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Highlights

Virtual Machine Environment

Integrated Website Implementation

Discovering Thoughts, Inventing Future

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A Survey on Encryption and Improved Virtualization Security Techniques for Cloud Infrastructure

By Koushik Akkinapalli & R. Rajeswara Rao
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Abstract- Cloud Computing is one of the latest developments in the IT industry which offers on-demand services without requiring to create an IT infrastructure. It provides scalability, high performance and relatively low cost feasible solution for organizations. Despite of all its advantages, security is still a critical challenge in cloud computing paradigm. This paper presents a survey on some possible techniques used for encrypting user data and also providing techniques used in improving virtualization security for the cloud infrastructure.

Keywords: *cloud computing, scalability, security, virtualization.*

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A Survey on Encryption and Improved Virtualization Security Techniques for Cloud Infrastructure

Koushik Akkinapalli [α] & R. Rajeswara Rao[σ]

Abstract- **Cloud Computing is one of the latest developments in the IT industry which offers on-demand services without requiring to create an IT infrastructure. It provides scalability, high performance and relatively low cost feasible solution for organizations. Despite of all its advantages, security is still a critical challenge in cloud computing paradigm. This paper presents a survey on some possible techniques used for encrypting user data and also providing techniques used in improving virtualization security for the cloud infrastructure.**

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I. Introduction

Cloud Computing is an upcoming model which provides on-demand access to the resources provided on the network for different users accessing the service from the cloud in an efficient manner[1].The main advantages of cloud computing are providing increased scalability, providing cost effective services to users, customization of applications in an efficient manner, providing better storage space for users etc[2,12].

The different service models provided by the cloud are Software as a Service (Saas), Platform as a service (Paas), Infrastructure as a service (Iaas). In Saas model CSP(cloud service provider) provides the capability of controlling the applications running on the cloud. The benefits of this model are providing better administration, compatibility, collaboration among different users. In Paas model, CSP provides an infrastructure for deploying the applications which have been developed using programming languages that are specified. The benefits of this model are costs can be reduced and up gradation of different services can be done in an optimized manner. In Iaas model, CSP provides the necessary resources for deploying the consumers systems and applications. The benefits of this model are different administrative tasks can be automated in an optimized manner and better services based on policies [1,3,13].

There are several deployment models which are emerged as cloud came into existence. A cloud deployment model specifies the location for physical servers that have been deployed. The deployment models are private cloud, community cloud, Public cloud and hybrid cloud [1]. In private cloud, only one organization makes use of services in the cloud. In community cloud, organizations with similar requirements shared cloud infrastructure. In public cloud, computing resources are accessible to all the users utilizing cloud services owned by the organization. In hybrid cloud, different deployment models are combined with various cloud infrastructures. [3].

The different services provided by the cloud are shown in fig below.

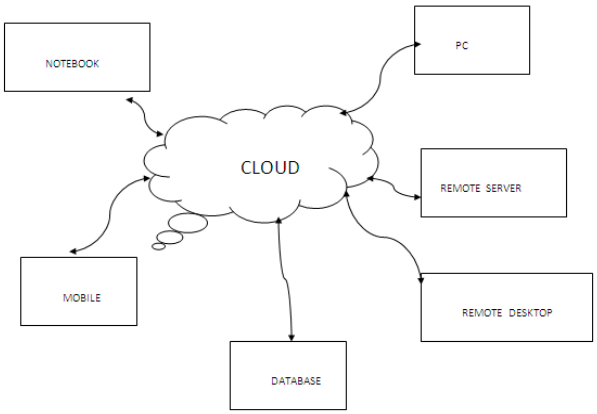

Figure 1 : Cloud Services

II. Encryption

It is the process of providing security to the user's data in such way that only authorized users can only access it. The several possible encryption techniques used for securing user's data in the cloud are given as follows[4,5].

- Attribute Based Encryption(ABE)
- Homomorphic Encryption.
- Cloud Computing Confidentiality Framework

a) Attribute Based Encryption

It is a cryptographic technique where encryption and decryption of data in the cloud is based on user's attributes and several access policies have been defined based on their attributes. The access policies can be classified into two types[6,7,8]

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- Key –policy ABE
- Ciphertext-policy ABE

The features of an ABE are listed below

- providing confidentiality for user's data.
- providing fine-grained access control for the user's data.
- Scalability
- providing user accountability
- preventing against collusion attacks[6].

i. *Process of ABE*

The process of ABE involves the following steps. The steps are summarized below

- The set of attributes are defined for different users hosting their data in the cloud.
- The key authority generates public key and master secret key for given set of attributes in order to encrypt the user's data
- The user is eligible to decrypt the encrypted data if number of attributes in user's data private key matches with set of attributes in encrypted data by specifying threshold value[6,9,10,11].

ii. *Key Policy ABE*

In this scheme access policy is built into user's private key and encrypted data is described with attributes of different users.

iii. *Advantage*

It provides more flexibility for controlling different users.

iv. *Disadvantage*

In this scheme, key authority can't decide the particular user who can decrypt the data [6,8].

v. *Ciphertext Policy ABE*

It overcomes the problem in Key policy ABE by building access policy directly into the encrypted data so that key authority can decide the particular user that can decrypt the data[6,8].

b) Homomorphic Encryption

It is promising research area and also cryptographic technique where complex mathematical computations are performed on encrypted data without decrypting them using user's private key. The essential characteristics of Homomorphic encryption are given below[14,16,17].

- It is scalable cryptographic technique operating on any type of data hosted in the cloud.
- This scheme applies only to cloud providers.
- No authentication mechanism is needed.

i. *Homomorphism*

Let (A,+) and (B,*) be the two groups and there exists a relation f:A->B then f is group homomorphism in A and B if $\forall x,y \epsilon A$ such that f(x+y)=f(x)*f(y)[15].

ii. *Applications*

- Analyzing Biometric information
- Medical Analysis
- Marketing Analysis
- Survey Analysis

iii. *Process of Homomorphic Encryption*

The different steps in performing Homomorphic encryption is summarized below where + and * denotes two algebraic operations.

- Let $r \epsilon M$ be prime number chosen from M which is large and also taken as a secret key.
- Let p and q be two arbitrary integers with $(p,q) < r \epsilon M$.
- Encryption of p and q can be performed which is shown below.

$p' = p + (t1 * r)$ where $t1 \epsilon M$ is random large integer

$q' = q + (t2 * r)$ where $t2 \epsilon M$ is random large integer

- $p'+q' = p+(t1*r)+q+(t2*r)$ and when performing decryption on mod r gives $p+q$(additive homomorphism)
- $p'*q' = p+(t1*r)*q+(t2*r)$ and when performing decryption on mod r gives $p*q$(multiplicative homomorphism)

iv. *Example Explanation of Homomorphic Encryption*

Given r=7,p=2,q=3,t1=4 and t2=5

$p' = p+(t1*r) = 2+(4*7) = 30$

$q' = q+(t2*r) = 3+(5*7) = 38$

$(p'+q') \bmod r = (30+38) \bmod 7 = 68 \bmod 7 = 5 (p+q)$

$(p'*q') \bmod r = (30*38) \bmod 7 = 1140 \bmod 7 = 6 (p*q)$[16].

v. *Advantages*

- provides confidentiality, integrity and data protection.
- reduces the burden to cloud providers each time in decrypting the data in cloud.

c) Cloud Computing Confidentiality Framework

The steps for the framework are summarized below

- Identify business goals and objectives.
- Perform impact analysis i.e., identification of system and processes in organization,
- Data and system classification specifies what data needs to be secured and how valuable data and information systems are.
- Select security control selection of system along with data protection.
- Define the limitations in system taking into account trust, policy, system task and data protection dimensions
- Specify cloud security solutions (system, behavioral and hybrid) shown in fig below and make decision on cloud architecture [18].

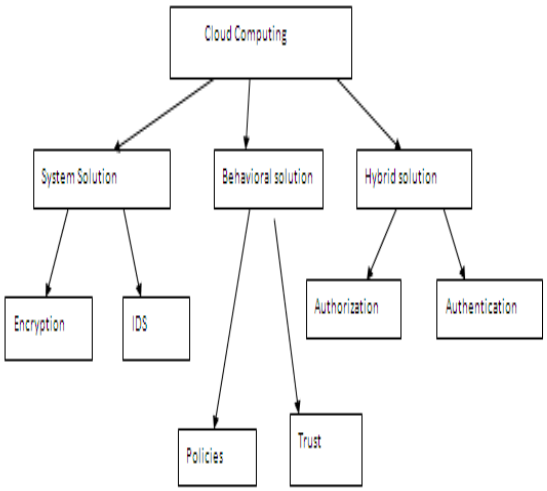

Figure 2 : Cloud Computing Confidentiality Framework

i. *Advantages*

- It provides authentication, confidentiality, integrity and data protection.
- It explains effective security controls for protecting data in private cloud environment

III. Secure Virtualization using Split Visor Architecture

Most Intel processors operate in two modes

- Virtual machine extension (VMX) root mode.
- VMX non root mode.

Split visor runs in VMX root mode where as Guest Visor and VM's runs in the VMX non root mode shown in the fig below [20].

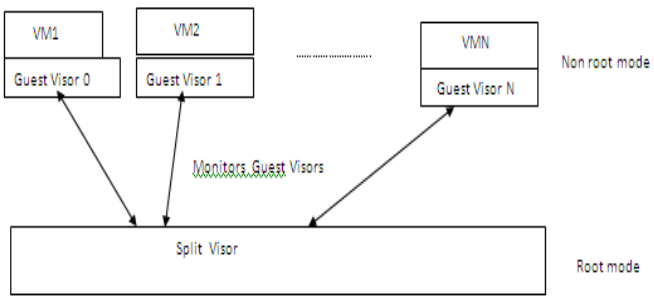

Figure 3 : Split Visor

Guest Visor VMC's (data structure maintaining the control information of VMX transition)is controlled by the split visor and VM's VMC's is controlled by Guest Visor.

i. *Advantage*

- It is more secured architecture which is responsible for isolation between different users VM's.

IV. Secure Virtualization using Security and Reliability Monitors

There are two features introduced for increasing security performance in virtualization technology using security and reliability monitoring units [19]

a) VSEM
b) VREM.

There are two more units(hypervisor security monitor(HSEM) and hypervisor reliability monitor(HREM) available in hypervisor level). The proposed architecture is shown in fig below [19]

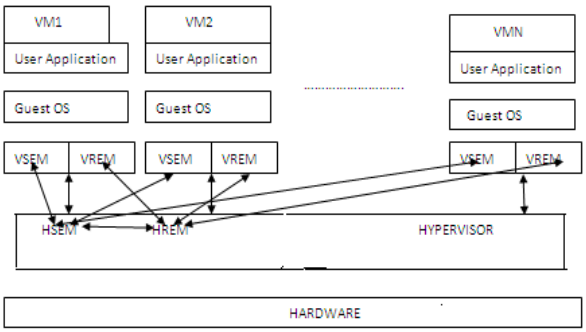

Figure 4 : VSEM And VREM

a) VM Security Monitor (VSEM)

It identifies attacks and malicious behavior of the virtual machine by helping HSEM. It is generally operated at two levels [19]

- In Level1, VSEM's monitor their own VM's. The proposed system identifies the VM as attacker if hypervisor recognizes the number of service requests more than specified threshold then VSEM notifies HSEM and switches to Level2[19]
- In Level 2, it monitors and captures the activity of each VM where hypervisor sets activity limits for types of activities until HSEM notifies that VM is not an attacker. HSEM gets the reliability status from VREM [19].

b) VM Reliability Monitor(VREM)

Reliability requirements such as workload have been monitored and load balancer is being notified (within the hypervisor) that sends the workload status to HREM and decides to give VM more resources or not. The proposed HREM detects the overflow attacks if any when VM requests more resources than specified value [19].

i. *Advantages*

- The proposed architecture safeguards each virtual machine against all the possible attacks.
- The proposed architecture provides efficient way for reducing the workload from hypervisor based virtualization.
- It also decentralizes the security related tasks between hypervisor and VM's [19].

V. Conclusion

Cloud computing is an emerging technology which provides on demand-resources to customers. It provides high performance, scalable nature and low cost feasible solution to all the customers. Security is still major concern in cloud computing and it has to be provided with an utmost priority to the customers. Encryption techniques have been illustrated for securing the data hosted in cloud. This paper also illustrated techniques in improving virtualization security for cloud environment.

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Big Data Management for MMO Games and Integrated Website Implementation

By Abdullah Alqwbani, Zhang Zuping & Fares Aqlan
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Abstract- With the popularity and success of massively multi-player Games (MMOGs), the development of MMOGS has got a quantum leap on game's contents and entertainment which attract huge number of players making MMOGs these years a big business which increased to billions of dollars revenue each year worldwide. But with this number of players and these game contents, the data volume produced from games has rapidly increased and used by simultaneously game players around the world. This data require high performance, fault tolerance and scalability. Considering all these demands the popular used relational database becomes a big challenge and cannot overcomes the challenges and cannot meet the requirements for MMOGS data storage.

This paper focus on using big data technology tools to completely meet the requirement of MMO games. My work can be divided into two parts: the first part we proposed Cassandra database for MMO games data storing and the integration of Hadoop with Cassandra nodes for high performance in operations process. The second part: we implement a new MMO website with new payment methods, new advertisement program by friend's invitations and other enhanced function.

By implementing this website and comparisons of results of our database management, we show the applicability of our approach as well as the relative performance benefits of designing new games or website using our architecture.

Keywords: *MMO games, big data, electronic websites, NoSQL, Cassandra.*

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I. Introduction

MMOG stands for Massive Multiplayer Online Game. MMOG is the kind of online game that allows thousand of players to play simultaneously, from all parts of the world. Players which play these kinds of games are able to stay in the game over longer time of period which is typically 6-12 months. During this time they are able to develop their own game style. Even if a player stops playing the game the servers will still be online with other players. Online games are a blooming market with many opportunities as well as challenges for game developers [1].

In the history of MMOGs of role playing type with poor graphics, and poor contents and easy data management module, this was not because of the non interest from the developers, but because of the bandwidth limits and the rear of technologies. But nowadays, when broadband connections are increasing by number around the world as well as powerful PCs available for reasonable prices, more computer graphics can be applied and more contents of game could be raised including database models which lead to the huge popularity of MMOGs around the world.

The popularity MMOGs has increased on various platforms in recent years but their development process has not kept pace. Some parts of the development process are still having the manual performance in the field of game content development process. The modern games have turns from simple applications to very sophisticated information systems. But however the game content is they still have a common of tracking user's actions and response and understanding users' feedback.

In the case of large MMOGs systems it still has difficulty making correct decisions without reliable player feedback, and game providers still have scalability problems to meet growing populations of users. Because the popularity of the gaming environment have attracted more game users, Resulted from that the data generated through such multi-player network games are increasing rapidly, Addressing that The MMOGs struggle to achieve much more than 500 transactions per second[2].

And this transaction rate cannot be improved by adding nodes in cluster as what have been used in some game database systems. With the increasing number of players and concurrent database access, the RDBMS becomes a bottleneck in a large scale MMORPG.

In the age of big data and it's new technologies modules and software we could say MMOGs is also should benefits from these technologies.

