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ISSUES AFFECTING QUALITY OF SERVICE IN GRID COMPUTING, CUSTOMER SATISFACTION PERSPECTIVE

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Abstract

Grid computing combines the services of different computers running on often different networks to accomplish a task for an enterprise. Quality of service in grid has been one of the core areas. Achieving quality of service in grid while bringing together customer needs and issues in grid computing has not been brought together to help improve on it. This paper proposes the bringing together of customer satisfaction parameters in solving issues related to quality of services in grid computing. This has been done through studying of related works in quality of services and customer satisfaction areas while looking at issues in grid that affect quality of service either directly or indirectly. The paper has based much on already documented work from various researchers and academia. It is expected that the proposed incorporation of customer satisfaction parameters with issues in grid will enhance quality of service and improve on market share of particular enterprise, service or product.

Abbrv: QoS: Quality of Service

1. INTRODUCTION

Customer satisfaction is the greatest parameter that enterprises need not to compromise [1]. In this highly competitive world where a simple element of dissatisfaction can lead to customer low turnout and a consequent loss of business, firms should be more careful with their services in order to maintain customer patronage and even attract new customers [2]. One of the major parameters of customer satisfaction is QoS [3]. Enterprises that span their business products and services across the globe using computer systems require highest levels of QoS to their clients. One notable computer system that is being used by companies is grid computing. Just like in any other design, grid computing has challenges that affect QoS in one way or another [4].

Grid computing gives enterprises a capacity to use computer resources that are anchored on different domains and likely from variant geographical location irrespective of their boundaries [5]. This capability increases access to computer system resources such as data, reaching out to old and new clients, and provide for system expandability. Despite the promising capabilities of grid computing, there are challenges that affect its QoS which in turn may negatively affect customer satisfaction [6].

Understanding the challenges that impede grid computing can assist in designing a robust service that in turn will attract customer satisfaction and ensure business sustainability [7]. It should be taken on board that at the time of writing this paper, covid-19 is also on the rise and hitting hard on the progress of many businesses as many customers are not easily accessing the services physically leaving online services as an option [8]. These online services run on grid computing for considerably large companies that span their services across geographical divide.

In this paper, a comprehensive analysis is drawn on existing challenges faced by grid computing with a view of developing countermeasures to the challenges that work to maintain customer satisfaction and even attract new customers.

The target audience of this paper ranges from IT based to non-IT based enterprises [9]. Even those businesses aspiring to engage the functionalities of grid computing can be part of the target audiences. Some may not have made a clear decision in as far as the use of grid computing is concerned, them too may form part of the target audience with an aim of assisting them to make a clear and informed decision. It is in the plans of every business enterprise to expand both in operation and in profit [10] and as such every large and ambitious business accord accessibility of its customers to services of the grid computing.

The first segment discusses the overview of this paper, the second segment discusses the description of grid computing to give a proper understanding of the concept. The third segment outlines with description the issues or challenges that impede smooth functioning of grid computing with illustrative examples. The fourth segment discusses the customer expectation which will work as a basis for designing countermeasures to issues of grid computing. The fifth segment will discuss the means of overcoming issues or challenges in grid computing with a view of customer satisfaction. Then the sixth segment will present the conclusion of the paper.

2. RELATED WORKS

Some scholars and researchers have done some works in the same area and is given in the table below with their solution; xpln 3-4 lines

#	AUTHOR(S)	PROBLEM FOCUS	SUGGESTED SOLUTION
1	Jang-uk In et al	Novel Framework for policy based scheduling in resource allocation of grid computing	Discussed QoS constraints
2	Daniel A Manasce et al	QoS in grid computing	Formalization of resource allocation
3	D. Colling et al	Support for QoS in grid computing	Framework for supporting QoS guarantees via both reservation and discovery of best-effort services based on match making of application requirements.
4	Xian-He Sun et al	Support QoS to meet user's demand	Classification and systematic understating of QoS and its framework
5	Lars-Olof Burchard	QoS architecture for future grid computing applications	Guarantee in QoS in allocations of resources of different kinds

