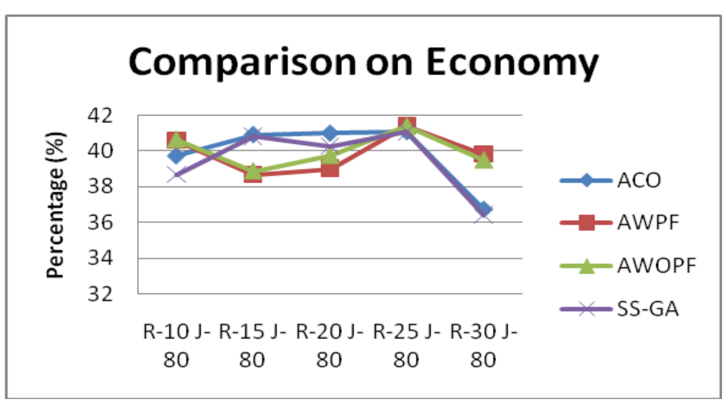

Figure 16 : Comparison on Economy with constant Job 80

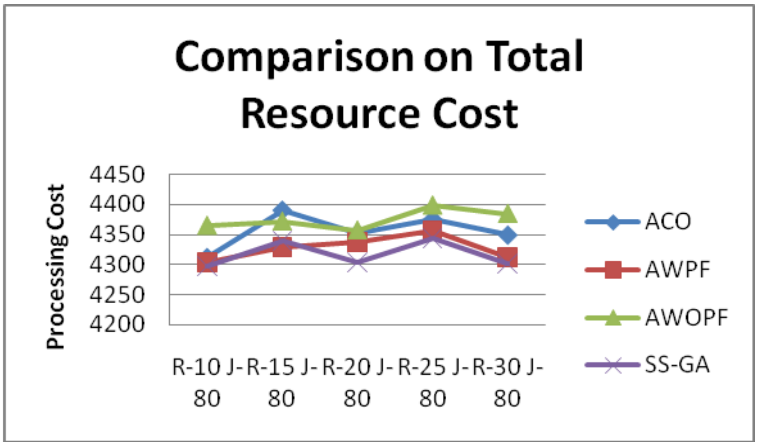

Figure 17 : Comparison on Total Resource Cost with constant Job 80

The above line graph shows the proficiency of the proposed fusion Swift Scheduler and Genetic Algorithm (SS-GA) based resource allocation.

V. Conclusion

In this paper, a mechanism was proposed to allocate the jobs efficiently to the corresponding resources during the process. The proposed method was implemented in the Microsoft Visual Studio 9.0 environment with dotNet framework. This paper has taken GA-SS based algorithm to achieve the quality of service in the resource allocation. In the first phase, the jobs in the job pool are to be scheduled according to its priority. The scheduling of these jobs was done by Swift scheduler. In the second phase, the scheduled jobs can obtain their corresponding resource to allocate by Genetic algorithm. The genetic algorithm performs major operations like fitness, crossover and mutation in the scheduled jobs to achieve less flow time and cost. The experimental result shows that the proposed GA-SS based scheme was much better than the other traditional methods like First Come First Serve (FCFS), Shortest Job First (SJF), Swift Scheduler (SS) and Ant-Colony Optimization (ACO) algorithms in terms of makespan, cost, resource utilization and economy. And also, the experimental results were verified that the proposed methodology can be adaptable to give good results while varying the number of jobs and resources in the input data set.

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E-Learning Improved Architecture for Clouds

By Gunjita Shrivastava, Anukrati Dubey & Sandeep Sahu
University of RGPV, India

Abstract - E-Learning is spreading around the world with leaps and bounds with the growth of Internet. People are keen to get high skilled knowledge from the knowledge pros in the industry and a very new concept of cloud computing is also not unaffected with E-learning. With the intense penetration of the Internet in the life of mankind and fast acceptance of the cloud computing is making researchers to design the various architectures for the cloud applications in generalized manner and specific to the applications. E-learning facilitates the students, teachers, universities and educational service providers to get the services with all ease and 24x7 bases.

In cloud computing we mean by a Cloud as a type of parallel and distributed system over the network and virtual machines which are managed for load balancing with high provision for security, and its services are offered to the customers using SLA (Service Level Agreement). Whereas, Cloud Computing includes both applications and hardware & system software running applications.

From the studies of various research papers and works done by various researchers it has been found that the major areas of focus in the field of cloud computing are architecture definitions, security, integration of services on various layers, inclusion of Various network and communication devices being developed rapidly.

Keywords : cloud computing, e-learning, cloud architecture, virtualization, distributed computing.

GJCST-B Classification : C.2.1

E-LEARNING IMPROVED ARCHITECTURE FOR CLOUDS

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Main focus in cloud computing based e-Learning is to have a centralized server for keeping e-Learning resources. In this research, a new distributed architecture is being proposed to provide an opportunity to the learners around the world to use the resources being shared by the faculties and online communication between the faculties and students.

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I. Introduction

Cloud computing has been growing with a very fast rate as the acceptance of cloud resources is rapid among the persons. The many fold advantages of the cloud computing are also making it popular between the persons of all ages and streams. The users of the cloud are on all over the Internet from web space hosting providers, through data centres to virtualization software providers. Since cloud is a new term and its fuzzy nature is causing everyone to define cloud according to their own perspectives for the cloud.

Major definitions for the cloud has been given by many scientists and major companies who have accepted cloud computing are Google, Apple, IBM, Microsoft and Yahoo and others are providing high quality cloud computing services.