Using NoSQL database and integrating it with Hadoop file system will be the proper solution for data management and data handling to improve speed, reliability and scalability of these large gaming applications. In this paper our work focused on two parts: the first we proposed new approach using NoSQL database for MMO log data, game data, and state data for processing, storage, and transmission among databases, servers, and players. The second we implement an MMO games website using traditional database RDMBS to handle account data. This website also has enhanced and new functions can achieve more

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users and has more flexibility on advertising and payment in this site. In the first part we chose Cassandra for our NoSQL database read and write and Hadoop over Cassandra for analytics work. In the second part the account data does need high data processing performance so we chose to use MYSQL and PHP for our website implementations.

a) Motivation and problems

Each and every day, the gaming population as a whole generates terabytes of information. This is due to the multiple platforms that exist for both online and offline gameplay these days. More importantly, each and every time they play, gamers leave massive trails of digital breadcrumbs. These large pools of unstructured data can be analyzed. Coupled with information garnered from social networks revealing a player's real-life preferences, the data can provide valuable insights to help gaming companies tailor the game to more closely match the gamers' profile. There are far fewer vendors focusing on the computer and MMO games, and no single analytics provider appears to focus on delivering game platform analytics [3].

The sale of in-game products provides a serious revenue stream for the gaming industry. And big data enables companies to deliver tailored and targeted in-game advertising that speaks to the needs and wants of the individual player. Additionally, through big data, companies can adopt Amazon's successful e-commerce model by recommending virtual products based upon what other gaming customers bought.

The main issue is that the existing architectures of MMORPGs using RDBMS to manage data, which limits the availability and scalability. Also have no enough use for analyzing all these data generated by all users around the game and benefits from them to improve game functions and get more profits.

Happy Farm has 228 million active users and 23 million daily users [4]. World of Warcraft has over 11 million monthly subscribers worldwide. MMOGs pose unique data scale and rate challenges. MMOGs generate and manage massive amounts of information; for example, the database logging user actions for Everquest2, a popular MMOG, stores over 20 new terabytes (TB) of data per year. Other projects such as CERN's Large Hedron Collider or the Sloan Digital Sky Survey produces data orders of magnitude larger than MMOGs, but these projects are using large and pre-provisioned (expensive) computational and data infrastructure that game companies cannot afford. Furthermore, the data production rate for these other projects is stable over time spans of days or even weeks, whereas for MMOGs the daily user activity has peaks and may even change hourly [5].

The global games market is this year expected to reach $70.4 Billion, an increase of 6% from 2012. MMO games will account for $14.9 billion, or 21.2%, of these global revenues. The Asia Pacific region (APAC), which is now the largest games market in the world, generates 34% of global game revenues.

APAC accounts for an unprecedented 64% of revenues when focusing on MMO games, highlighting the immense popularity of MMO games in the APAC region relative to the rest of the world. North America (NAM) and Europe,

Middle East and Africa (EMEA) account for 17% and 16% of MMO revenues respectively with Latin America (LATAM), which grew by 15% since 2012, accounting for just 3% [6].

1. *Scalability problem:* The RDBMS, because of ACID constraints, is hard to scale-out. And the MMO games very flexible database.
2. *Performance:* RDBMS is based on relational algebra. It stores the data on relational model for read and restores them back to original model for writing data from RDBMS, which will consume resources and will be considered as not efficient way for data read/write.
3. *Complexity problems:* Data in an RDBMS are stored in different tables using foreign keys to link them. In new and big MMO Games, the state data are so much and more complex, so in this highly concurrent data accessing, RDBMS is getting hard to handle the operations efficiently.
4. *Structured problems:* with the fixed schema in RDMBS, structure of a table must be pre-defined. And in MMO Games is always need to fix bugs and need to maintain data according these improvement features and game development process which will need to alter existing structure frequently.
5. *Cost problems:* expensive license from the database vendor for RDBMS cluster.

II. Big Data and mmo Games

Big data has many definitions we chose the common one for describing big data in our paper

"Big data is a collection of data sets so large and complex which becomes difficult to process using traditional database management tools or traditional data processing applications in reasonable amount of time" [7].

For Storage such as Amazon S3, Hadoop Distributed File System. For MapReduce programs such as Hadoop and Hive, Pig, MapR and For Visualization GraphViz, Protovis, Google Fusion Tables. Big Data becomes a use case for multidisciplinary problem solving [8]. In MMO games Variety means Game event logs, user profile data, social interaction data captured during games between players. And

Volume and Velocity means points of data collected from millions of monthly users.

Massively Multi-player Online Games have emerged as a most intensive data application nowadays, being massively used by simultaneously game players around the world. This data require high level of performance, fault tolerance and scalability [9]. The term of game can be categorized in general to Casual/flash game portals, Multiplayer web game portals, Browser-based MMO games, Client-based MMO games, Social games [10]. What makes these MMOGs so addictive is the sense of meaningfully interacting with thousands of people halfway across the globe [11].

Big Data approaches to gaming are held to be desirable for several reasons. One is because they afford a numerical (and therefore more "scientific") approach to the study of human behavior. Additionally, it is believed that, because of the character of virtual worlds' design, all players' actions are recorded in at least some form, so the database can be seen to yield an inclusive, more or less complete record of activity. Consequently, some major problems of sampling are believed to be obviated, so that Big Data analyses of traces from virtual worlds make for an easy, complete, and quantitative approach to the understanding of social phenomena [12].

NoSQL systems are designed to capture all data without categorizing and parsing it upon entry into the system, and therefore the data is highly varied. SQL systems, on the other hand, typically place data in well-defined structures and impose metadata on the data captured to ensure consistency and validate data types. MMO games generate huge data that need to be analyzed at different levels and for different purposes, from high-level analysis of the number of players in a MMO game allocation to the detailed analysis of the user mouse clicking and keyboard typing behavior for audit and analysis purposes. Usually, a replica of the data to be analyzed needs to be created, which raises the problem of maintaining consistency between the original and the replica(s). Similar to other cases of information replicas in distributed systems, creating exact copies of the data for analysis purposes may not be only expensive, but also unnecessary [13].

a) SQL Database vs. NoSQL Database for MMO games requirements

In this paragraph, I will make a simple comparison between SQL database and NoSQL database considering the most needed features in big applications like MMO Games. There are many differences between SQL and NoSQL database from different aspects. In a RDBMS stored structured table, the data in the table can be queried by using standard SQL language, which NoSQL don't have. NoSQL is a summary term describes a set of non-relational databases, may scale out horizontally to a very large size. NoSQL stands for \not only SQL". So NoSQL is not about to do not using SQL any more, but not only limited to SQL. NoSQL is not a terminator of SQL, but an alternative or enrichment to the SQL World [14].

Generally, SQL is not in minority compare to NoSQL, It is still the first choice for most database problems. SQL database exists for a very long time and almost everyone who works related with programming is familiar with relational database. In addition with the development of many extensions of SQL systems, working with SQL system becomes more and more easy. In the SQL database field, it has a big amount of mature products and a large number of tutorial, support, etc. available. That is why SQL database still remains the first choice position for all database problems. We will now give a short comparison from aspects of scalability, performance and consistency between SQL database and NoSQL database.

i. *Scalability*

Scalability is one important advantage that comes from distributed database of no SQL and came to be used to remove the disadvantage of RDBMS. In the horizontal scaling of a SQL database requires administrative overhead after it scale out to a certain size, the performance of the scaled SQL database will decrease. While on NoSQL don't need a table structure that makes NoSQL particularly suitable for scaling out. The architecture of many NoSQL databases is also running on inexpensive computers for data storage. Normally, the NoSQL system can reach a very high scalability by simple adding new nodes into the cluster, even during the runtime. NoSQL systems can provide well and stable scalability constantly despite of the high volume of data. So the NoSQL database is superior compare to SQL database with the aspect of scalability [15].

The NoSQL databases have less schema model and no joins that makes NoSQL databases are efficient from the SQL databases. One of the reasons why NoSQL exists is that SQL systems have limited performance when it extends to a certain scale. The performance of NoSQL is much better than SQL of writing or reading. When the data volume increase, the contribution of a schema and scalability to the performance of the database is more obvious. But it should be understood that not all NoSQL databases are created alike where performance is concerned [16].

ii. *Consistency*

In order to return the up-to-date value to all users, a number of conditions must be met. Some middle-ware appliances (Such as CloudTPS for Google's BigTable and Amazons SimpleDB) also exist, which are adding full ACID features to some NoSQL systems. In this type of database, it can determine which operation is governed by the ACID and which is by "Eventually consistency". But even so the NoSQL in terms of consistency is still not as strong as SQL,

because SQL database has an absolute consistency which means it doesn't allow any inconsistent state exists. Some of NoSQL systems still generally do not provide ACID transactional properties: updates are eventually propagated, but there are limited guarantees on the consistency of reads [17]. So when choosing database users have to decide the proper one for database to have fully powerful database for their systems.

In here I will summarize some advantage of no SQL database

1. The ability to horizontally scale "simple operation" throughput over many servers,
2. The ability to replicate and to distribute (partition) data over many servers,
3. A simple call level interface or protocol (in contrast to a SQL binding),
4. A weaker concurrency model than the ACID transactions of most relational (SQL) database systems,
5. Efficient use of distributed indexes and RAM for data storage, and
6. The ability to dynamically add new attributes to data records.

We can say the NoSQL provide schema less data model to be faster read and write in the database to SQL. Some of NoSQL database available are Cassandra, HamsterDB, CouchDB, Riak and others. All these databases have advantage and difference of storage, performance and availability.

b) MMO games architecture

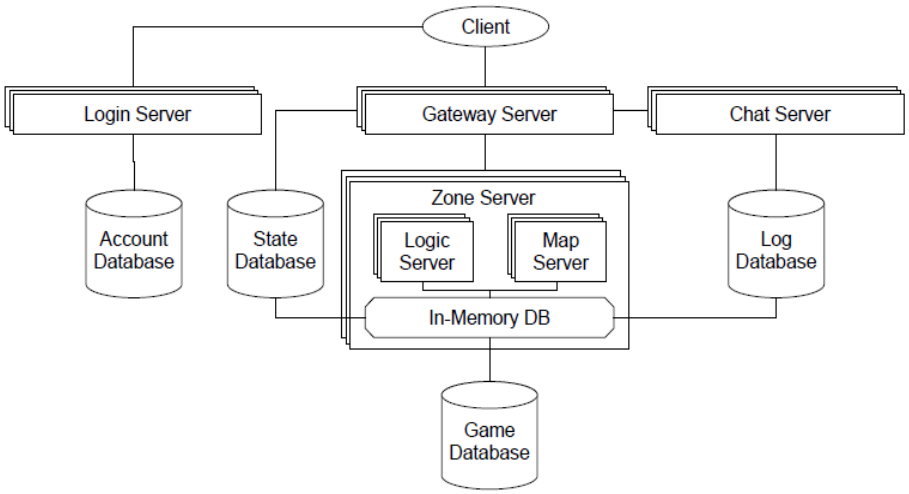

Figure 1 : MMO games basic architecture

And in our case of MMO games the basic architecture contains Game client, Game server Web application server and Database management system. The figure 1 shows the architecture.

III. System Analysis and Functions

a) Proposed System for data base management

Along the development of gaming industry, the games has gain more success and revenue, but with a huge amount of users and advertisement costs, the game still need to be improved to satisfy users amount and companies demands. The technology brought by big data has confirmed that the game can be improved to hold huge amount of data and can be used easily for analysis works.

The website of MMO is the first stage of users to play the game, The users comes for fun to play games so the website should be more beautiful more social and easy to use.

The MMO games data can be divided to two main parts:

- *Account data*

Which we used an enhanced platform to perform more useful method for users Account data: this category of data includes user account information, such as user ID, Password, recharges records, and account balance. This data is usually only used when players log in or log out of a game or for accounting purposes. In this part of data we proposed to use RDMS, because the data is not huge amount and does not need a real time analysis and need to be more secured. The figure below shows the architecture we proposed for our system.

- *Game data*

Game data contains:

- *Game world data*

Data such as world geometry and appearance, object and NPC (Non Player Character) metadata (name, race, appearance, etc.), system logs, configuration and game rules/scripts in an MMORPG are generally only modified by game developers. Some

significant part of the game data is often stored on the client side to minimize network traffic for unchangeable data.

- *State data*

As we discussed above, PC (Player Character) metadata, position and state of characters and objects, and inventory in MMORPGs are modified constantly. Currently, the change of state data is executed by an in-memory database in real-time and recorded in a disk resident database periodically.

- *Log data*

Analyzing user chat history and operation logs in an MMORPG is the most objective and direct way for game providers to evaluate a game, find out the operating habits of players, explore the game development trends, and even supervise the financial system of the game world.

i. *Proposed architecture*

After dividing MMO data we can now show the proposed architectures of our model, there are a variety of persistent architectures in use and different game may has its own architecture but there is still a common and standard element since the technology still the same. We did not modify or produce a new architectures model for our system but we have proposed new programs for using in the MMO games architectures model.

As we see in the figure 4.1 we have proposed to use traditional database tools for managing account data. Account data will be integrated through the website system which we developed using MYSQL database since these data still not huge amount and can be managed by using RDBMS efficiently [18]. In the other side game data like log and state data we proposed to use and new technology database system to manage since these data are very huge and need high performance for read/write operation and for analyzing process. We proposed Cassandra for creating database and Cassandra Hadoop for handling database analyzing process.

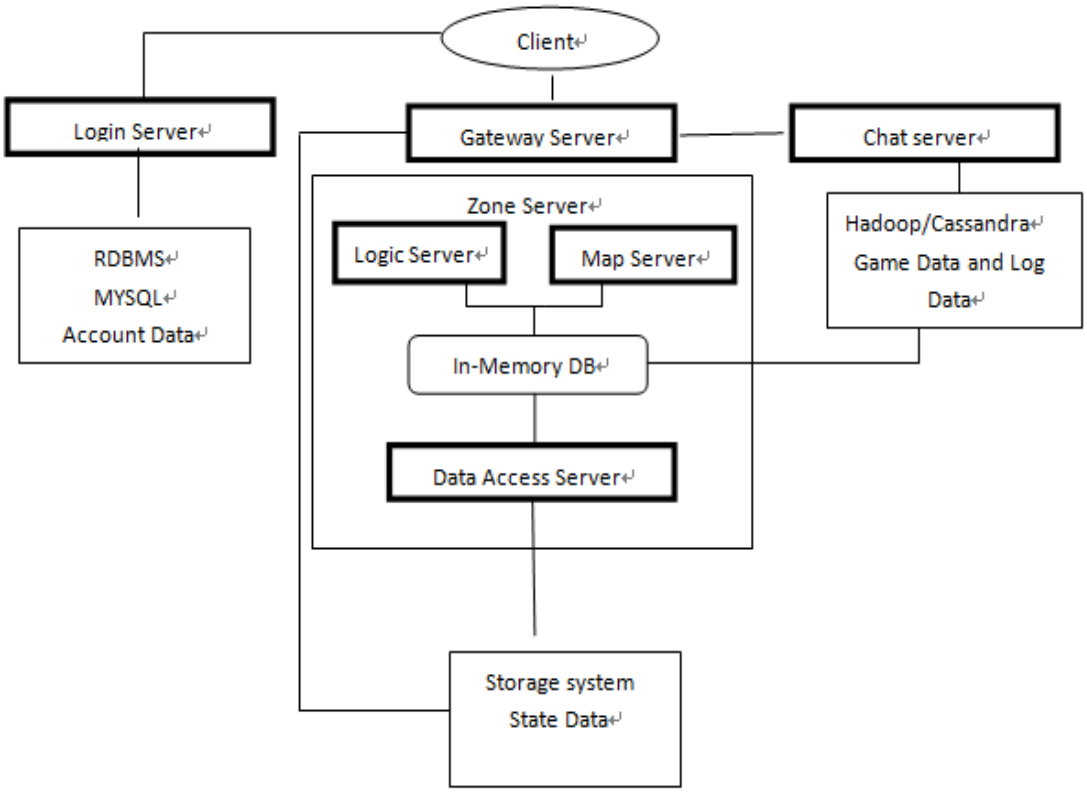

Figure 2 : The Proposed Architecture for MMO Game management system

ii. *Cassandra*

Cassandra is an open source non-relational, NoSQL, column oriented database, and it can store large amounts of unstructured data. Cassandra is peer-to-peer model Cassandra's data model offers the convenience of column indexes with the performance of log-structured updates, strong support for renormalizations and materialized views, and powerful built-in caching. This makes it not only tolerant against single points of failure but also easily horizontally scalable [19]. Cassandra is similar to the other extensible record stores in its data model and basic functionality. It has column groups, updates are cached in memory and then flushed to disk, and the disk

representation is periodically compacted. It does partitioning and replication. Failure detection and recovery are fully automatic. However, Cassandra has a weaker concurrency model than some other systems: there is no locking mechanism, and replicas are updated asynchronously [20].