6	R.P. Prado et al	Providing QoS in grid computing through multi-objective swarm-based knowledge acquisition in fuzzy schedulers	QoS provision in the grid scheduling level with fuzzy rule-based schedulers through multi-objective knowledge acquisition considering multiple optimization criteria
7	Sirisha Potluri and Katta Subba Rao	QoS based task scheduling algorithms and the parameters used for scheduling	Improve the efficiency of the QoS based task scheduling algorithms
8	Paul Manuel	Service level agreement is prepared combining QoS requirements of user and capabilities of cloud resource provider	Model that improves calculations on availability, reliability, turnaround efficiency and data integrity
9	Abdelzahir Abdelmaboud et al	Study on QoS approaches in cloud computing	Identifies where more emphasis is placed in current and future research directions
10	Ehab Nabiel Alkhanak et al	Cost optimization approaches in scientific workflow scheduling in cloud and grid computing	Analysis of the problem of cost optimization
11	N.L.P Suciptawati et al	Study on customer satisfaction toward Village Credit Institution	Improved customer satisfaction determinants
12	K. Devika Rani Dhiviya and C. Sunitha	Exploring the benefits of grid computing architecture	Explanation of benefits of grid computing architecture
13	Daniel A. Menasce	Finding relevant issues that must be considered in designing grid applications that deliver appropriate QoS	Defined metrics, relationship between resource allocation and service level agreements and QoS related mechanisms
14	Shruti N. Pardeshi et al	Benefits of grid computing architecture	Discussion on benefits of grid computing architecture
15	Manjeet Singh	Overview of Grid Computing	Clarification on grid computing resources and operation
16	Gabriele Pierantoni et al	The efficient and secure utilisation of cloud resources to run applications is not trivial due to, among other things, how to specify and manage QoS properties governing cloud applications	Cloud technology agnostic approach to application descriptions based on existing standards and describes how they can be processed to manage applications in the cloud computing
17	Paul Manuel	Challenges in role of trust in commercial cloud environments	Novel trust model based on past credentials and present capabilities of a cloud resource provider
18	Seema Kumari	Surveying job scheduling in grid computing to integrate QoS	Job scheduling algorithm in grid computing benefiting researchers to carry out future work and develop a better algorithm
19	Seungmin Rho et al	Whether distributed system based on resource content is sufficient to specific scheduling requests for global QoS considering workload balance across the grid	A peered network that provides an efficient message routing mechanism and proficiency in to satisfying QoS in distributed environment

		Whether the distributed system constructs a hierarchical peer-to-peer network	
20	Andre D'Amato and Mario Dantas	Challenges of grid computing to the allocation of resources	Provision of management decisions on quality of context in processing context information

3. OVERVIEW OF GRID COMPUTING

A network of computers performing a task together which a single computer would hardly do is referred to as Grid Computing. On such a network, computers carry out their functions under the same protocol in the same way as one supercomputer does [11]. In other words, they form what is known as a virtual supercomputer. Analysis of huge datasets [12] and simulations that demand high computing power are some of the major tasks that are done by the grid. Main resources that shared on the grid are processing power and storage [13]. These tasks are performed in such applications as distributed supercomputing which enables grid computing to spread its functionality across different geographical areas [8], high-throughput supercomputing where a large amount of processing power for an extended time is required, on-demand supercomputing [14] which handles fluctuating demands where three attributes are characterized and include pay-per-use, self-service, and scalability, data-insensitive supercomputing where huge volume of data is put into divisions which are then worked on at the same time just like in parallel computing, and collaborative supercomputing where one organization collaborates with another to make use of its supercomputing abilities [15].

The grid computing architecture provides for smooth running of the services by integrating resources with their hardware, operating systems, local resources management and security infrastructure [16], [17]. The architecture for Grid Computing has five layers of Fabric, Connectivity, Resource, Collective and Application which assist in the running of the services of the Grid [18].