The cloud solutions provided by these either commercial solutions in one form or another, or actively sponsor research centres pursuing development of marketable technology.

The major layers in cloud architecture deal with the different parts of the cloud applications. The parts of the cloud includes PC, mobile or other hand held devices used to connect to the cloud over Internet, various servers which are used to accept the client requests and provide services to them from the cloud, the tools specific to the various cloud applications such as database, hardware resources, applications etc. and finally a data center and broker applications which provide the authentication, authorization, confidentiality and sharing of resources to the various users of the Cloud.

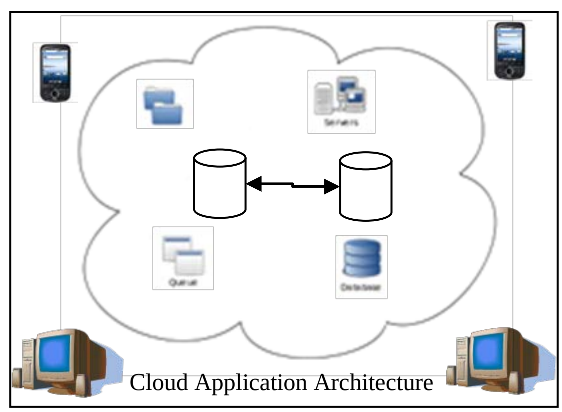

Figure 1 : Cloud Computing

According to the usage of the cloud it is either public, private or hybrid cloud. When a Cloud is made available in a pay-per-use manner to the public, we call it a Public Cloud and the service being sold is Utility Computing. When the services are reserved for some specific organization then the cloud is considered as Private cloud and it works for specific organization. Some of the user oriented applications such as shopping carts, banking services etc requires both behaviors of Public and Private Clouds, such clouds are termed as Hybrid Clouds.

Cloud computing is a wide area network based computing, where shared resources such as software, and information are provided to computers and other devices whenever a client demands them either as paid or free services.

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On the basis of the above discussion, platforms like YouTube, Vimeo, Flickr, Slideshare and Skype are included in a list of cloud applications – platforms that hold your data (images, video, presentations, voice) and manages them all so you don't have to worry about them.

a) Merits & Demerits of Cloud Computing

Merits of cloud computing are too many to enlist all but a few bigger advantages of the cloud computing are as follows:

i. Cloud computing facilitates the equal flow of data between the outsourced and outsourcing services.
ii. Data Center concept allows for centralized data collection and hence all the users get equal amount of updated data.
iii. The easy flow of information allows the host organization an assurance to the employees about their work and data management.

The major problems with cloud computing is as follows:

i. Leads to management problems
ii. Disagreement within the information technology departments
iii. The webmaster will have to set up new systems for dealing with the conflict
iv. Additional communication system and its configurations are required, so that there is another company involved in the business might not get affected.
v. Businesses that deal with responsive data will be concerned about safety of their mechanism [2]

II. Architecture of Cloud Computing

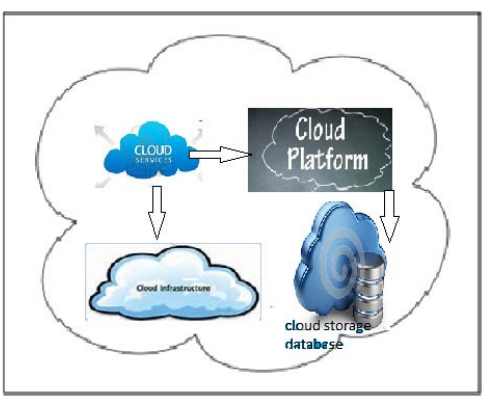


Figure 2 : Architecture of Cloud

Cloud architecture is consisting of multiple resources working for cloud altogether with each other having loose coupling between them so that the system will not have direct dependencies and any of the part can be added, updated or changed in case of requirement/failure without affecting the rest of the system. It involves both hardware and software applications.

For loose coupling between the various applications over the cloud messages queues are used so that dependencies between them will be manageable.

The Cloud Computing Architecture is the structure of the system, which consists of on-premise and cloud resources, services, middleware, and software components, their geo-location, their externally visible properties and the relationships between them. In the area of cloud computing, protection depends on having the right architecture for the right application. Organizations must understand the individual requirements of their applications, and if already using a cloud platform, understand the corresponding cloud architecture.

A cloud computing architecture consists of a front end and a back end. They connect to each other through a network, usually the Internet. The front end is the side the computer user, or client, sees. The back end is the "cloud" section of the system.

a) Cloud Computing Architecture

i. *Front End*

This requires dealing with the client side resources such as network; client application downloads created using various languages such as HTML, JS, XML, JSON etc. Web services like electronic mail programs use web browsers such as Google Chrome, Firefox, Microsoft's internet explorer or Apple's Safari. Other types of systems have some unique applications which provide network access to its clients such as messenger applications, ftp clients etc.

ii. *Back End*

Various servers running over the cloud, Data Center and Data Center Broker applications, Server Disks, Network Infrastructure, various applications to manage communication with the client, processing client requests, connecting with front end application etc are kept in this category of back end architecture of cloud computing. Groups of these clouds make a whole cloud computing system. The major categories of applications are any type of web application program such as video games to applications for data processing, software development and entertainment. Usually, every application would have its individual dedicated server for services.

In current cloud architecture a central server is established which is used for administering the whole system, monitoring client's demand as well as traffic to ensure that everything of system runs without any problem. A rule set is used to control the server activities generally called as protocols which are followed by this server and it uses a special type of software known termed as middleware.