Like HBase, Cassandra is written in Java, and used under Apache licensing. It is supported by Data Stax, and was originally open sourced by Face book in 2008. It was designed by a Face book engineer and a Dynamo engineer, and is described as a marriage of Dynamo and Big Table. Cassandra is used by Face book as well as other companies, so the code is reasonably mature. Client interfaces are created using Face book's Thrift framework [21].

Cassandra automatically brings new available nodes into a cluster, uses the phi accrual algorithm to detect node failure, and determines cluster membership in a distributed fashion with a gossip-style algorithm. Cassandra adds the concept of a "super column" that provides another level of grouping within column groups. Databases (called key spaces) contain column families. A column family contains either super columns or columns (not a mix of both). Super colunns contain columns. As with the other systems, any row can have any combination of column values. Cassandra uses an ordered hash index, which should give most of the benefit of both hash and B-tree indexes: you know which nodes could have a particular range of values instead of searching all nodes. Cassandra seems to be gaining a lot of momentum as an open source project, as well. For applications where Cassandra's eventual consistency model is not adequate, "quorum reads" of a majority of replicas provide a way to get the latest data. Cassandra writes are atomic within a column family. There is also some support for versioning and conflict resolution.

a. Data Model

Model of Cassandra a column is the smallest component of data model, in Cassandra column is the smallest component of data and it is a tuple of name, value and time stamps. Timestamps is to determine the resolution for a multiple version of the same record. Columns are related with certain key can be mentioned as a row, rows may contain a several columns. Column family is stored in separate files by row key order. Keyspace are the owner of column families in Cassandra database.

Replication and Consistency, in Cassandra there is replication factor, which used to ensure no loss from any failing nodes and strategy_options = [{replication_factor:1}]; In this query we used replication_factor:1 which means that any write request will not be considered finished unless at least one server returns success in the entry to it log [22]. And for read process replication_factor:1 means we only need one replica node to return the client request. Cassandra also offers configurable consistency, which provides the flexibility to consciously make trade-offs between latency and consistency. In Cassandra there are two main partitioning ways: random and byteorderd partitioner. The first one is used to in most cases and used hashing to evenly distribute rows across the cluster. Each Cassandra node takes a value that specified the range of keys for which they are responsible. And the second one is used to orders rows by keys.

What we mean is the write and read, in Cassandra to any node in data center for reading or writing the data, these data will automatically partitioned and replicated for them throughout the cluster. Which the write will commit to log durability then to memtable in memory, when the memtable is full, it is turned to an SSTabel (sorted strings table) and writes are atomic in row level, that's mean A write request is sent to all replica nodes, but the consistency level determines how many of them to wait for a write transaction to be considered completed [23]. For a read request, the coordinator contacts the replica nodes specified by the consistency level.

iii. *Cassandra for MMOGs*

Cassandra has a decentralized (peer-to-peer) structure. Each node is identical and is able to initiate reads and writes independently. Data are automatically replicated to multiple nodes [24]. Cassandra has no network bottleneck and single points of failure, which can insure the write performance requirements of state data to MMO game. This is different with RDBMS (e.g., MySQL Cluster) and some other Cloud storage systems such as Google Bigtable which usually adopt a primary/secondary model and may become a challenge. Cassandra provides a column family based data model, which is more efficient than a simple key value store. Every row in a super column family in Cassandra consists of a row key and a dynamical set of super columns, each of which maintains a different number of columns [25]. So we can manage the data of one player in a one row, and partition data based on row key across multiple nodes in the cluster. Hence, there is no more join operation during reading data, and the read performance will be increased. Cassandra adopts a shared-nothing architecture and a simplified data model. So it can scale out easily by adding new hardware, and reach a linearly increasing read and write throughput. That is also the reason that we can manage game data like state and log data in Cassandra. Another advantage is that Cassandra provides a quorum based data replication mechanism. That means as long as a write can receive a quorum responses, it can complete successfully. In this way, Cassandra ensures availability and fault tolerance. Additionally, by controlling the number of replicas that must respond to a read request, Cassandra offers a tunable data consistency.

a. *Data consistency*

Cassandra employs Read Repair to guarantee data consistency. It means that all replicas must be compared in order to return the up-to-date data to users. In MMO games, state data may have hundreds of attributes and are distributed in multiple data centers. Hence, such a feature will significantly reduce the read performance and increase the network traffic. Note that Cassandra records timestamps in each column, and uses it as version identification. We set all columns in a single row with the same timestamp, so that only one row key and one timestamp are stored for a single row on the server side. In addition, these timestamps are partitioned and managed by access servers in parallel. For these two reasons, accessing these timestamps in the server side is not a challenge.

b. Data partitioning

In order to get a high performance of accessing the entire state data of a character or object, we manage these data in a single row and partition them based on row key horizontally. However, this method increases the processing costs of querying data across characters [26]. We can partly relieve this problem by creating indexes or semantics.

b) MMO Games website and typical features

i. *Database design*

Our system is counted as an e-commerce system with the same database design, so we will not discuss it in detail since the relation tables still the same as any e-commerce site. As we discussed in our proposed system, we will use RDBMS for account database and website implementation. We have used MySQL which is a popular relational database management system. It can provide high performance and stability. It is used by websites developers to build different types web Applications. It was in March 2014 the world's second most widely used open-source relational database management system (RDBMS) [27].

In this section I will introduce the extra tables that will be in the MMO game site to show how the system handle database processes between users. In this figure 4.2 we can see the main tables.

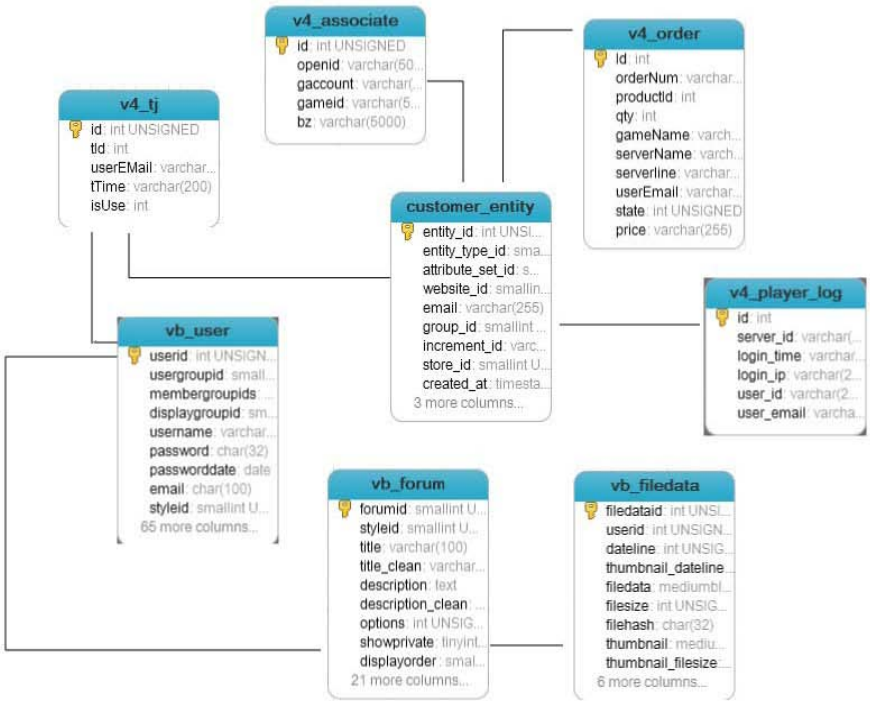

Figure 3 : Website database basic entities diagram

The database is designed to handle user or admin queries during the use of websites. The user can log the website and play the game in our site and most of online games site, there is no need for real delivery process, since the product bought by user is delivered to his account in the game. The log table stores user log to the website, the order table stores user's orders and when the user pays successfully the database update order table. Next I will introduce the main functions in this site, in the figure we can see the main function we have developed in this website. We have used popular tools to design and implement our website functions including Ajax, PHP and XML. Ajax stands for Asynchronous JavaScript and XML, which is a collection of many mature technologies [28],

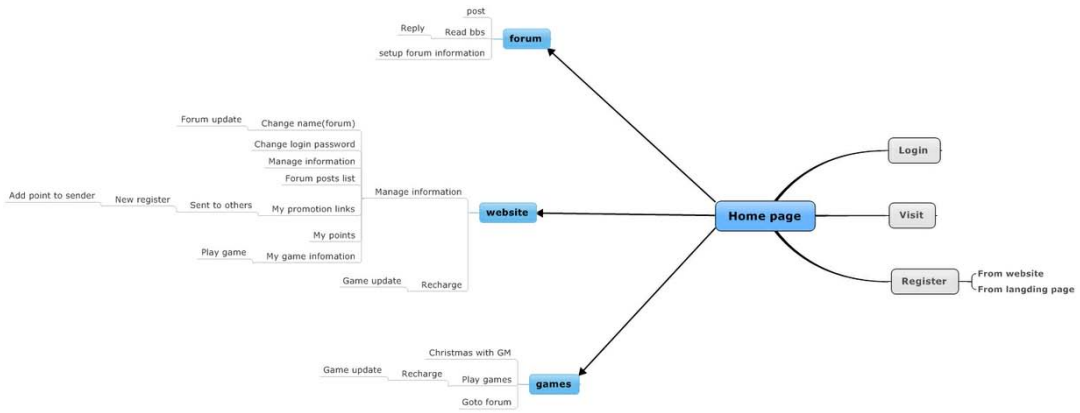

Figure 4 : Website functions flowchart

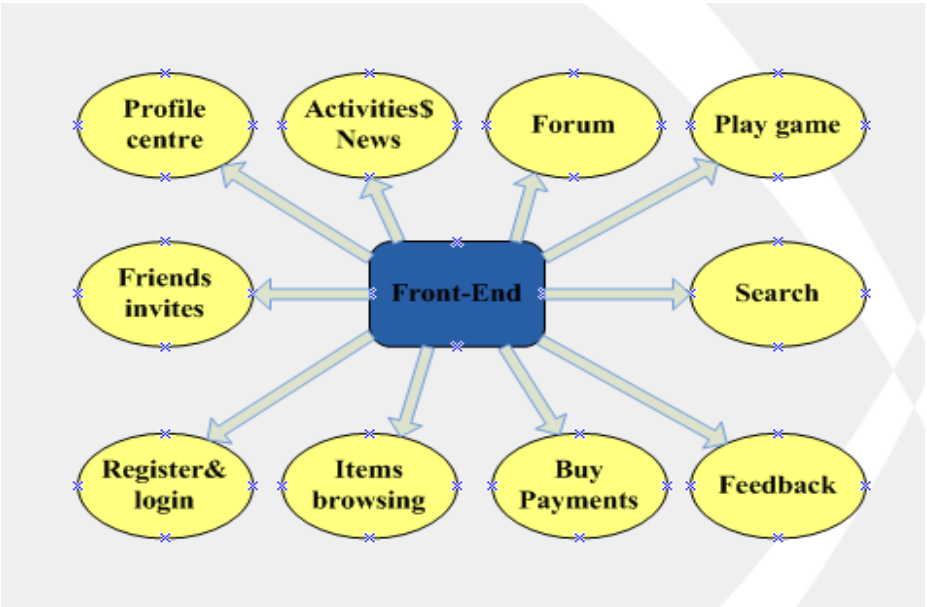

Figure 5 : Website front-end functions

ii. *Home page*

The homepage mainly have three functions (login, visit, register) but in details the main page still have other functions like browsing news or products(virtual items) and sending feedback to site managers. After the user login to his account in the main page he can navigate to forum or login directly from the forum login form, he can post threads or make a reply to others and share ideas very easy. He can also manage his profile in the forum like images or signatures and moments. In the website function users can do different functions some of them which we mainly focus on and uniquely introduced in this paper. Users can modify his password or other information, also can apply for password forgets to have an auto mail to let him create new password for his account. User also can browse items in single website of games since the system is able to have more than site to own different games.

iii. *User's promotions (friend's invitations)*

In this section I will introduce unique idea of sharing and making advertising function. From our understanding the more social games or website is the more successful; also nowadays doing advertisement is costing more than the product itself. The idea of this function is in the gaming business and virtual world users can do some activities in order to earn some points (virtual currency). So here we developed a new function for users to earn some points by inviting their friends to the website and games.

The user can copy his unique link and send him to his friends by any communication channel or send this link to any social site, so any registration comes from this link it will be recorded in the database linked to this user who sent the link. By this way the website can

have many registration and many users coming from its old users without costing any real money.

iv. *Payment methods (cards payment)*

In the website page user after logging can click buy button to buy items to his account on the game. User can choose from the general payment methods by credit card or bank transfer or choose our new method using card which can be send to him by email, delivery or company split branches. This function can gain easy success and reduce the cost of the company from revenue share between payment companies. Also it will be easy and convenient way for user to pay by small amount without using banks or credit cards. The more payment methods we have the more users we can attract to pay successfully. The website can have its own distributors for these cards or have any other distributors by sharing some of its revenue among them, which will be for sure less than traditional payment methods share. The figure shows the main process steps of purchasing items on MMO game website.

IV. Design and Implementation

In this chapter we will introduce the proposed idea of using big data technology for game database and using traditional database for accounts data in our MMO GAME website. The figure 4.1 shows the architecture proposed in this paper.

a) Game system

For the first point of my proposed idea implementation, we will introduce the database of game which can be used to evaluate the aspect of MMO games. The game as usual uses a server side and client side. The server has id logic, like receiving the commands from clients and sending games states back to clients. I will introduce how we can interact with the new technology introduced in big data.

i. *Functional Requirements of game system*

The focused idea in this paper to have an implementation can show the mean and use of new technologies in big data in MMO games and the difference between the proposed system and traditional systems. The implementation should have a simple architected for game and client server's which can accept high number of clients to log the game. The game data should be stored in distributed database (Cassandra). Game server has side logic to react with client request. The user can connect and communicate with game server via GUI (graphical user interface). The figure 5.2 shows the proposed architecture with Cassandra nodes.