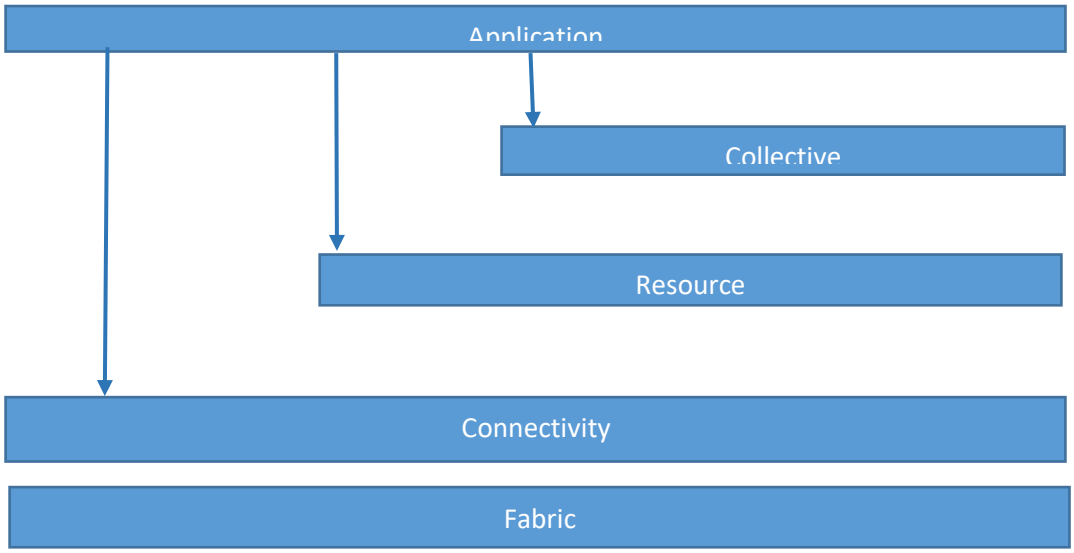

Fig 2.0 Grid Computing Architecture [18]

3.1. OUTLINE OF ISSUES THAT AFFECT QOS [19]

The Quality of Service that is required to sustain the customer satisfaction has to be free of challenges. These challenges or issues must continuously be reviewed to ensure that all emerging and outstanding [20] issues are addressed. Some issues or challenges are directly related to quality of service [21] while others are not, however, all of them place a very notable impact on quality of service. The review process of issues must provide a mechanism of getting customer feedback which will later be used to improve on a related issue [22]. The main issues in grid computing are as follows;

i. **Lack of defined Standards**
This remains a big problem especially in security such that major forums like Global Grid Forum are trying to bring something like Grid Security Infrastructure, a specification that is based on upcoming web services security standards. The Open Grid Infrastructure and Open grid Service Architecture [23] are aimed at enabling a multivendor grid interoperability [24] which is still not implemented and lack of standards remains an issue.

ii. **Lack of specific software for Grid**
The grid has limited specific software availability and this usually creates copyright and licensing issues for source code. Some software models are poorly adapted to run in the grid computing and swiftly scale up or down depending on need by customers. For example, assuming software license based on CPU usage [25], costs can rapidly go up as more processors are required into service.

iii. **Same Resources are applied in different type of Services.**
Heterogeneous resources are used in the grid [26]. These resources are geographically heterogeneous and involve very large volumes of data which makes it difficult to handle such amount data. In different geographical locations, there are usually diverse standards and regulations on data now in a situation where the same resource is accessing data from various locations, this may not be readily possible.

iv. **Hard Application Development**
Most grid software is not open source and therefore not available for developers to access, modify and develop new grid applications. As already stated that the available software has no clear and specific standards. This however does not provide a way to incorporate ever-growing changes and needs in customer satisfaction.

v. **Narrow Area of Applications**
Since grid computing is capable of solving very huge data intensive problems, its application domain is limited. Cluster computing is a solution to medium and small size problem solving. This is sometimes attributed to diverse regulations on data management in contiguous domain of operation.

vi. **Difficult Administration and Management**
Management and administration of huge and regionally distributed resources in diverse environment remains part of the major challenges. This is also attributed to varying regulations and laws on relating to electronic data in different geographical areas.

vii. **Problem in resource sharing between different services.**
Sharable resources may not be used where some type of service is given at once by the majority of the grid. There are many cross-cutting technical issues related to grid computing in authentication, allocation of resources, resource

discovery [27] that impinge on resource sharing and therefore affect quality of service in relation to customer satisfaction.

3.2. MEETING CUSTOMER EXPECTATION

Every system has those who run it and those who benefit from its services. Those who run it could be its owners or work on employment on behalf of the owners. While running the system, some may require services of the system to become their input. These and those who completely benefit from the system become the system's customers or clients. Customers usually pay for goods and services of any system which in turn help the system run well as its resources are in constant supply.

Knowing and understanding customer expectations and align them to a particular system or business is a major step in maintaining good customer relations.

Here are some of the few and basic customer expectations;

3.2.1. Personalization

This requires that a customer customize their needs on the system. This includes meeting the exact needs of particular customer. Some services even put names of customers on the services they are require to make sure they appeal to their ego. For example some Auto teller machines if they are inserted a user card.

3.2.2. Quality service

Services and products must meet their description and compete well with other corresponding services and products on the market.