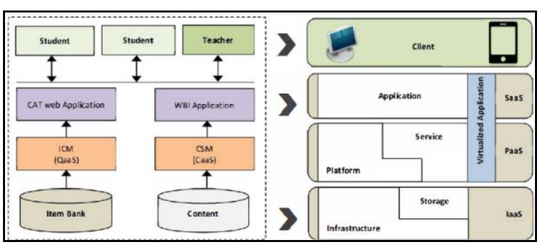
Middleware is an intermediate application which allows computers that are connected on networks to communicate with each other. Many companies that are service providers need hundreds of storage devices. The cloud computing system must have a copy of all the data of its client's. RAID is used for data backup and management over the cloud.

III. Existing System

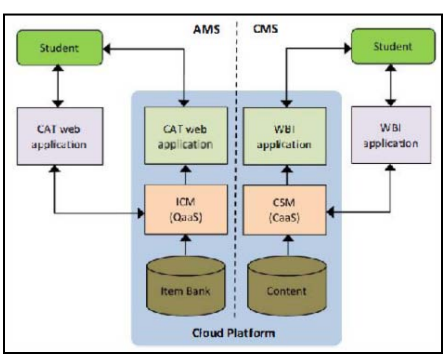
According to Manop Phankokkruad, 2012 [1] has addressed the problem of the cloud computing as, the classical e-learning system is based on client/server architecture thus they lack of the scalability, flexibility and interoperability. It makes the learning resources cannot share, and the system improvement is not easily. In their paper [1], authors have proposed a new architecture for e-learning system that the architecture separate into three layers includes infrastructure, platform and application.

On Infrastructure layer, the learning resources from the traditional system are transferred to the cloud database instead of the usual DBMS. Whereas on Platform layer, a new e-learning system that consists of the CMS, AMS, and other service components were developed. These components were developed to be the intermediary between cloud database and the applications. [1]

Finally on application layer, CAT web application and WBI application were developed for interacting with the student's client. [1]



Cloud Service Architecture for e-Learning System



The Implementation Components of the Cloud on E-Learning System [1]

Mingwei Wang, Jingtao Zhoul, Shikai Jing et. Al. 2012 [2] have specified in their work that the proposed systems must be self adaptive and should provide the flexibility to the clients as per their requirements. The cloud manufacturing vision (GetCM) is introduced to provide the on demand architecture with reliability, flexibility and reliability based on cloud computing. In contrast to the conventional networked manufacturing paradigm, the paper analyzes from technological, functional and economic aspects to provide the evidences of the benefits from GetCM.

Focuses of this paper are placed on the vision and the outline of GetCM architecture.

Yangpeng Zhu, Jing Zhang, 2012 [3] have focused in their research over SaaS layer and specified that software as a Service is becoming a popular research field in software development for its feature of low costing entry, easy implementation and zero infrastructures.

With the extensive development of SaaS software, how to create a safe, stable, user-configurable, high performance, low cost SaaS development model has become a key issue. As the structures of various Cloud computing platform and the increasing number of tenants[6], combination SaaS system and the cloud platform can reduce operational costs, provide more and more flexibility and scalability.

IV. Proposed Algorithm

Cloud Computing is facilitating users around the world for the best of the services available across the world on their machines through web. It is beneficial for both the service providers (they get huge clientele) and clients (they get all available services).

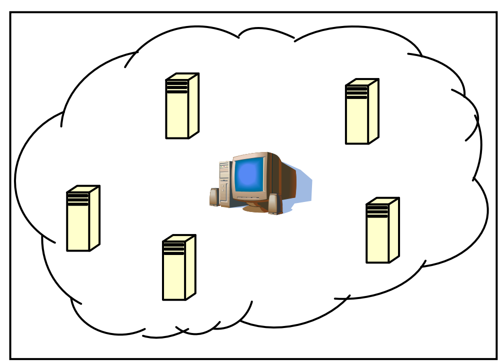


Figure 3 : Simple Cloud

E-Learning is one such service which is required to all the students around the world so that the best faculties around the world can be available to them on pay per use basis.

In this research, a new distributed architecture is being proposed to provide an opportunity to the learners around the world to use the resources being shared by the faculties and online communication between the faculties and students.

Studies of the research papers reveal that the cloud computing is enhancing rapidly and various architectures for cloud oriented processing are being proposed specifically such as e-Learning, Manufacturing, Multi Tenant Architecture etc.

In e-Learning, has proposed an architecture which is centralized server database oriented architecture. In this research, emphasis is on SaaS development for providing a cloud solution for e-Learning, which is the area where no other researchers have been proposed earlier. [1]

For e-Learning on Cloud, we need to implement Cloud Application which shall be working on SaaS Layer. Proposed application will be developed in following steps:

Step 1: There are two users, one working as teacher (admin) and other as student (learners).

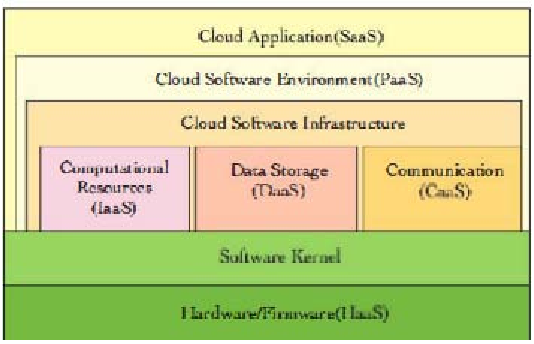


Figure 4 : Cloud Computing Logical Diagram

Step 2: Online text whiteboard and examination system shall be used for presenting the working of the proposed algorithm.