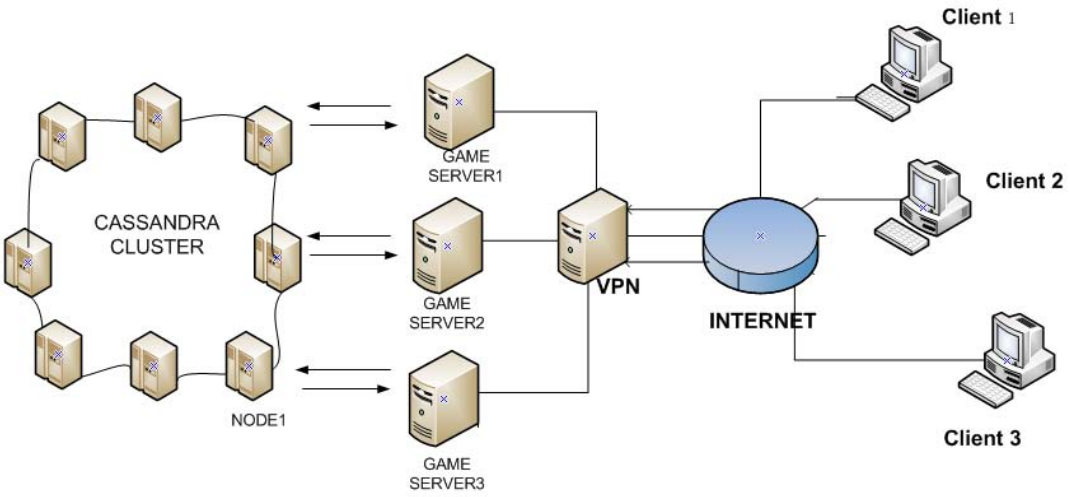

Figure 6 : Infrastructure of the proposed system

In this paragraph I will introduce software used in this implementation in brief. Cassandra has a decentralized (peer-to-peer) structure. i.e., each node is identical and is able to initiate reads and writes independently. Data are automatically replicated to multiple nodes. Therefore, there is no network bottleneck and single points of failure, which can satisfy the write performance requirements of state data. This is different with RDBMS (e.g., MySQL Cluster) and some other big data storage systems. Cassandra is the best program due to its high performance and scalability, it was written in java and has the most compatibility with Java environment and most of the existing relative mature tools are supported in form of Java libraries. For the communication between server and client we proposed to use darkstar. Darkstar is an Apache project which is designed for MMO game network architecture.

ii. *Proposed Architecture of the system*

To describe our proposed architecture with Cassandra nodes we will show the available hardware resource, we used the architecture below. The figure 5.3 shows the software and architecture proposed in our paper.

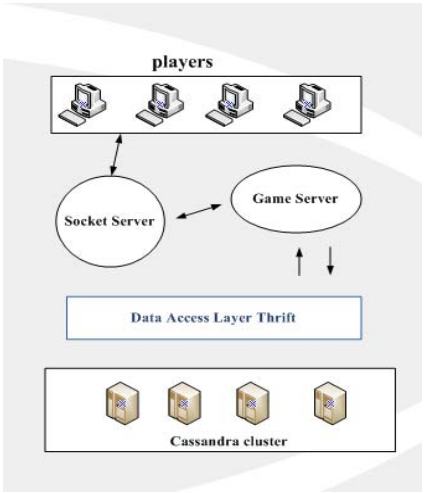

Figure 7 : System's software and architecture

The client and server communicate via a socket server. The socket server is supported by a project Darkstar. Later we will brief introduce the project Darkstar. Game server stores game logic and manages game state data when the game is running.

The database layer deals with the basic data accessing operations. It is responsible for data querying and inserting in all underlying column family which hosts the game player information, inventory information, user logging, user statistics and game world information in Cassandra cluster. A game player connects to the Darkstar Server by giving their credential information. When the user login is successful, the user can then create or choose a hero to play the game. Darkstar Server is response for calculating the world state and user state in associate with commands sending by players.

iii. *MMOGs Database Schema Design in Cassandra*

To be clear about game database design in Cassandra and new database system, we will firstly introduce RDMBS of game and secondly explain the difference between Cassandra and RDBMS on design concept and finally present Cassandra as a proposed solution for the game database system.

a. Traditional Game Database Schema

As we know in the RDMBS systems the database introduced in tables for all game data, these tables has a foreign key to refer to related data in other tables. I will introduce the basic entities of MMO games using RDBMS.

Table 1 : Simple comparison between relational and Cassandra models

Relational Model	Cassandra Model
Database	Keyspace
Table	Column Family (CF)
Primary key	Row key
Column name	Column name/key
Column value	Column value

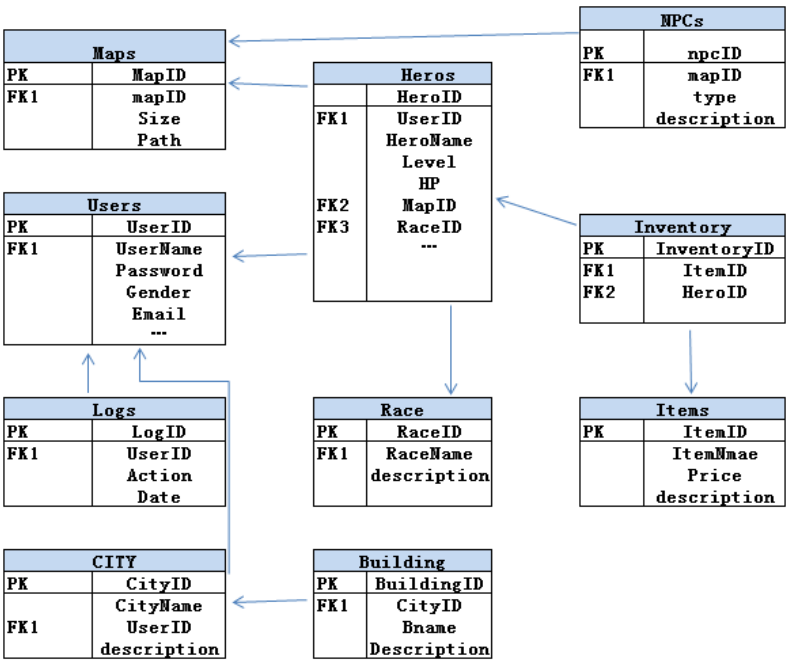

Figure 8 : E-R Model design of MMO Games basic entities

In Cassandra, de normalization is the base. A standard and very efficient way of working with the Cassandra data model is to create one column family for each expected type of query. With this approach, data is denormalized and structured so that one or multiple rows in a single column family are used to answer each query. All data are stored in ordered columns and the columns constitute a row which is uniquely identified by its rowkey.

A dynamic column family takes advantage of Cassandra's ability to use arbitrary application-supplied column names to store data. Dynamic column families allow you to pre-compute result sets and store them in a single row for efficient data retrieval. Each row is a snapshot of data meant to satisfy a given query, sort of like a materialized view which means each row of a column family could have different set of columns.

In the basic tables of MMO games database we could have these kind of query figure.

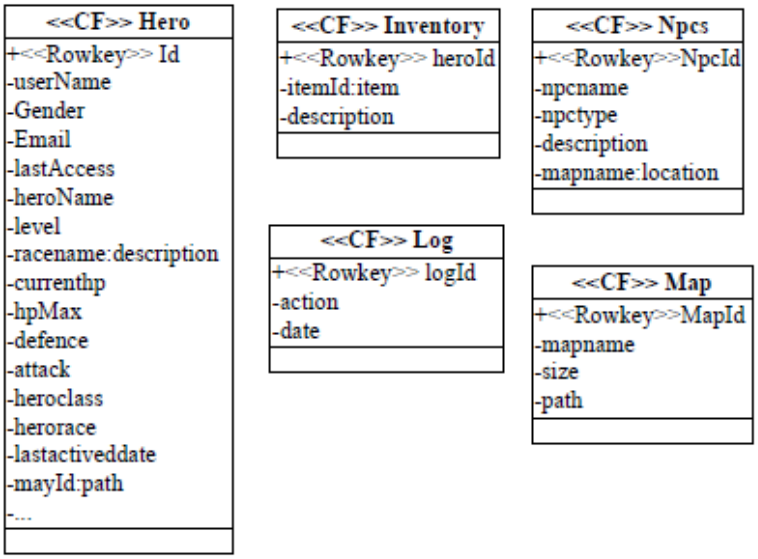

Figure 9 : Cassandra column family design

Now to explain how the query work in Cassandra, let's see this example

b. Get maps

When the game starts, all maps information should be load to the memory, so when the user logs the game and the game has loaded enough resources, it transitions to a menu screen so the user can present his desired maps and start his transactions. To do this we need a query to scan the Map column family by Rangeslicequery and load its information to the memory.

After determining the needed query pattern of the game or at least the most important query will be needed. We will show how to use them in the best practice. We can also add any query we need in future by using CASSANDRA features like indexes and nested indexes. In the world of MMO games, the character of user is the most essential data. It needs high availability and consistency. some of player data should have transaction, like when the user get certain prestige the lord nobility should increase and get a new features like heroes limits or buildings levels etc. to keep the data updated we need to store data in one row. That's because Cassandra does not provide ACID properties so (no complex transactions support), but it still provides some useful atomicity guarantees. More precisely, Cassandra has always provided row-level atomicity of batch mutations. This means that multiple batched writes to the same row are applied by nodes atomically. By this feature we can use "slice query" to get a range from start to end columns.

From the tables of MMO games database, if we want to find a hero created by user we can also "slicequery" using starting and ending case, and then any information that we want to get. And if we want to get users skills in the tech system, the skill table for every user is integrated with tech system so we can avoid join, because every user's technique is stored in one row. This is will have highly performance but it may cause redundancy. We can use queryslice with specifying user's id. In the figure below we can see the sample of tech system games we have created for skill instance and its information.

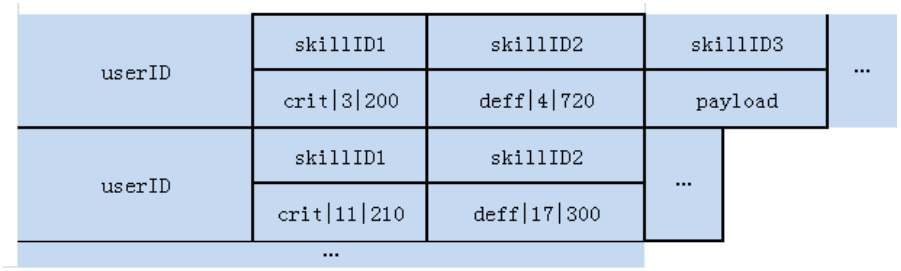

Figure 10 : Cassandra column family skills

c. Storing data

To Store the log data, we need a table like log column family. The game event log data are stored in this column family. As shown in Figure 5.7 the row key is ddmmyyhh: eventtype and one row represents events within one hour of a day. The server will generate a new row in every hour and all events occurring within this hour will be recorded in this row. The column name stores the time when the event occurred in a suitable granularity, such as seconds. The column value stores the payload. Many events could happen within one hour so that a row in the log column family can be very wide. Cassandra's row can hold up to 2 billion columns. So we don't need to worry about the capacity of a row. However, in Cassandra, one row will not be split across nodes and stored together in one node. If we simply use the hour as our row key and keep the event data within an hour together in one row, this will be issue:

Firstly, if we have a super large row with millions of columns, the size of this row can be so large that they cannot host in memory entirely. Second, since the data is handled by only one node in cluster, the entire write request will consequently go to the single node which is holding the row for the current hour, and then this node would be probably a hot spot. The event log data in one MMO Games could be very large, so we have added an event type after the row key so that there will be several rows for different event type within one hour. So the write operations for different event types will go to different nodes in the cluster. By retrieving data, we could use a multi-get for an hour from all of the nodes and merging the results in the application.

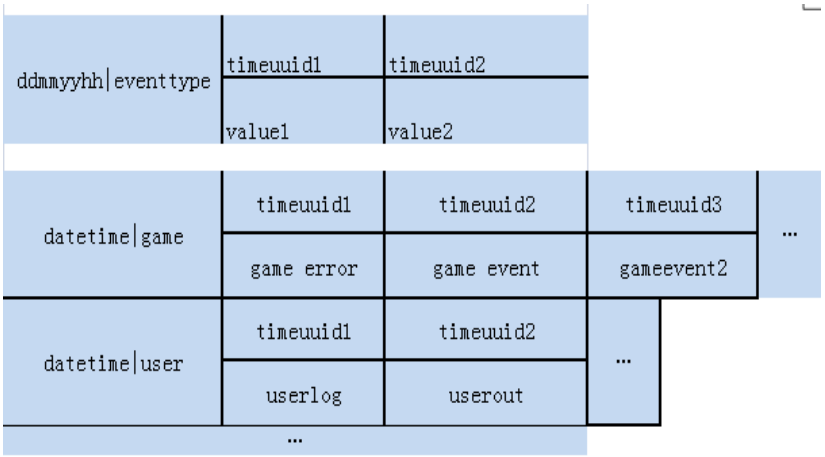

Figure 11 : Cassandra column family event log sample

iv. *Server class in Cassandra*

game.Cassandra.dao: it contains common Data Access Objects (DAO). We have applied the traditional DAO layer for isolating the business layer and data accessing layer. Every class is an implementation of data access interface. For instance the class Cassandra DAO Game Player helps us to access the Column Family Hero in Cassandra.

- *game.Cassandra.data*

the basic data structure locates in this package, such as game user and command.

- *game.darkstar.network*

this is the basic networking framework. It is the implementation of Darkstar and is responsible for essential networking packet sending and receiving

- *game.Cassandra.Factorys*

it contains some factory classes, such as *Game player*- Factory, Item Factory which are used to generate the random basic data for testing purpose.

- *game.Cassandra.gamestates*

it contains classes that stores some game logic used information and some game logic.

- *game.darkstar.task*

in this package, we have implemented some tasks which are performed periodically.

- *game.login.authenticator*

this package contains classes which are responsible for the authenticate job.

v. *Configuration of Cassandra with Hadoop*

It is highly recommended to facilitate data management and real-time analysis along with complex data intensive processing. Cassandra can run Hadoop Map Reduce jobs in the Cassandra cluster. Map Reduce jobs can retrieve data from Cassandra and then output results either back into Cassandra, or into a file system. Hadoop/Cassandra Cluster Configuration to configure a Cassandra cluster for Hadoop integration overlay a Hadoop cluster over your Cassandra nodes. This involves installing a Task Tracker on each Cassandra node, and setting up a Job Tracker and HDFS data node.

When a Hadoop Task Tracker runs on the same servers as the Cassandra nodes, each Task Tracker is sent Tasks for data in the local Cassandra node. This causes tremendous gains in efficiencies and processing times, as the Cassandra nodes receive only queries for which they are the primary replica, avoiding the overhead of the Gossip protocol.