Assuming that a customer rates some expected value on service and product attribute as V_E, and then the system gives the customer service and product of some value V_A, such that the resulting difference;

$$\delta = |(V_A - V_E)/V_E| .100\%$$

Expected quality services would be $\delta = 0\%$, but if the value of δ is towards 100%, then expect to lose that customer expectation

3.2.3. Quick resolution of complaints

When providing feedback in relation to how the system is running, a customer may give a complaint to be resolved. While such complaint may only look like meeting the customer expectation, the same is good for system improvements. If such resolutions are done in shortest time possible they become an incentive to maintain good customer relations.

3.2.4. Low effort experiences

Time and energy can be a measure of how a customer enjoys a system or business. If either of the two is seen wasted while using the system, no customer would like to come again to such king of service. In today's competitive market share, service providers are putting their efforts together to ensure that services are handy.

3.2.5. Updated knowledge

Quick replies by system runners to customers would be another incentive to keep them around. Each time a customer looks for information about a product and service, real-time and correct replies are the best. Use of clear and simple language increases customer appeal in this.

3.2.6. User-friendly platforms

In today's world there are many communication platforms. Systems and businesses need to make use of every platform to reach as many customers as possible. Fingertip platforms such as WhatsApp, Facebook, Instagram, Linkedin, SMS etc, are easily accessible and loved by many customers. Making use of these may likely appeal to customers and sustain their satisfaction.

3.2.7. Relevant products and services

This could be the most demanded expectation of a customer. This is where a customer expects to get what they required from your system or business. Expectedly, this starts right from distant advertisements. Electronic and ordinary billboards, radio and placard adverts then to product packaging. A customer always expects no difference between what has been advertised and the real product and service. If the difference is numerically zero, then the quality of service is the highest and so customer satisfaction.

Figure 5 below is the basic understanding to overcoming issues in the grid in respect to customer expectations.

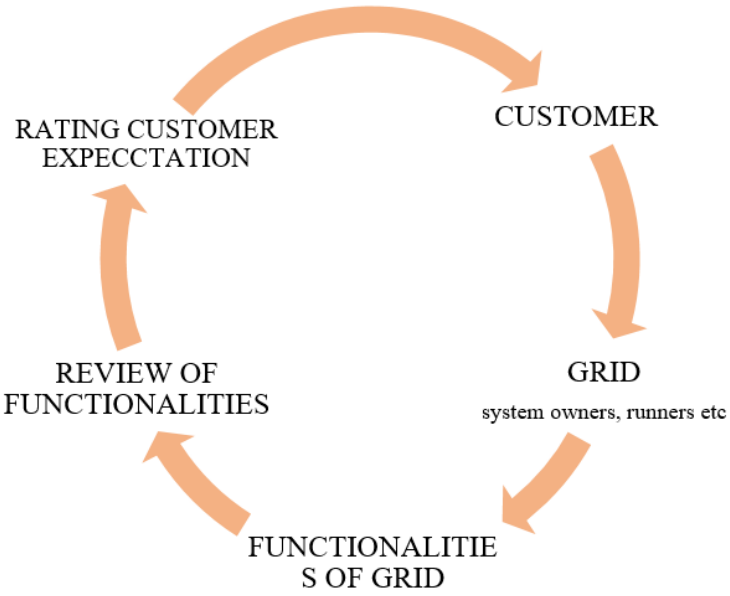

Fig 5: Customer satisfaction cycle in Grid

4. CONCLUSION AND FUTURE SCOPE

Grid Computing simplifies work processing which would otherwise be carried out for a very long time [28]. This technology has underlying issues which in one way or another affect QoS and has potential of dissatisfying a customer. Considering that customer satisfaction is of great importance in running businesses [29], focussing on the issues in grid computing and reviewing customer satisfaction parameters would help please the customer and in turn help the business run.

The difference between the customer expectation and what the grid provides will determine customer satisfaction. This difference must always be close to or equal to zero.

Overcoming the challenges in grid computing in relation to customer expectation [30] requires trying to bring together the challenges and the customer expectations. This process should be done periodically by system runners. Issues highlighted in section 3 above may change from time to time and this may require timely revision.

Applying the error formula to evaluate customer satisfaction [31], then the value of δ must be kept at 0% if possible otherwise lower values would help.

It would be of great importance if in all designs of grid computing, issues of the grid be brought together with customer satisfaction in order to maintain highest quality of service.

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