Step 3: There will be two or more servers which will share the information from each other. (Cloud)

Step 4: Teacher can add from any server and students can learn from any server to show the mapping of the clouds.

Step 5: DBaaS (Database as a Service) is also implemented which provides mechanism for data interaction for SaaS layer and manages data using Distributed database management system (DDBMS) so that speed of processing shall always be up to the mark.

Step 6: The overall system architecture defined in this paper is straight forward and allows for simplicity of processing for the users of the clouds.

The two major services being offered as on the proposed architecture are white board and online examination system. Whiteboard is a utility services for the faculties to teach using text, images and other multimedia services available online and in this proposed work it is being implemented using AJAX based chatting service which will allow the faculties to send files over the cloud for all the students who have joined the online class room.

Online examination system is a evaluation system which will be implemented for evaluating the skills of the students who are undergoing the course. It will include objective type questions for evaluation. A common home page shall be there to show the current toppers of the examinations conducted for the students of the system.

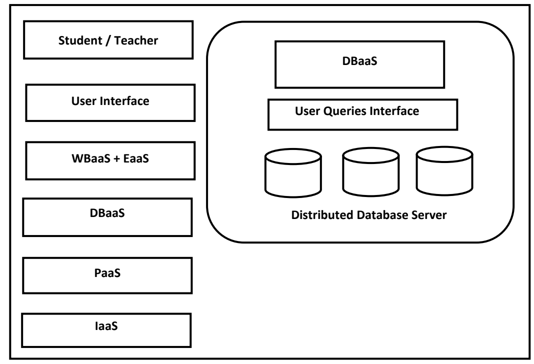


Figure 5 : Proposed Cloud Architecture

V. Conclusion

Studies of the various papers and works done by authors have been done to find out the problem and it is found that the cloud computing is apparently a new technology which is growing very fast and provides new horizons to the computing world. It is technique where implementations are not too many and the major players in industry are very few. The situation is so because a lot of structural, architectural and security work in various applications of the cloud is still to be done. This work selects a similar problem of E-Learning through cloud computing and proposes a new architecture for the same.

E-Learning has been taken as the application area to showcase the working of proposed cloud architecture. Several application areas have been found and it is concluded that e-Learning is the emerging field in which lot of work has not been done for the security of the contents and users.

Various papers and researches in the area have been studied to find that other algorithms in this application area are focused on to provide the contents to the clients.

VI. Future Work

The proposed work is being implemented on simulation environment using standard machines, in future the same can be deployed over the real cloud environment and test it for its accuracy and performance.

A further improvement in the architecture at IaaS and PaaS layers may be helpful in increasing the performance of the e-Learning system.

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Fault Tolerant Scheduling of Partitioned and Grouped Jobs in Grid Computing (FTPG)

By K. Srikala & S. Ramachandram
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Abstract - Computational grids have the potential for solving scientific and large - scale problems using heterogeneous and geographically distributed resources. In addition to the challenges of managing and scheduling resources reliable challenges arise because the grid infrastructure is unreliable. There are two major problems in Scheduling the Grid 1) Efficient Scheduling of jobs, 2) Providing fault tolerance in a reliable manner. Most of the existing strategies do not provide fault tolerance. There are some algorithms which provide fault tolerance but, they do a large amount of redundant computation to provide fault tolerance. This paper addresses this issue and minimizes redundant work by using a group level table of data. This technique is suitable for partitioning and group scheduling of jobs.

Keywords : grid computing, grid scheduling, fault tolerance, redundant computation and group result table.

GJCST-B Classification : C.2.1

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I. Introduction

Internet computing has become popular and its popularity is growing with the emerged infrastructure such as web services and computational grids. It is possible to develop applications that support various Internet wide collaborations through seamlessly harnessing appropriate Internet resources. Grid computing is different from distributed computing as grid computing is concerned with large-scale resource sharing, innovative applications and the orientation is high – performance. Therefore, it is important to provide fault tolerant scheduling of jobs.

In this paper we propose a fault tolerant scheduling algorithm for partitioning and group scheduling of jobs, i.e., partitioning a Heavy Weight job into a group of Light Weight Jobs and Scheduling Light Weight Jobs as a group.

There are three categories of fault tolerant approaches proposed for Grids. They are Job replication, Check pointing and rollback and Adaptive fault tolerance.

a) Job Replication

In Job replication the same job is replicated to be executed on multiple, not dependable resources to guard the job against a resource failure. Number of replicas could be generated statically or dynamically using the history of failure percentage of a node.

b) Check Pointing and Rollback

In this the state of the running job saved at some fixed points called check points. This state used for recovery of the job in case of a resource failure.

c) Adaptive Fault Tolerance

This is the approach where Job replication combines with Check pointing. Here, only one replica will be executing and all other replicas updated periodically, so that if active replica is not available during the recovery of a resource failure we use other replicas.

In First two Categories of Fault Tolerance mechanisms there is so much redundant computation involved which leads to high overhead. Though the redundant computation minimized in adaptive fault tolerance communication overhead is still there in this.