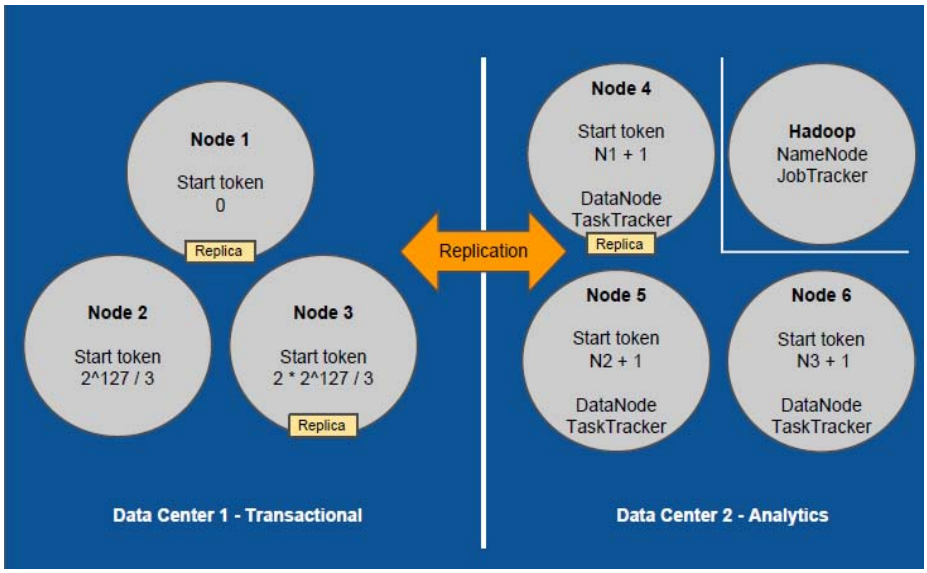

Figure 12 : Cassandra Hadoop cluster

As we see on figure 5.8 we need to install a Hadoop Task Tracker on each of your Cassandra nodes to allow the Hadoop Job Tracker to assign tasks to the Cassandra nodes that contain data for those tasks.

Using Cassandra with Hadoop leaves the distribution of data to the partitioning strategy set for the input and output column families within Cassandra. Random Partitioner will evenly split the data among the nodes. This means that with Random Partitioner each Hadoop worker has local access to almost the same amount of data. On the other hand, the Byte Ordered Partitioner causes the data splits to be collected on a small set of nodes, hence, the data locality is restricted to a small set of nodes and the remaining workers have to pick up splits remotely. This would cause an extraneous of data movement in the cluster and in turn affect the turnaround time negatively

b) Implementation of MMO Games Website

In the second part of our research we implement a website which can host many games in case of massively multiple online games having the ability to accept players to register and log the game and play or go for the related y website features Like website forum or blogs.

We illustrate the main function of the site and the use of it in the e-business field of MMO market.

i. *Game and Website Integration*

To integrate web site with game server we need to provide: Website that the user can browse and sign up and login. Game server login button which the user can click on to login the game.

After the user log in the website he can clicks on games button to browse game available in it and log in easily to the game.

The listing below shows the code behind this integration between website and game server. The main integration steps can be done by three functions:

a. Website game log

After the user log into his account in the website he can use all website function provided by website like blogs, forum threads, browsing items, sharing friends invitations or log into the MMO game available on the website. To log into the game we need to provide authen -tication to the game side from our site, the listing

shows the function of login the game. If the user has logged in the website the function will direct him to the game server and log easily and enjoy the game.

```
  $UID=$USER->getID();
  $utime=time();
  $key=
  $token=md5($uid.$utime.$key.$sid);
  $gameserver='http://alqtest.com/?uid='.
$uid.'
  &time='.$utime.'&token='.$token.'&sid
='.$sid.'';
  //after clicking log the website button
will redirected to
  http://alqtest.com/?uid={$uid}&time={
$time}&token=${token}&sid={$sid}
```

Listing 1 : Code of login the game from website

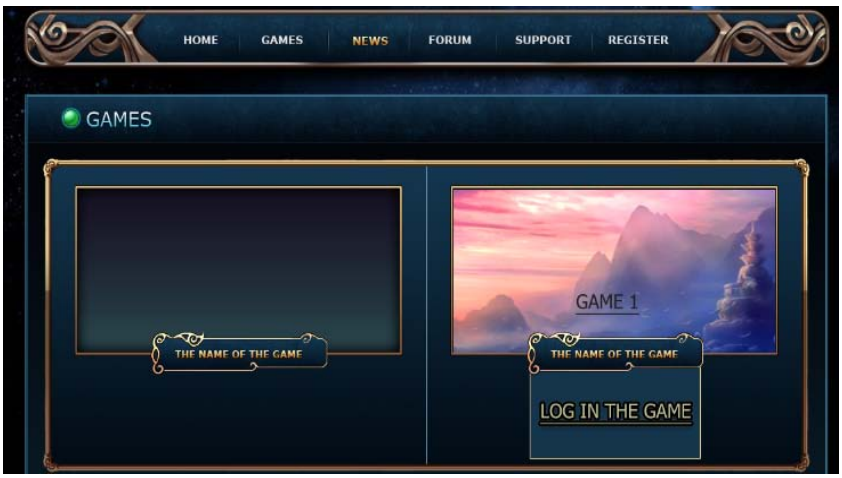

Figure 13 : Website Game login

b. Checking player info from the game

After logging the game, the user will have character name and level and other information on the game. This information will be stored in the game database for analyzing and development plan for game. But in the website we still need some basic information of the user to pursuit website activities and sending items, the listing shows how to retrieve character name of the user from game database, and the listing shows how to retrieve the character's level.

c. Recharge: buying items from website to the game

The user can recharge his account by click the button of recharge and choose product then pay and receive it in his game account with very easy and simple steps.

The flowchart 14 shows the steps of purchasing process in our implementation website and the figure 15 shows the table structure of order table in our database.

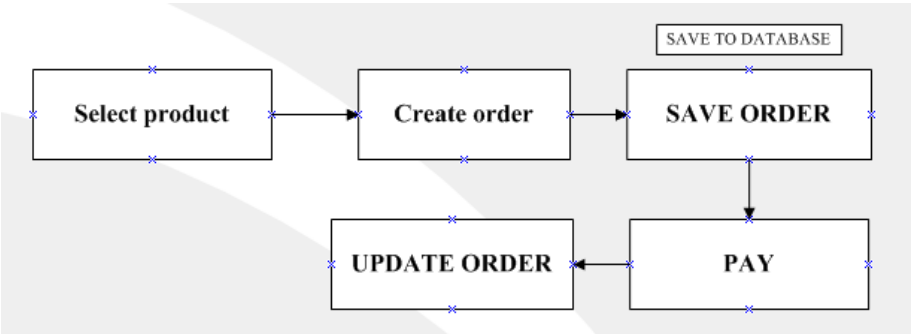

Figure 14 : Website Purchase Flowchart

1	**Id**	int(11)	
2	**orderNum**	varchar(255) latin1_swedish_ci	
3	**productId**	int(11)	
4	**qty**	int(11)	
5	**gameName**	varchar(255) latin1_swedish_ci	
6	**serverName**	varchar(255) latin1_swedish_ci	
7	**serverline**	varchar(255) latin1_swedish_ci	
8	**userEmail**	varchar(255) latin1_swedish_ci	
9	**state**	int(10)	UNSIGNED ZEROFILL
10	**update_time**	timestamp	
11	**price**	varchar(255) latin1_swedish_ci	
12	**payment**	varchar(50) utf8_general_ci	

Figure 15 : Order Table Structure

In this section we introduced a new easy way for building and interaction platform between game and website to let users stay linked in to the website and insure the Active degree of them by affecting the website activities for example share ideas, Activity-like and other activity which the user can participate on the website and get gold (game currency) or virtual items to the game directly without using game backend manager. By these three interfaces we can easily interact and retrieve most need data from game data. Users or players can easily login by providing their emails and password to enter the website and the game. Player can enjoy game playing, purchasing, chatting etc.

ii. *Website users register*

In our implementation we chose to create two the website by two methods: The first way is basic way by entering visitor information and clicks submit to become a user.

The second one is by using the user social id like Facebook or Google so the user does not need to provide his name or email to register. Registration can be made by the way chosen by the user, for more explanation we can note and follow the steps of registration method through using Flow Chart Diagram as shown in figure 16.

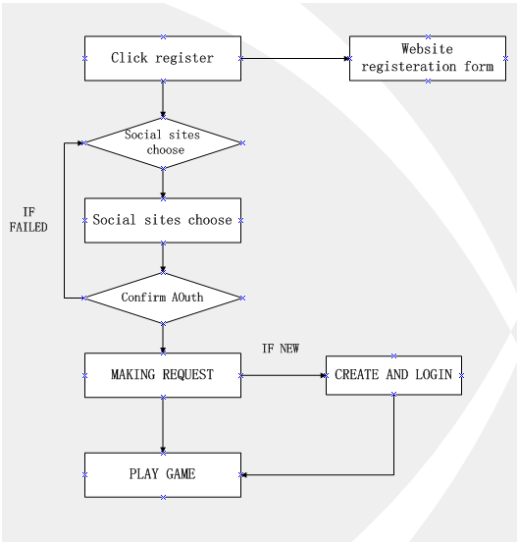

Figure 16 : Flow Chart of registration Process

When a user is signed in, we get an OAuth token for making API requests on their behalf, which we can use to let the users register fast and do not need to remember any login OAuth and better understand your user, connect them with their friends, and create a richer and more engaging experience.

In this part we would like notify the importance of users registration on MMO games market field, when any website launch a new game or new game server, will launch advertisements on different sites or search engines and will have a great amount of new browsers to his site or his landing pages, so the more easier way to register the more users we will have and of course more benefits the site can make.

Users can be used to stay linked to users and see who not log for certain amounted of time and send him an email to remind him website activities or new servers or games. Using this function can prevent website to lose users and keep them aware of all new contents of the website. The listing shows the general code for sending emails to websites users.

iii. *Friends invitations*

In this function we developed a new way to advertise our website or game without any costs. Any user will have a unique link which he can use it and send it to his friends and invite him to register from this link.

When the user registers for his new account, the system will record the source where he comes from (search engines, main websites or friend's invitations). when the new user have the TID then the system will record the user and his logging time, the same way we can have any information between these users according their relation on the database. By this function the website can run advertisement from the current users to invite their friends to play the game or to visit website. And when we want to display the friends that

any user have, we can just set where clause to ID=TID to display friends to users. According our understanding and experience the more social is the game or website the more success it can gain, so by using this function the website can be between friends, will make more social and let the users stay longer on the game. The figure 17 shows the main database table structure of friends invitations, so the users can check his friend's level and logging time, to stay linked to them.

id	int(8)	UNSIGN
tId	int(8)	
userEMail	varchar(200)	utf8_general_ci
tTime	varchar(200)	utf8_general_ci
fromurl	varchar(500)	utf8_general_ci
game_name	varchar(500)	utf8_general_ci
game_level	varchar(500)	utf8_general_ci
game_paid	varchar(500)	utf8_general_ci
isUse	int(8)	

Figure 17 : User friends table structures

In the website management back-end we check user friends by id or emails and see how many friends they have or what server they logged to analyze their progress and send them game items to stay active in the game or the website.

The figure 18 shows the test id of my email having my friends checked from the website management back-end.

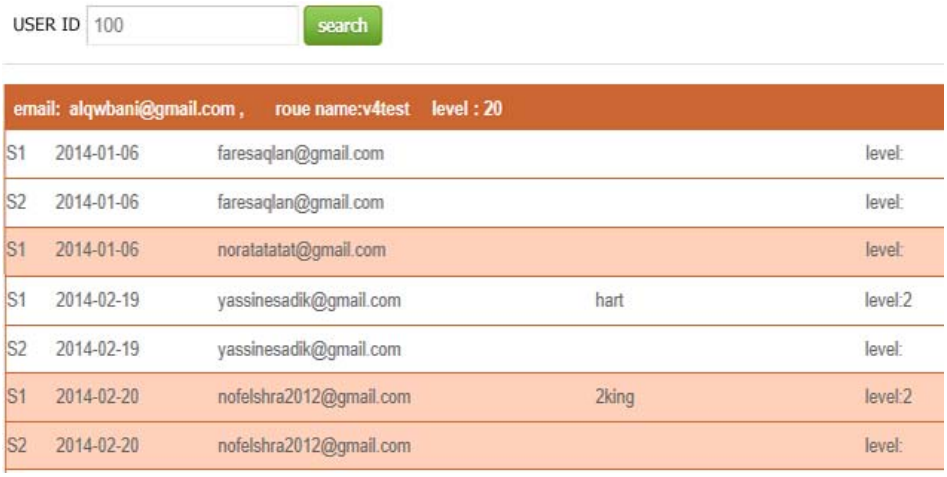

Figure 18 : Backend checking invitations interface

iv. *Cards payment methods*

And in the website page user after logging can click buy button to bay items to his account on the game. User can choose from the general payment methods by credit card or bank transfer or choose our new method using card which can be send to him by email, delivery or company split branches.

This function can gain easy success and reduce the cost of the company from revenue share between payment companies. Also it will be an easy and convenient way for user to pay by small amount without using banks or credit cards.

The figure shows the system back-end page for creating cards keys. We can choose the unit of package item and set the account we want to create then click create to have all cards key. Then we can use the email to send these cards keys or print them to cards the sending them to company branches or handler to sell these cards to users so they can use them easily on the website. The figure 19 shows the page from website which the user can use to choose payment method and pay for his desired item.

Figure 19 : Cardkey Generating interface

And in the website page user after logging can click buy button to bay items to his account on the game. User can choose from the general payment methods by credit card or bank transfer or choose our new method using card which can be send to him by email, delivery or company split branches. This function can gain easy success and reduce the cost of the company from revenue share between payment companies. Also it will be an easy and convenient way for user to pay by small amount without using banks or credit cards. The user can enter his cod key as we see in the figure 20 and make his payment very easy.

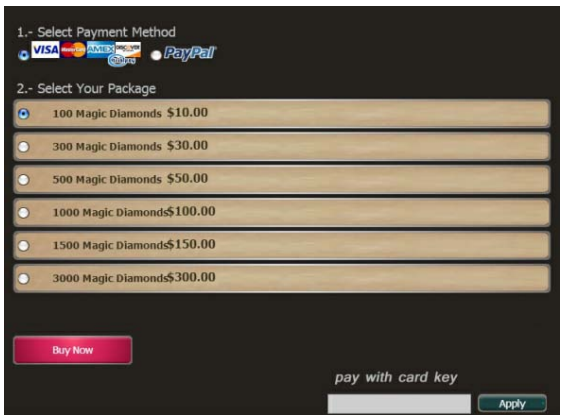

Figure 20 : Cardkey using interface

c) Evaluation And Results

In previous we have introduced the basic concepts of Cassandra and the implementation of the proposed system. Now by doing some experiments we can have the result which we can compare to current systems and have a bright view about the advantage of our proposed systems in the field of MMO Games.

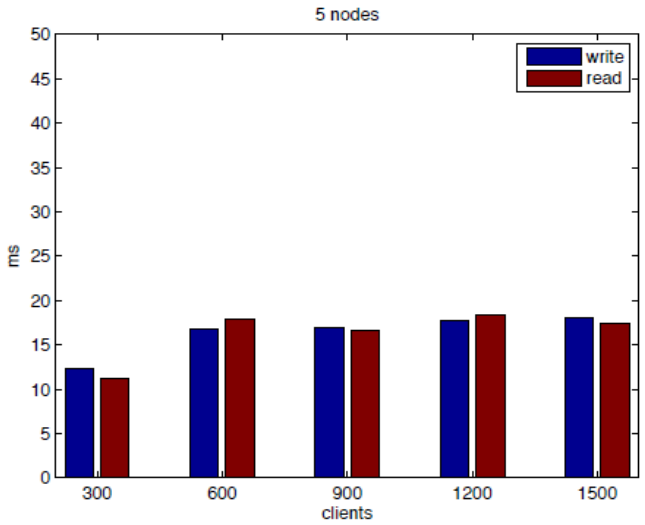

Figure 21 : Cassandra node read/write performance

As we see figure 21 here we can see the test of 5 Cassandra nodes performance, when the number of nodes reaches to 5, the performances of Cassandra cluster is the best in all range of clients' number, both of reading and writing response time with 5 nodes Cassandra cluster are about 15ms. With increasing number of clients in 5 nodes Cassandra, there is no obviously variation of reading and writing response time. Evidently, the performance of 5 nodes Cassandra is stable in our test. 5 nodes cluster is obviously the best one.

- *Scalability*

To evaluate scalability of a MMO game we have to handle that from two aspects: the scalability of game server and database.

From the proposed system above, we can find that with the constant adding game sever, the maximum number of players increases linearly from 100 to 1500, which proves that the game server has scalability. For database scalability we can see scalability of Cassandra cluster in MMORPG.

If we carry out 5 tests to evaluate the scalability of database, and set the maximum number of concurrent players to 1500, the number of nodes of Cassandra cluster is set from 1 to 5. The number of game server is fixed to 3. Each of the game servers is connected by 100, 200, 300, 400, and 500 clients in turn. That means, the Cassandra cluster handles 300, 600, 900, 1200, 1500 clients separately. Every client sent 500 reading or writing commands. In another word, Cassandra cluster needs to handle 150,000,300,000, 450,000, 6000,000, 750,000 commands in turn.

Base on the analysis and comparisons above, we can conclude that Cassandra can meet the performance demand of MMOGs in general. The more nodes Cassandra has, the more concurrent players Cassandra can support. With the increasing number of players, the reading performance of Cassandra will be improved a lot; the writing performance stays relatively stable.

d) Comparison Using Cassandra And Hadoop Integrations

Using Hadoop with Cassandra cluster is obviously much better than using only Cassandra nodes In figure 5.10 we can see the comparison between operation time of Read/Write mix workload is an indicator of throughput, or transactions per second, that can be achieved by an OLTP database environment. For an environment to handle increased throughput is critical as it shows how well the database will handle growing levels of business. The better a database can handle increasing throughput also informs you about how well the database can scale. Cassandra has been proven to handle growing transactions at rates much more capably and efficiently than other environments ensuring that your business can scale and be successful. So we did choose Cassandra to run our application and proposed it to be used in MMO games application.

In next paragraph we will show the result of using Cassandra nodes and Cassandra-Hadoop nodes.

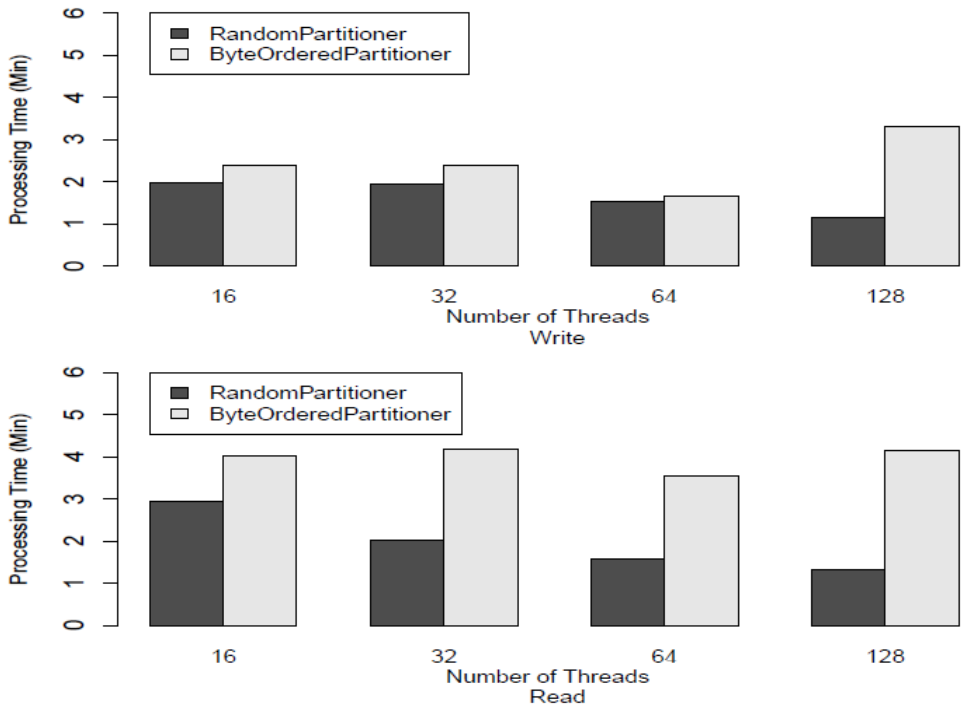

Figure 22 : Cassandra with Random and ByteOrder Partitioner

Using Cassandra nodes only we can see the result performance as figure 22 shows, by using Hadoop-Cassandra nodes it shows different and better result as figure 23 shows

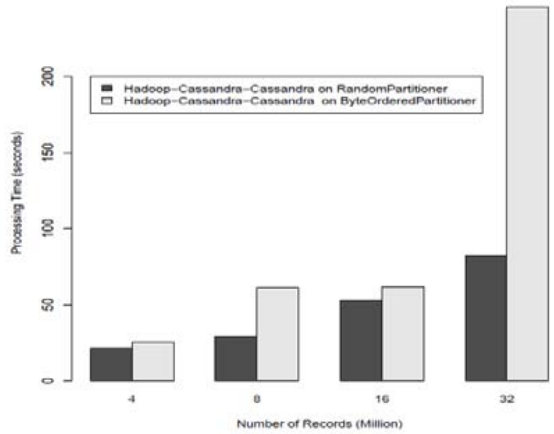

Figure 23 : Hadoop-Cassandra with Random and Byte Order Partitioner

As we see in figure 24 the performance of Running Hadoop with different setups for processing intensive and memory intensive operations.

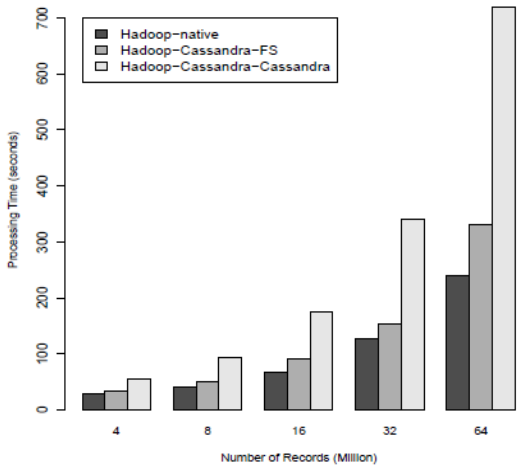

Figure 24 : Hadoop and Cassandra with different setups

By comparing the test results between only Cassandra nodes and Hadoop-Cassandra nodes in performance, and compare these result to our 5 nodes test using 1500 users we can determine that Hadoop integrated with Cassandra can handle operations faster than any system in term of MMO games analysis. In the end of this chapter we would like to insure by using our proposed database system structures and tools the MMOGs will have better performance and better benefits. And by using our website functions like invitation advertisements, payment methods and flexible registration form, the game's website we have better influence and will get more active users as well as gaining more profits.

V. Conclusion and Future Work

a) *Conclusion*

Along with the popularity of MMO games and the huge number of players and developer engaging this field, the promising present success will lead to have a bright future of MMO games business. With the growth of MMO games it will face more challenges. The importance analysis of players to allow developers to understand in real time why users are giving up the game and identify others players at risk of leaving the game so can make their strategies and improvement to prevent all games risks. And the main challenge is the huge amount of data produced rapidly in MMO games, nowadays big data technology and tools has come to applications with promising features. Hadoop (HDFS, MapReduce) and NoSQL are in the top of these technologies.

Hadoop is used in maintaining, scaling, error handling, self healing and securing large scale of data. These data can be structured or unstructured. NoSQL is non relational database to handle huge structured and unstructured data. in this paper we chose these technology in order to meet MMO games requirement and overcome the current challenges. Paper has gone through two parts

The first part: by proposing a new methodology for MMO games database using Cassandra NoSQL database system for MMO games. Cassandra data schema must rely on the query pattern so through increasing data redundancy, Cassandra stores all the data that might be queried together in one column family in order to avoid join operation and improve read performance. The results acquired from our paper shows using Cassandra are obviously much better than using traditional database systems. and when Using Cassandra with Hadoop leaves the distribution of data to the partitioning strategy set for the input and output column families within Cassandra and comparing this integration result to other Cassandra nodes result is shows Hadoop-Cassandra can serve much better on MMO games operations especially the read process since Cassandra is optimized for write operations.

The second part: the aims of this part are to design a MMO games website so that the user can visit and choose game and play. The purpose is to attract high number of customers as much as possible, moreover stay active users and facilitate the payment process to increase the revenue to the website and games.

This part can be done through new functions has been developed in this project

1. New payments method using cardkey to increase the flexibility of payment to users and enhance the sales.

2. New advertisement method using friend's invitations to increase the loyal active users and decrease the cost of ads.
3. Social and flexible registration and activity methodology has been implemented using social id to register and auto mail reminder to help users stay active and loyal to the games and website.

b) Future work

As we have seen in our paper the system with high partition tolerance and availability (like Cassandra) will have to lose some consistency in order do its job especially in real-time or high speed queries.

In my plan for future work is to design full functional system with big data technology for online applications including MMO games and focus on data analytics using Hadoop, hive and Cassandra. Hive and Hadoop to perform map/reduce engine, and use hive do queries to reinsert data to Cassandra. The goal of using Hive and Hadoop with Cassandra is to have real-time analytics with high performance, fault tolerance and consistency features.

VI. Acknowledgements

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Enhancement of Map Function Image Processing System using DHRF Algorithm on Big Data in the Private Cloud Tool

By Mr. U. Mehraj Ali. & Dr. A. John Sanjeev Kumar
Thiagarajar College of Engineering, Madurai, Tamilnadu, India

Abstract- Cloud computing is the concept of distributing a work and also processing the same work over the internet. Cloud computing is called as service on demand. It is always available on the internet in Pay and Use mode. Processing of the Big Data takes more time to compute MRI and DICOM data. The processing of hard tasks like this can be solved by using the concept of MapReduce. MapReduce function is a concept of Map and Reduce functions. Map is the process of splitting or dividing data. Reduce function is the process of integrating the output of the Map's input to produce the result. The Map function does two various image processing techniques to process the input data. Java Advanced Imaging (JAI) is introduced in the map function in this proposed work. The processed intermediate data of the Map function is sent to the Reduce function for the further process. The Dynamic Handover Reduce Function (DHRF) algorithm is introduced in the reduce function in this work. This algorithm is implemented in the Reduce function to reduce the waiting time while processing the intermediate data. The DHRF algorithm gives the final output by processing the Reduce function. The enhanced MapReduce concept and proposed optimized algorithm is made to work on Euca2ool (a Cloud tool) to produce an effective and better output when compared with the previous work in the field of Cloud Computing and Big Data.

Keywords: cloud computing, big data, mapreduce, euca2ool, DHRF algorithm.

GJCST-B Classification : D.4.2, I.4.10

Strictly as per the compliance and regulations of:

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I. Introduction

Cloud Computing is a well known concept also known as, IT on Demand. Cloud computing is the concept, which is run by most of the IT companies like e.g. Amazon's EC2, Intel's Intel Manager. Cloud computing package has a set of clients and servers. The packages are powered with high storage capacity, high flexibility and high computing performances. Cloud computing has the several concepts in it like, cloud storage and cloud security; cloud storage reaches to the users a lot. Euca2ool is a Cloud tool, proposed in this work is to enhance the uses of this tool; where the user has to create an account in the Eucalyptus Partner Cloud (EPC). Since this tool can easily interact with Amazon's EC2 on any operating system, this Ecu2ool has been selected in this work.

Java Advanced Imaging (JAI) is regularly used for encoding and decoding the image that is saved in the HDFS. JAI is introduced mainly for the betterment of imaging processing process. The job of the JAI is to translate or to transform the image format. The concepts of Big Data, JAI, Hadoop and Map Reduce functions are proposed in this work. This work is executed with the private cum hybrid cloud tool called Euca2ool.

The Fig. 1 shows the full Architecture of the proposed work. Two set of processing techniques are applied over the input and Fast corner_9 corner detection is also used in the system. Presently, this regular set of work is made with the other corner detection method and scheduling algorithm for 2D to 3D data processing [1]. In the proposed work, it has been proved that, there is another better corner method, improved SAD matching and Scheduling DHRF Algorithm, which could benefit the client in the useful manner. DHRF algorithm has proved that, it works better than the existing algorithm while processing the Reduce function. One of the main concepts in the proposed work is introduction of JAI used for image transformation. If the images are in the improper format, JAI changes the image to the right format.

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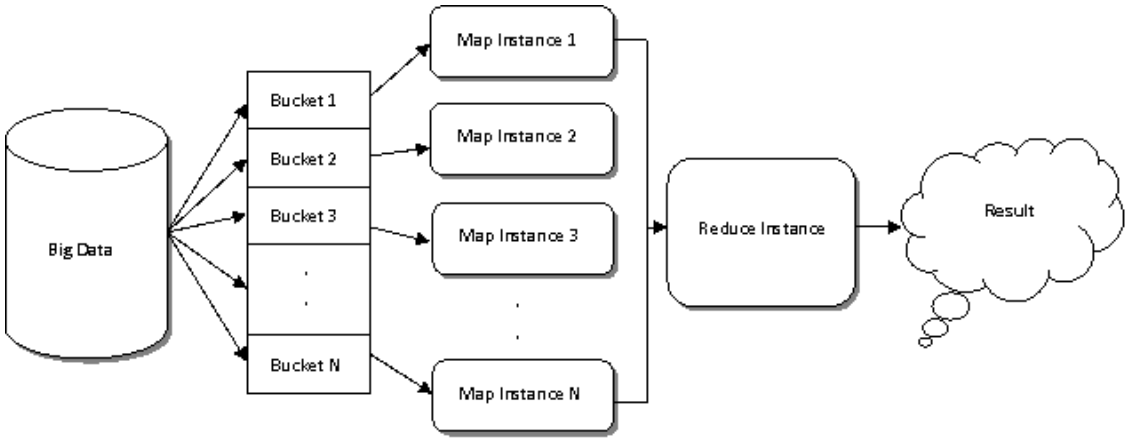

Figure 1 : Architecture of Hadoop for Map Reduce Function

The Fig. 1 shows the full Architecture of the proposed work. Two set of processing techniques are applied over the input and Fast corner_9 corner detection is also used in the system. Presently, this regular set of work is made with the other corner detection method and scheduling algorithm for 2D to 3D data processing [2]. In the proposed work, it has been proved that, there is another better corner method, improved SAD matching and Scheduling DHRF Algorithm, which could benefit the client in the useful manner. DHRF algorithm has proved that, it works better than the existing algorithm while processing the Reduce function. One of the main concepts in the proposed work is introduction of JAI used for image transformation. If the images are in the improper format, JAI changes the image to the right format.

The raw data formats input are converted to the fixed frame size and then the data compression is done. The compressed data is scaled to a fixed frame size. The received output will be a better one with high flexibility, less time estimation and less error percentage. Mostly the medical data will be in the DICOM format and rarely in the JPEG format and the output received will be in the .jpeg format.