FTPG provides Fault tolerant scheduling of jobs by maintaining a group table of values for Orphan jobs (Jobs not able to reach Parent Job because of failure of processor at Parent Job). M. Amoon et al [1] developed Design of a Fault – Tolerant Scheduling for Grid Computing using Job replication. This uses a fixed number of replicas. Ming Tao et al [2] developed a New Replication Strategy for Grid Workflow Applications. They conclude that their strategy optimizes the replication phase in terms of the characteristics of the workflow applications. J.H. Abawahy et al[3] developed Fault Tolerant Scheduling Policy for Grid Computing Systems. This uses job replicas. Malarvizhi et al [4] developed Fault Tolerant Strategy for Computational Grid Environment.

This Scheme uses history of fault occurrence of nodes. August´_n Caminero et al [5] developed Extending GridSim with architecture for Failure Detection. In all these Schemes the main drawback is redundant computation and some techniques are not able to complete the jobs within the deadlines as a result there is no Quality of Service provided. These are the observations that bring new challenges in designing Fault tolerant Scheduling of jobs, That allows application to continue execution in case of a resource failure. The FTPG addresses all the issues mentioned above.

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II. Related Work

Review of literature reveals that grid environments are more failure prone as the resources may come and go at any time. The most popular fault tolerant mechanism is check pointing. Check pointing is used in Grid computing by systems such as Condor and Cactus. Writing the state of process to a stable storage is the main overhead of this technique. As discussed in the previous section creating greater number of replicas and starting them altogether causes Overhead because of redundant computation.

FTPG is different from other fault-tolerance algorithms. This technique is suitable for partitioned and grouped gridlets. That is Heavy weight gridlets are partitioned into a group of Light weight gridlets and Light weight gridlets are scheduled as a group.

FTPG based on redoing work lost in crashes. FTPG eliminates the common problem of most fault tolerant algorithms that is redundant computation done by a live processor as a result of crash of its parent processor. This happens in case of Orphan gridlets. Therefore, the Overhead in FTPG is very less. In most of the existing fault tolerant algorithms the processor which has finished working of an Orphan gridlet must discard the result of this gridlet because it does not know where to return that result.

The main objectives of FTPG technique are

- Reduce the amount of redundant computations.
- Providing Fault tolerant service within deadlines imposed by the user.

III. Fault Tolerant Scheduling Algorithm

In this section the fault tolerant scheduling algorithm for a group of light weight jobs presented and shown in Figure 1.

```
1. Start
2. forall (gridlets lost because of a crashed processor)
     put job back into the work queue.
3. forall (descendant gridlets of crashed processor)
    if (descendant is finished)
    store the result in group table.
    else
    abort the descendant.
```

Figure 1 : The crash recovery procedure for a live processor

IV. Process

FTPG is suitable for Scheduling a group of light weight jobs. That is when user submits a Heavy Weight Job that is partitioned into Light Weight Jobs and these Light Weight Jobs are scheduled as a group. Or if the user generates Light Weight Jobs they are scheduled as a group. FTPG is based on storing a table of values for the Orphan Jobs. Suppose that a grouped job is sent for execution. All the members of a group has access to group result table designed for this group. This table is used during the crash recovery procedure for storing/reusing the Partial results of Orphan job. (A job/gridlet becomes Orphan when it is not able to send its result back to the parent job.) . Each job can be identified by using its group id, job id and other parameters. When the light weight job's processor is not able to locate its grouped job processor each of the light weight gridlet becomes an orphan and its results are stored in group result table. This table is replicated on all the processors of the group members. The replicas of the table do not have to be strongly consistent because if the processor is not able to find a job it can be recomputed quickly since we are using Light weight jobs here. So updates of the table are propagated asynchronously (for ex: after a fixed amount of time). Since the table stores only Orphan jobs, number of jobs stored is very less. Therefore, the overhead by using the table is very less.

With the use of a group table we are storing only the results of finished jobs. They are very easy to store at the same time redundant computation exists only for partially executed light weight jobs. Though this computation is redundant as the gridlet is light weight gridlet it can be computed very quickly and it is possible to finish the jobs within the deadlines imposed by the user.

Figure 2 and Figure 3 demonstrates an example of before the crash and after the crash of group level processor GJ2.

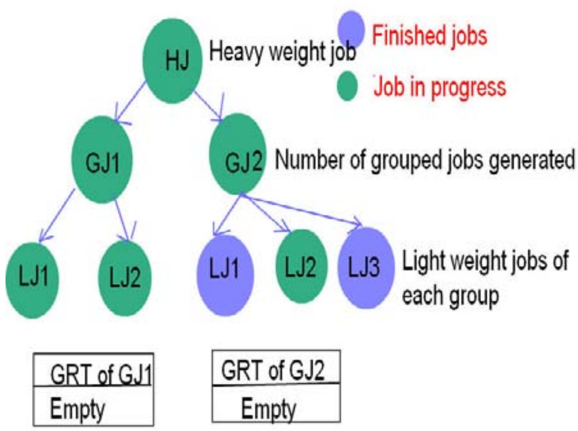

Figure 2 : Before the crash of GJ2's Processor

As shown above when the Parent processor is crashed Orphan jobs store the output of finished job in Group result table (GRT). If the processor of Light weight job that is under computation is crashed it can be recomputed as the job is a Light weight job and it takes less time for executing it.

Replicas of the table are maintained at each of the processor of Light weight jobs in a group. Update propagation is Asynchronous, The replica's need not be strongly consistent because all the jobs are light weight jobs , So if the finished job's entry is not found in a table it can be computed again in a short period.

In this technique very less amount of redundant computation is there after a crash and adds very little overhead. This Technique is suitable where the jobs are partitioned and a grouped job is sent for execution. In this way redundant computation is minimized that is present in other schemes like check pointing and job replication.

V. Simulation Environment and Results

The Algorithms for comparison (Check pointing (CP),Fixed number of job replicas (4 replicas) FJR (4),Adopted job replication AJR, and fault tolerant Scheduling of Partitioned and grouped jobs FTPG) are implemented on a machine based on Pentium 1.6GHz with 120GB HDD and RAM of 1GB on Microsoft Windows XP. This experiment is carried out on a simulated grid environment provided by Gridsim.

The Simulation environment consists of 6 resources. These 6 resources have 25 PE's in total having different processing capabilities in terms of Millions of Instructions per Second (MIPS).Further it is assumed that there are 8 users with 12 to 30 jobs.

FTPG is compared with CP, JR (4) and AJR and the results are recorded on graphs.

The parameters used for performance comparison are explained below.

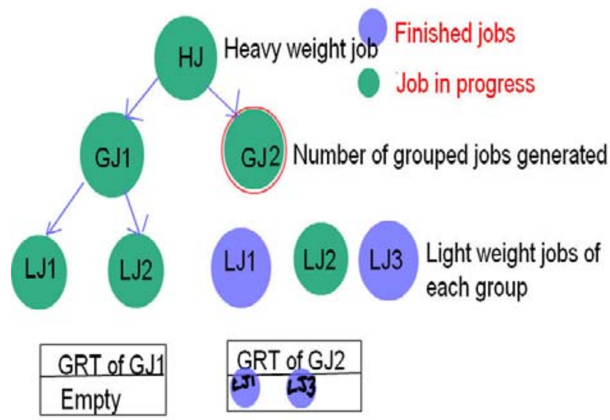

Figure 3 : After the crash of GJ2's Processor

a) Redundant Computations

Calculations that are carried out by more than one processor.

b) Processing time of gridlet

The amount of time taken by the processor to finish execution of gridlet.

c) Fault tolerant Service

Fault-tolerant service describes a technique that is used in case of a processor failure, a backup component or procedure can immediately take its place with no loss of data.

The following are the graphs drawn for comparison.

Figure4 shows the number of gridlets completed within the deadlines when 20% faults are injected. We can see that a good percentage of gridlets are completed by using FTPG when compared to AJR, FJR (4) and CP. As the deadline is increased number of jobs completed is also increased. Where as it is not true in case of CP and FJR (4). When the Fixed number of replicas is used as the number of replicas increases the number of jobs executed will be less because of the less availability of resources. FTPG reduces resource wastage and increases user benefit.

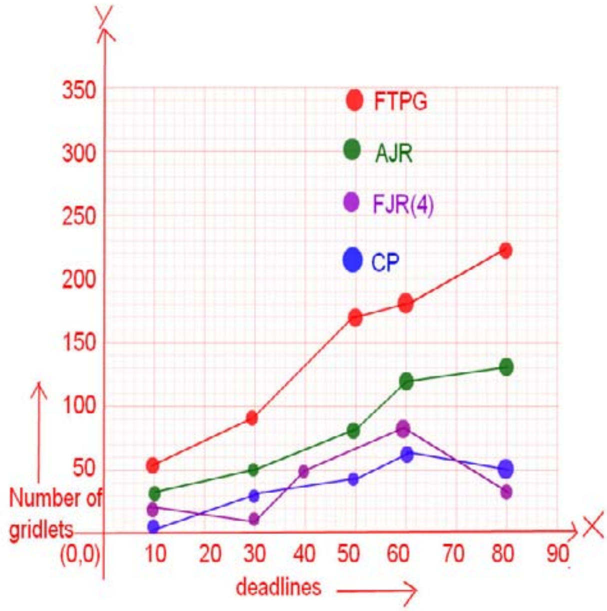

Figure 4 : Graph between the number of gridlets completed within deadlines when 20% faults are injected

The number of gridlets and their execution time is plotted in the graph as shown in Figure 5. These values are measured when 30% of the processors/resources are failed. It can be observed that as the number of gridlets is increased there is a very little increase in the execution time by using FTPG whereas in the other techniques AJR, FJR (4) and CP as the gridlets are increased their execution time increases drastically.

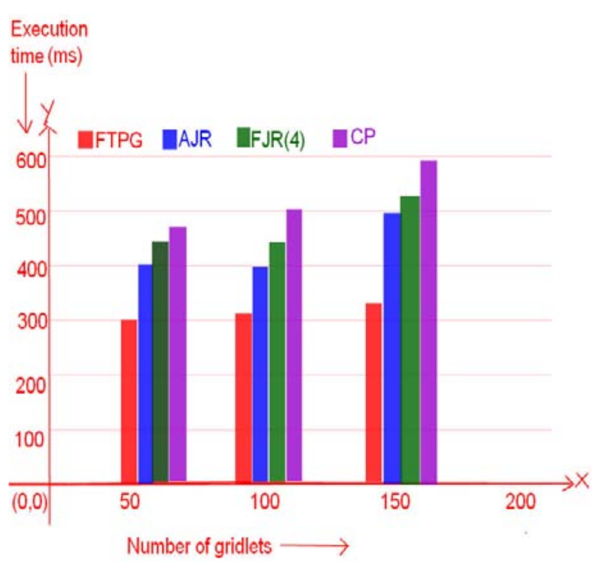

Figure 5 : Graph between number of gridlets and the time taken for execution when 30% faults are injected

The number of redundant computations when 30% of the resources failed is measured using CP, AJR, FJR (4) and FTPG and recorded on a pie chart. The results are recorded in figure 6. Figure 6 demonstrates that by using FTPG number of redundant computations were very less in percentage. This improves resource owner benefit by utilizing the resources properly. Therefore, it is good to use FTPG for fault tolerant Scheduling.