According to the literature, the best way to process the large volume of data is enhancing Hadoop. Hadoop basically has HDFS (Hadoop Distributed File System) and Map Reduce function. The enhancement of Hadoop over Cloud Computing will obtain additional improvement in result and also in the waiting time. Hadoop can solve the problems like failure of Machines, fault tolerance, which occur during the processing of large set of data. These minor problems may result in the failure of the work. So, in order to overcome these problems, Hadoop is used.

When the speed of the machine did not match with the Map Reduce function, the tasks will be delayed [3]. To rectify this problem, the Ecu2ool is used to manage the works of the Map Reduce function. To reduce the waiting time during the operation, a Dynamic Handover Reduce function (DHRF) algorithm is implemented in the Reduce function. The proposed algorithm will work on the reduce function to reduce the waiting time during the operation.

If there are a few small files, then Map task processes only a little amount of input data, and as a result, there are many unscheduled Map tasks [4]. The concept of unscheduled Map task is common. In the proposed work, the Map task are unscheduled, the process of intermediate data to the Reduce function will be a little hard task. So, according Tin-Yu Wu et al [1], a switch algorithm was proposed. But, since there may occur some technical fault while processing the Reduce function, Handover technique is implemented. So that, the process will wait, until each process gets over completely. The HDFS system is utilized in this process. The cases may be either the small pieces of data or the large volume of data; the HDFS storing system supports all the formats for storing the data.

This paper reports the experimental work on big data problem and its optimal solution using Hadoop cluster, Hadoop Distributed File System (HDFS) for storage and using parallel processing to process large data sets using Map Reduce programming framework [5]. Big data chunks with different size and sequence will be computed in each node, so that transfer of a chunk is overlapped with the computation of the previous chunk in the node, as much as possible [6]. The data transfer delay can be comparable or even higher than the time required for computing the data [7]. Use of Dynamic Switch of Reduce Function (DSRF) algorithm, a scheduling scheme on the Reduce functions for users who compute simultaneously to acquire Reduce resources to finish the tasks efficiently [8].

In the proposed work, Dynamic Handover Reduce function (DHRF) algorithm is implemented in the Reduce function where the system waits until the process get over. The proposed module converts the size and format of the image using the following options:

max Width, max Height, Image Format [2]. JAI is introduced with small change in the coding. If max Width, max Height, is the case, it would take more space in HDFS. This may result in occupation of more space. The Reduce function will wait for the Map function to generate intermediate data; the Reduce function can switch to another task to combine the image data first [1]. The case of incompletion may occur while processing the Reduce function in the existing work, when the machine get faults like virus attacks, corruption of Operating System and others.

a) Hadoop Distributed File System (HDFS)

Hadoop Distributed File System is the file storing section of Hadoop. Fig. 2 shows the format, by which the inputs in the various forms or formats are stored. Those inputs or the data gets stored in HDFS to process the Map Reduce Function. HDFS handles both the structured and unstructured data. The Hadoop's job is to split the data and distribute to the hosts to compute. This work will be done simultaneously in the parallel manner. This is called as distributed and parallel computing. The host depends upon the strength and the storage of the computing capacity.

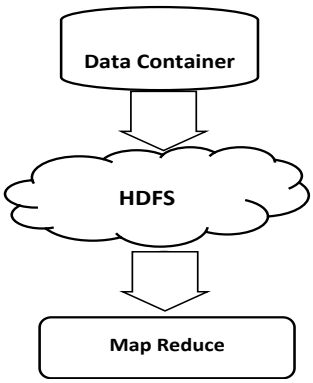

Figure 2 : Modules in MapReduce Function

II. Data Processing Techniques

In the proposed work, two various types of image processing techniques are applied for the input (Big Data) as shown in the Fig.3. The first technique is the combination Grayscale and Sobel edge detection. The second technique is the combination of Gaussian Blur and Fast Corner detection method. The Grayscale conversion is the best method to convert the original image into Black and White image and Sobel edge detection is the method of detecting the edges of the images.

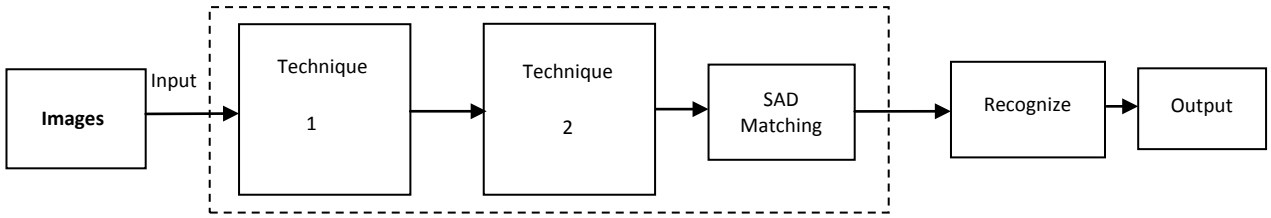

Figure 3a : Sketch of Data Processing Techniques

Gaussian Blur is the best blurring technique ever, used here to blur the input image. Finally the Fast Corner Detection technique, since that is the best technique. After the completion of both the processing, the data is then transferred to the next level of Matching called SAD matching. Then the integration of the intermediate data is done to recognize the output.

a) Harris corner detection

The Harris corner detection is used in case when there is a correlation in the threshold of data. A detection method which could give a better result than the Harris corner is, Fast corner_9 which is shown in Fig. 4. Fast corner_9 has been applied in the proposed work, to fine tune the result than the Harris corner, Susan, zheng and harr [9] methods.

$$E(u,v)=\sum_{x,y} w(x,y)\left[I(x+u,y+v)-I(x,y)\right]^2$$

The given equation finds the solution for the Harris corner method with the argument (u,v).

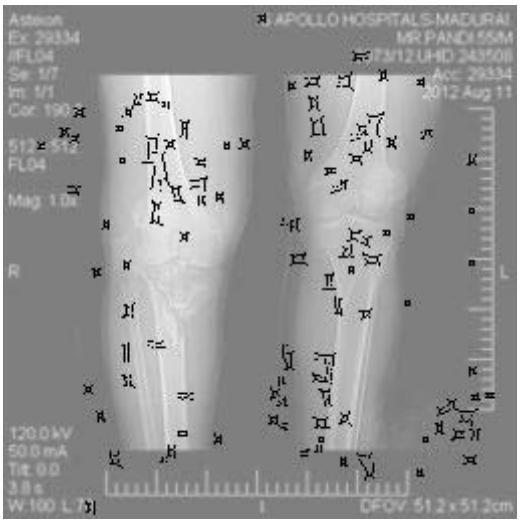

Figure 3b : Threshold data obtained through Harris Corner Method

In Harris corner, a square mask with point *p (x, y)* was established. When the mask of Grayscale value is higher than the threshold, the point P is defined as the corner. Here *E* denotes the patch area, *I* denotes the given image. Where *(u,v)* denotes the image patch point and while processing, *(x,y)* get shifted from *(u,v).*

b) Fast Corner 9

In the presence of various Corner detection methods include Harris corner method, Susan, zheng and harr. Among these methods, Fast corner_9 is used due to higher clarity when compared with other corner detection method. This Fast corner detection has come from Moravec (SSD) and the Harris Corner Detection (second derivative of SSD). By using the non minimal suppression it is determined. This is calculated by subtracting the original value, by comparing the *p* value and with *t* value. This has been implemented on Client Machine with the configuration Intel (R) Core 2 duo, 4 GB RAM and 2.93 GHz processor and the Server with the Configuration of IBM X 3400 M3 Server, Intel Xeon E 5507 (Quad Core), 2.26 Ghz Processor, 146 GB DDR3-1333 Mhz ECC RAM, 146 GB 10K SAS Hard Disk Drive.

$$v = min\begin{cases}\sum(p - pixel\ value)n + if\ \ \frac{1}{n}\ (value - p) < t \\ \sum(pixel\ value - p)n + if\ \ \frac{1}{n}\ (p - value\ ) > t\end{cases}$$

Where *p* denotes the Grayscale value and *t* denotes the Threshold value.

c) Sum of Absolute difference (SAD)

SAD is a mathematical term that has been enhanced here to find between differences the two P blocks of the processed data.

$$SAD = \sum_{(u,v)\epsilon\, w}[A_1 1(u,v) - A_2(x+u, y+v)]$$

Where, A_1 and A_2 are the two images. Like the Harris Corner method, here also (u,v) denotes the image patch area and while processing, (x,y) gets shifted from (u,v). Before the implementation of SAD there is an existence of SSD (Sum of Squared Differences) to find the difference. As SSD is an old, it isn't able to produce a clear result like SAD. The Relationship between the intersection points detected by Harris corner detection method and labels the corresponding points for computers to judge the corresponding locations of intersection. In relationship between the corners, the interpolations are used to judge the location of the corner while being photographed to simulate the data.

III. Proposed Work

Euca2ool is a Cloud tool that is private cum hybrid Cloud Tool. Though there are many tools to solve the problems in big data.. This enhanced tool will definitely give the better result in both the time and cost estimation. Basically Hadoop is enhanced of HDFS and Map Reduce function. Since the Map Reduce function is an open source, the codes can be edited and modified. The coding is edited now in the Map part. The coding is made in such a way that, the inputs are split into maximum of ten parts. So that the Map function will be easy while processing. This change in the Map function will reduce the processing time.

The coding or the application set up of the image processing techniques is installed on the Euca2ool, to run the experiment. Basically Map is the primary function in the process of Big Data. Splitting the data into maximum number of part is called as Map Function. In the proposed work, Pre-Map concept is implemented. Pre-Map is the concept of Map the Map function. The situation in which, when the Map function is proposed to do, the data will be mapped before the Map function into maximum number of parts.

a) How Cloud Computing is involved in Image Processing in the proposed work?

The HDFS is used to store, retrieve and process the data. Few image processing techniques are used in the cloud computing. Since, Big Data is referred to the context called image/data. When the data is taken as the input, it is made to undergo the Map Function. The function of the Map function is to Split the data into maximum number of data called as intermediate data. Those intermediate data are split to process further. Two sets of image processing techniques are used in the Cloud Computing.

JAI does the task of converting the data. Either the data may be a structured or unstructured one. By using the JAI, the data are converted to structured data. Fig 4 shows the results of obtained from the data processing techniques. Further, the inputs are processed first with the Pre-Map technique. Pre-Map technique is used, to split the data before sending the data to Map function. This Pre-Map function split data in to maximum number of parts, in order to reduce the processing time during the Reduce application.

After the function of Pre-Map and Map Function gets over on the Data, the data are set to intermediate data. The Map function is done by the client machines. These intermediate are made to undergo the two set of image processing techniques. To avoid the waiting time, the Dynamic Handover Reduce Function (DHRF) is applied on each and every intermediate data. This results in the output of the input (Big Data).

Figure 4 : Results of Data obtained from image Processing Techniques

IV. DHRF Algorithm

DHRF (Dynamic Handover of Reduce Function) is an algorithm implemented in the proposed work. The function of this algorithm is to reduce the waiting time during the Reduce function. The work of the reduce function is to integrate the processed data. Two sets of image processing techniques are applied on the intermediate data such as Grayscale, Sobel, Gaussian and Harris Corner detection. These techniques are applied on the splitted data which are produced after the application of Map function. Each and every intermediate data are applied with two techniques.

```
BufferedImage res = new BufferedImage(width,height,BufferedImage.TYPE_BYTE_GRAY);
                    // Initialize the image process
byte[] bytesCompressed = compressor.compress(imagetoCompress);
Deflater deflater = new Deflater();
deflater.setInput(bytesToCompress);
                    // Produce the data compression
BufferedImage resizedImage = new BufferedImage(IMG_WIDTH, IMG_HEIGHT, type);
Graphics2D g = resizedImage.createGraphics();
g.drawImage(originalImage, 0, 0, IMG_WIDTH, IMG_HEIGHT, null);
g.dispose();
                    // put the data into scaling
static{
   URL.setURLStreamHandlerFactory(new FsUrlStreamHandlerFactory());
}
                    // write the map reduce structure
 in = new URL(PATHTOBEMAPPED).openStream();
IOUtils.copyBytes(in, System.out, 2, false);
                    // set the server to handle mapper
FSDataOutputStreamout=fileSystem.Create(path);
   InputStream in = new BufferedInputStream(new new File(source)));
                    // mark data into HDFS of Hadoop
Process the image until completing the grayscale,sobel, guassian, fast corner, SAD matching of the image.
                    // operate the data process until the data processed
```

map(in_key, in_val) -> list(out_key, intermediate_val)

reduce(out_key, list(intermediate_val)) -> list(out_value)

// Set the MapReduce Operation

FileSystem fs = file.getFileSystem(context.getConfiguration());

FSDataOutputStream fileOut = fs.create(new Path("your_hdfs_filename"));

// write the data mapper

reduce(WritableComparable, Iterator, OutputCollector, Reporter)

continue until reducer task is complete

// send mapper output data to reducer

JobConf.setNumReduceTasks(int)

// set small unit value to the task and reducer wait queue

interrupt.task

store the result(image).

When the image is processed by the template, the image is compressed and scaled then produces the Map functions. In the first set of Grayscale method, it delivers the image in black and white without noise disturbances. The Grayscale image output handovers the edge detection technique to the next process. It removes the outer layer of noise disturbance. So enhancement of the best edge detection technique called Sobel edge detection technique is done.

Then the implementation of Gaussian blur reduces the image noise. It is for pre-processing stage for any image enhances structure. So the retrieval of formal blur image can be used for the detection of corners. The corner method defined as a point of two different edge directions and dominant. In this, corner detector works uses only a segment test, so the result is very accurate and quality at the mean time of time reducing in the .jpeg format.

Finally Map function results are sent to reduce operation. The implementation of DHRF algorithm focuses on Reduce function integrating the task and allots the process to produce the result .Jpeg format. In Reduce function, it involves the small unit of value for determining the task and sequentially it completes the process. Whether the process is completed, it produces the result .jpeg format.

V. Result and Discussion

Fig 5 shows the result of the Fast Corner method. In this figure, the sharp edges and the damaged parts are pointed out sharply. The red mark shows the infected corners. When compared with the Harris corner method in the existing work [2], this is proved to be the best corner detection. The application of the two image processing techniques, gives the expected result.

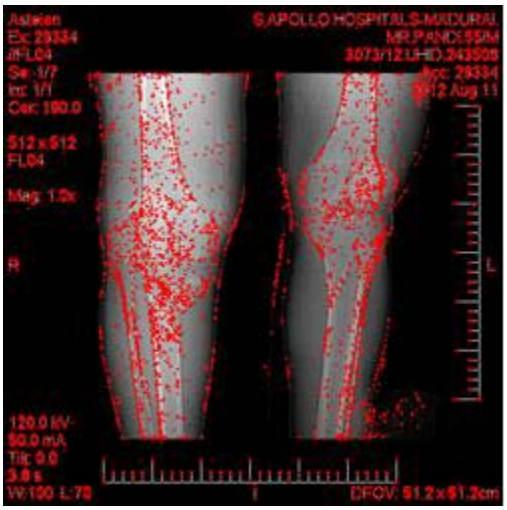

Figure 5 : The result shows the sharp edge and damaged part through Fast Corner method

The main advantage during the execution was, the output of the data is marked with better quality and there is the usage of Fast corner_9 method to detect the corners of the image. While comparing with existing, proposed Fast corner_9 method shows the corner more clearly. During the comparison, it has been proved that, the method applied in the proposed algorithm works better than the existing. Whatever the size or format of images may be, the result will be produced in the pre defined format. The result occupies less space when compared with the size of the input for storing.