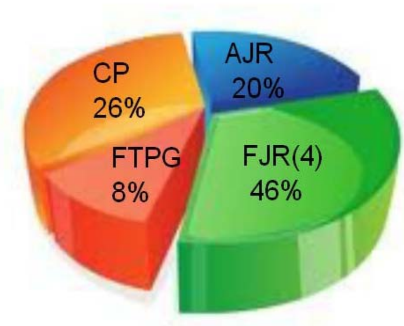

Figure 6 : Redundant computations because of 30% of the resources are failed

VI. Conclusions and Future Work

The FTPG algorithm provides QoS to the user at a good level of acceptance. It uses very less storage for Group Result Table and redundant computations are greatly reduced. The Overhead in this technique is very less.

This technique improves user benefit by providing Quality of Service and improves resource owner benefit by minimizing the wastage of resources. This technique can be extended to include network failure, data and service resource failures.

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1. Choosing the topic: In most cases, the topic is searched by the interest of author but it can be also suggested by the guides. You can have several topics and then you can judge that in which topic or subject you are finding yourself most comfortable. This can be done by asking several questions to yourself, like Will I be able to carry our search in this area? Will I find all necessary recourses to accomplish the search? Will I be able to find all information in this field area? If the answer of these types of questions will be "Yes" then you can choose that topic. In most of the cases, you may have to conduct the surveys and have to visit several places because this field is related to Computer Science and Information Technology. Also, you may have to do a lot of work to find all rise and falls regarding the various data of that subject. Sometimes, detailed information plays a vital role, instead of short information.

2. Evaluators are human: First thing to remember that evaluators are also human being. They are not only meant for rejecting a paper. They are here to evaluate your paper. So, present your Best.

3. Think Like Evaluators: If you are in a confusion or getting demotivated that your paper will be accepted by evaluators or not, then think and try to evaluate your paper like an Evaluator. Try to understand that what an evaluator wants in your research paper and automatically you will have your answer.

4. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

5. Ask your Guides: If you are having any difficulty in your research, then do not hesitate to share your difficulty to your guide (if you have any). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work then ask the supervisor to help you with the alternative. He might also provide you the list of essential readings.

6. Use of computer is recommended: As you are doing research in the field of Computer Science, then this point is quite obvious.

7. Use right software: Always use good quality software packages. If you are not capable to judge good software then you can lose quality of your paper unknowingly. There are various software programs available to help you, which you can get through Internet.

8. Use the Internet for help: An excellent start for your paper can be by using the Google. It is an excellent search engine, where you can have your doubts resolved. You may also read some answers for the frequent question how to write my research paper or find model research paper. From the internet library you can download books. If you have all required books make important reading selecting and analyzing the specified information. Then put together research paper sketch out.

9. Use and get big pictures: Always use encyclopedias, Wikipedia to get pictures so that you can go into the depth.

10. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right! It is a good habit, which helps to not to lose your continuity. You should always use bookmarks while searching on Internet also, which will make your search easier.

11. Revise what you wrote: When you write anything, always read it, summarize it and then finalize it.

12. Make all efforts: Make all efforts to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in introduction, that what is the need of a particular research paper. Polish your work by good skill of writing and always give an evaluator, what he wants.

13. Have backups: When you are going to do any important thing like making research paper, you should always have backup copies of it either in your computer or in paper. This will help you to not to lose any of your important.

14. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several and unnecessary diagrams will degrade the quality of your paper by creating "hotchpotch." So always, try to make and include those diagrams, which are made by your own to improve readability and understandability of your paper.

15. Use of direct quotes: When you do research relevant to literature, history or current affairs then use of quotes become essential but if study is relevant to science then use of quotes is not preferable.

16. Use proper verb tense: Use proper verb tenses in your paper. Use past tense, to present those events that happened. Use present tense to indicate events that are going on. Use future tense to indicate future happening events. Use of improper and wrong tenses will confuse the evaluator. Avoid the sentences that are incomplete.

17. Never use online paper: If you are getting any paper on Internet, then never use it as your research paper because it might be possible that evaluator has already seen it or maybe it is outdated version.

18. Pick a good study spot: To do your research studies always try to pick a spot, which is quiet. Every spot is not for studies. Spot that suits you choose it and proceed further.

19. Know what you know: Always try to know, what you know by making objectives. Else, you will be confused and cannot achieve your target.

20. Use good quality grammar: Always use a good quality grammar and use words that will throw positive impact on evaluator. Use of good quality grammar does not mean to use tough words, that for each word the evaluator has to go through dictionary. Do not start sentence with a conjunction. Do not fragment sentences. Eliminate one-word sentences. Ignore passive voice. Do not ever use a big word when a diminutive one would suffice. Verbs have to be in agreement with their subjects. Prepositions are not expressions to finish sentences with. It is incorrect to ever divide an infinitive. Avoid clichés like the disease. Also, always shun irritating alliteration. Use language that is simple and straight forward. put together a neat summary.

21. Arrangement of information: Each section of the main body should start with an opening sentence and there should be a changeover at the end of the section. Give only valid and powerful arguments to your topic. You may also maintain your arguments with records.

22. Never start in last minute: Always start at right time and give enough time to research work. Leaving everything to the last minute will degrade your paper and spoil your work.

23. Multitasking in research is not good: Doing several things at the same time proves bad habit in case of research activity. Research is an area, where everything has a particular time slot. Divide your research work in parts and do particular part in particular time slot.

24. Never copy others' work: Never copy others' work and give it your name because if evaluator has seen it anywhere you will be in trouble.

25. Take proper rest and food: No matter how many hours you spend for your research activity, if you are not taking care of your health then all your efforts will be in vain. For a quality research, study is must, and this can be done by taking proper rest and food.

26. Go for seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

27. Refresh your mind after intervals: Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

28. Make colleagues: Always try to make colleagues. No matter how sharper or intelligent you are, if you make colleagues you can have several ideas, which will be helpful for your research.

29. Think technically: Always think technically. If anything happens, then search its reasons, its benefits, and demerits.

30. Think and then print: When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

31. Adding unnecessary information: Do not add unnecessary information, like, I have used MS Excel to draw graph. Do not add irrelevant and inappropriate material. These all will create superfluous. Foreign terminology and phrases are not apropos. One should NEVER take a broad view. Analogy in script is like feathers on a snake. Not at all use a large word when a very small one would be sufficient. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Amplification is a billion times of inferior quality than sarcasm.

32. Never oversimplify everything: To add material in your research paper, never go for oversimplification. This will definitely irritate the evaluator. Be more or less specific. Also too, by no means, ever use rhythmic redundancies. Contractions aren't essential and shouldn't be there used. Comparisons are as terrible as clichés. Give up ampersands and abbreviations, and so on. Remove commas, that are, not necessary. Parenthetical words however should be together with this in commas. Understatement is all the time the complete best way to put onward earth-shaking thoughts. Give a detailed literary review.

33. Report concluded results: Use concluded results. From raw data, filter the results and then conclude your studies based on measurements and observations taken. Significant figures and appropriate number of decimal places should be used. Parenthetical remarks are prohibitive. Proofread carefully at final stage. In the end give outline to your arguments. Spot out perspectives of further study of this subject. Justify your conclusion by at the bottom of them with sufficient justifications and examples.

34. After conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print to the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects in your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form, which is presented in the guidelines using the template.
- Please note the criterion for grading the final paper by peer-reviewers.

Final Points:

A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

The introduction will be compiled from reference matter and will reflect the design processes or outline of basis that direct you to make study. As you will carry out the process of study, the method and process section will be constructed as like that. The result segment will show related statistics in nearly sequential order and will direct the reviewers next to the similar intellectual paths throughout the data that you took to carry out your study. The discussion section will provide understanding of the data and projections as to the implication of the results. The use of good quality references all through the paper will give the effort trustworthiness by representing an alertness of prior workings.

Writing a research paper is not an easy job no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record keeping are the only means to make straightforward the progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear

· Adhere to recommended page limits

Mistakes to evade

- Insertion a title at the foot of a page with the subsequent text on the next page
- Separating a table/chart or figure - impound each figure/table to a single page
- Submitting a manuscript with pages out of sequence

In every sections of your document

· Use standard writing style including articles ("a", "the," etc.)

· Keep on paying attention on the research topic of the paper

· Use paragraphs to split each significant point (excluding for the abstract)

· Align the primary line of each section

· Present your points in sound order

· Use present tense to report well accepted

· Use past tense to describe specific results

· Shun familiar wording, don't address the reviewer directly, and don't use slang, slang language, or superlatives

· Shun use of extra pictures - include only those figures essential to presenting results

Title Page:

Choose a revealing title. It should be short. It should not have non-standard acronyms or abbreviations. It should not exceed two printed lines. It should include the name(s) and address (es) of all authors.

Abstract:

The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript--must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing references at this point.

An abstract is a brief distinct paragraph summary of finished work or work in development. In a minute or less a reviewer can be taught the foundation behind the study, common approach to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Yet, use comprehensive sentences and do not let go readability for briefness. You can maintain it succinct by phrasing sentences so that they provide more than lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study, with the subsequent elements in any summary. Try to maintain the initial two items to no more than one ruling each.

- Reason of the study - theory, overall issue, purpose
- Fundamental goal
- To the point depiction of the research
- Consequences, including definite statistics - if the consequences are quantitative in nature, account quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

Approach:

- Single section, and succinct
- As a outline of job done, it is always written in past tense
- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
- Exact spelling, clearness of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else

Introduction:

The **Introduction** should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- Explain the value (significance) of the study
- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from a abstract point of vision as well as point out sensible reasons for using it.
- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

Approach:

- Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done.
- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.

- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
- Shape the theory/purpose specifically - do not take a broad view.
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This part is supposed to be the easiest to carve if you have good skills. A sound written Procedures segment allows a capable scientist to replacement your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt for the least amount of information that would permit another capable scientist to spare your outcome but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section. When a technique is used that has been well described in another object, mention the specific item describing a way but draw the basic principle while stating the situation. The purpose is to text all particular resources and broad procedures, so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step by step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

- Explain materials individually only if the study is so complex that it saves liberty this way.
- Embrace particular materials, and any tools or provisions that are not frequently found in laboratories.
- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

Methods:

- Report the method (not particulars of each process that engaged the same methodology)
- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

What to keep away from

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.
- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
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Discussion:

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a argument should be. Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly described. Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved with prospect, and let it drop at that.

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
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- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

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Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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