The Fig 6 graphical representation is between the estimated time and total number of Machines. In the proposed system, the taken to process the image is comparatively less than that of existing system.

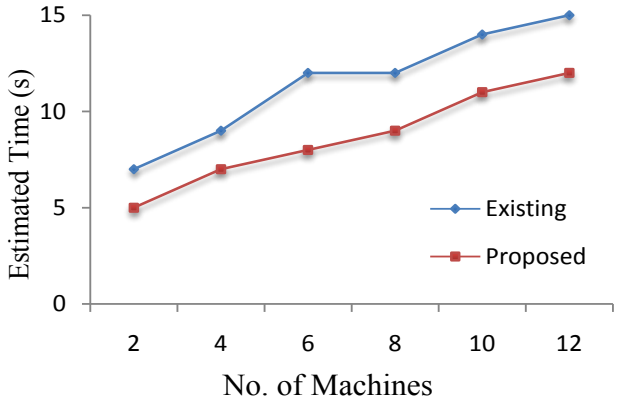

Figure 6 : Effect of proposed and existing techniques with respect to time and No. of machines

Finally, this Fig 7 shows the graphical representation between Existing Map function with the Proposed Map function. In the existing Map function, the data will simply just get splitted in the normal way. But in the proposed system, we have introduced Pre-Map technique, it basically Maps the data before sending to the Map Function. By default the data processing will be simple. This is graphically explained in the bellow picture.

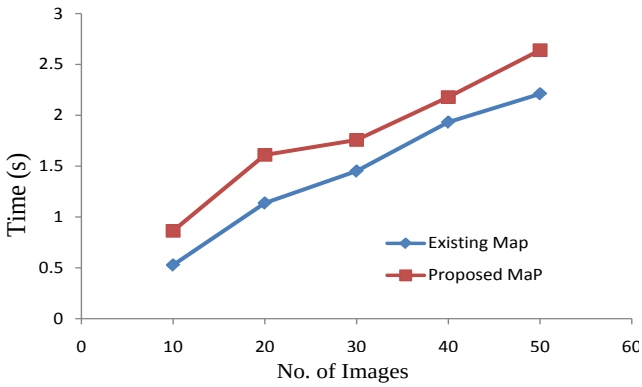

Figure 7 : Effect of mapping techniques with respect to time and No. of image

VI. Conclusion

Already an existing work was done with four data processing techniques and with an algorithm was implemented in the Reduce function. But in this proposed system, the processing techniques have reduced from four to two image processing techniques, with proposed an optimized scheduling algorithm. This work resulted with less waiting time and error percentage. An application of JAI and Pre-Map technique with Hadoop over Ecua2ool results with far better result in the entire manner when compared with the existing system. Further, our research works will be on application of scheduling over the Heterogeneous Networks for scheduling and resource allocation.

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Design of Simulator to Evaluate Performance Parameters of Scheduling Clouds in Virtual Machine Environment

By Dr. P. K. Suri & Himanshi Goyal

Abstract - Cloud computing acts as a vision of infinite computing resources that are provided on-demand to the cloud users as needed and are billed on pay as per usage basis. Cloud computing employs the concept of virtualization that provides an opportunity to achieve business and IT objectives. Scheduling is one of the most important challenges that a cloud computing environment faces. Scheduling process determines the order of execution of jobs and the virtual machine to which job is assigned to execute so as to improve the performance and quality of service and at the same time resources are utilized effectively. An attempt has been made in this paper to develop a simulator to schedule a job on allocated virtual machine so as to make efficient resource utilization. In the proposed work, scheduling is done on the basis of availability of allocated virtual machine, providing equal capabilities. We assumed that arrival of jobs in a cloud and their execution on a virtual machine is exponentially distributed. For analysing the proposed algorithm, the performance parameters of scheduling clouds are evaluated in Virtual Machine Environment.

Keywords: cloud computing, job scheduling, simulator, exponential distribution, response parameters.

GJCST-B Classification : D.4.2

Strictly as per the compliance and regulations of:

Design of Simulator to Evaluate Performance Parameters of Scheduling Clouds in Virtual Machine Environment

Dr. P. K. Suri [α] & Himanshi Goyal [σ]

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Keywords: cloud computing, job scheduling, simulator, exponential distribution, response parameters.

I. Introduction

Cloud computing environment pivots on sharing of resources to handle cloud applications. Cloud computing provides all types of IT resources as a service to the users and promotes high performance computing. Cloud providers offers their services as software as a service, platform as a service and infrastructure as a service. Cloud computing system rent the computing resources on demand and employs the concept of virtualization.

Cloud computing environment allocates resources in terms of virtual machines that share the resources of single physical computer among several different virtual computing environments. For example, if the physical machine has 15 GB of RAM, then virtual machines could have 15 GB in total, and can be distributed as per user requirements. After allocation, scheduling strategy is required to schedule the jobs on allocated resources to make them execute. Hence cloud resource management is specified by both allocating and scheduling the computing resources on virtual machines.

Scheduling is an important issue of a cloud computing environment that determines the order of execution of jobs and the system on which jobs executes. Because of the heterogeneous nature of cloud environment, the performance of applications is directly influenced by scheduling process. The scheduling of large and diversified group of jobs on virtual machines is considered as NP-complete problem. According to the scheduling strategy used, scheduler either maps the jobs over suitable resources as soon as they arrive or first places the jobs in a queue and then maps over resources for execution. There are various scheduling algorithms that are already present in cloud computing environment.

The present study proposed a simulator to schedule the jobs over allocated resources on the basis of availability of virtual machines. In the present work, a simulator is implemented to map the jobs over suitable machine on the basis of its availability to make them run.

The paper is organized into various sections; present one is the section I that briefly introduces the topic of our concern. Section II provides the overview of different scheduling algorithms that are already present in cloud computing environment. Section III provides the overview of proposed system. Section IV introduces the new cloud job scheduling algorithm that we have proposed. Section V interprets and demonstrates the results of proposed algorithm by using charts that represents response parameters. Section VI concludes the paper.

II. Related Literature

Scheduling is a challenging issue in cloud computing environment that determines the order of execution and the machine to which task is assigned. In this section, an overview of various scheduling strategies that are already presented in cloud computing system is presented. In [1], scheduling is done on the basis of execution time. At first, largest job is mapped to the machine with minimum completion time and then max-min is applied to the remaining job requests. In [2], scheduling is done on the basis of priority; each and every job is having a predetermined priority. In [3],

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priority and execution time are the two main aspect on the basis of which scheduling is done. Task with highest priority is assigned to the machine that provides earliest completion time. In [4] and [5], genetic algorithm is used to map the jobs over suitable virtual machine in minimum execution time. Later one is influenced by bees' colony life that is aspired by two main behaviors, one is reproduction and other one is food source searching. In [6], the parameter that is used to schedule jobs on resources is cost, best suited for the heterogeneous computing environment. In [7], an algorithm for scheduling jobs is proposed to meet the deadline and reliability requirements of the user. In [8], selection is made between max-min and min-min algorithm, the one that helps in minimizing the total completion time and to meet Qos is selected. In [9], scheduling strategy is based on priority that is assigned to both jobs and virtual machines. In [10], a workflow scheduling algorithm is presented to meet Qos requirements on the basis of negotiation between user and server. In [11], load balancing algorithm is presented that is based on the min-min algorithm and to satisfy user requirements more appropriately an improved user aware algorithm is presented. In [12], algorithm is presented to schedule real-time tasks non-pre-emptively. In [13], users select a method on the basis which scheduling is done and then are prioritized. In [14], location-aware scheduling is performed.

III. Proposed Work

Cloud resource management is concerned with allocation and sharing of resources. Different scheduling strategies are already present in cloud environment that are based on various parameters. We have proposed a scheduling strategy on the basis of availability of virtual machine. When user makes a request for resources to run an application, services provider allocates the resources in a form of virtual machine as per user needs. To run an application, a user may consist of multiple jobs which runs in virtual machines to make use of available resources required for its execution. Hence an optimal scheduling strategy is required to map these jobs over suitable virtual machine so as to increase the performance and to make resource utilization effective. Scheduling strategy that we have proposed in this paper is based on the availability of virtual machines. The objective of proposed simulator is to make effective resource utilization.

In the proposed work, it is assumed that n numbers of virtual machines (having same capabilities) are already allocated to a user to make use of resources so as to run an application. Jobs arrive at a cloud using any probability distribution for interarrival times. When a job arrives at a cloud, each of the machines is checked to determine if any of them is free. The job is assigned directly to whichever machine is free and if two or more than that are free then the job is assigned to the virtual machine that has been ideal for a longer period so as to make effective resource utilization. If all of the machines are busy in executing jobs, then the job requests joins the common queue. The jobs requests in a queue are serviced on a first-come-first-served basis. The service times for each servicing facility can be viewed as independent samples from some specific distribution.

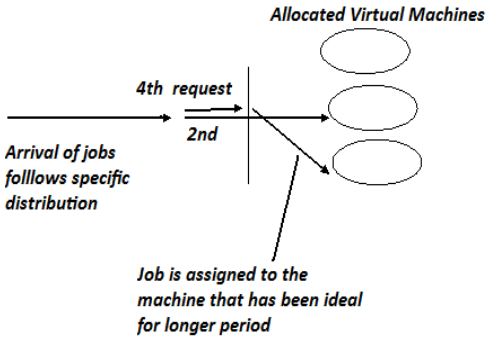


Figure 1 : When one or more machine is available

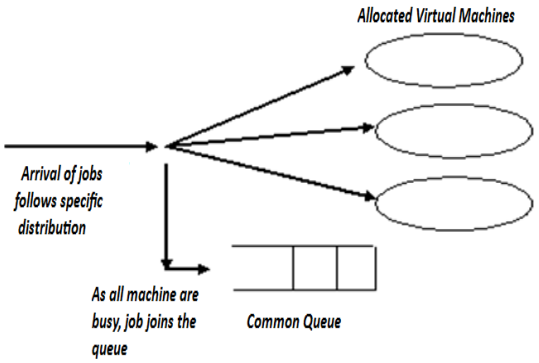
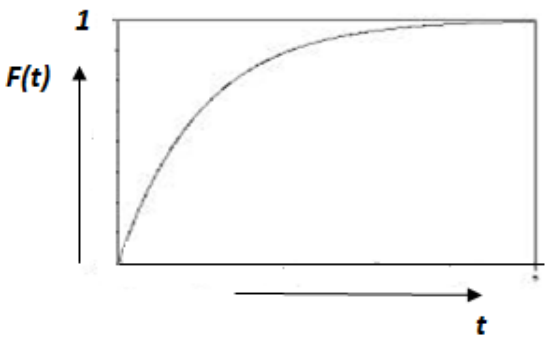


Figure 2 : When all machines are busy in executing other requests

a) Assumptions

- Arrival of jobs and their execution on virtual machines follows exponential distribution. The probability distribution function of this distribution can be shown as:



- Jobs arrive at a cloud one at a time with an average inter-arrival time, say alpha.
- At a time, only one job can execute on a single virtual machine with service rate say beta.

- The jobs in the queue are served on first-come-first-serve basis.
- Virtual Machines are having same capabilities.

IV. Cloud_sch_sim Algorithm

Symbol Used	Description
N	Number of jobs requires to run a cloud application
S	Number of allocated virtual machines
AT_k	Inter-arrival times of arriving jobs
ST_k	Service time of k^{th} job
CAT_K	Cumulative arrival time of k^{th} job
$CDT_{K,L}$	Cumulative departure time at machine l of job k
NDT_L	Next departure time from machine l
NAT	Next arrival time
QLT	Current Queue length
$Serv_l$	Describes which job is currently being executed by machine m

Step 1: Generate AT's and ST's for all jobs arrives at a cloud from exponential distribution $(1-e^{-\lambda t})$. These samples can be obtained by transforming uniform random numbers in the interval (0,1), according to eq.

$$T_k = (-((\log_e u_k)/\lambda))$$

Step 2: Do the initialization:
[Set:- $AT_0=0$, $CAT_0=0$, QLT=0
For (K=1,..N)
$CAT_K = AT_K + CAT_{K-1}$
For (L=1,..S)
$NDT_L = CDT_{K,L} = CAT_L + ST_L$
]

Step 3: Find machine (VM) m having minimum next departure time and hence executes the suitable job.

Step 4: If all jobs are already arrived at a cloud then go to step 9 else calculate the difference between next arrival time and minimum next departure time.

Step 5: If that calculated value is less than 0 then go to step 6, if equal to 0 then go to step 7 else go to step 8

Step 6: In this step, job that arrives at a cloud joins the common queue and set:
QLT+= 1, I= I+1 and NAT= CAT_I. Now go to step 3.

Step 7: Both execution and arrival takes place at this place as follows:-
The job that executes on machine m is:

$$\text{Max } [Serv_k] + 1, \quad k=1,\ldots S$$

Now add ST of corresponding job to NDT_m and then the corresponding job departs.

At the same time, new job arrives at a cloud and joins the queue. Now go to step 10.

Step 8: If (QLT >0) then go to step 4 else the job that arrives at a cloud is executed by machine m. And update the next departure time from machine m and go to step 10.

Step 9: In this step, the job leaves the queue on first come first serve basis and is executed by machine m and its next departure time is updated.

Step 10: If the job that is executed by virtual machine m is the last job then Print the computed statistics
Else go to step 3.

Step 11: End

V. Results

In this section, we have analyzed the performance of the cloud by implementing "CLOUD_SCH_SIM" Simulator. The performance is evaluated in three parts by using number of response parameters:

- Mean queue length (QL)
- Average waiting time of jobs in a cloud (WT)
- Throughput (TH)
- System Utilization (SU)

In first part, response parameters are analyzed for constant service rate (say, $\mu=12$), at varying arrival rate (λ). For the following analysis, we assume that 100 jobs are required to run an application and 2 VM's are allocated on which job executes. The resultant values of response parameters on the basis of following assumptions are recorded in table I.

Table I : Response Parameter Values for Constant **(Say, M=12)**, at Varying (Λ).

λ	QL	WT	SU
7	0.15	0.004800	0.291667
9	0.5	0.017988	0.375000
11	0.72	0.034038	0.458333
15	2.32	0.106794	0.625000
19	7.53	0.379477	0.791667

Graphs representing parameter values recorded in above table are shown below:

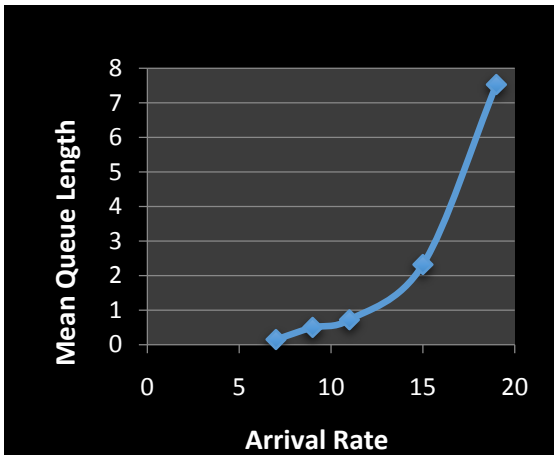


Figure 3 : Analysis of Mean Queue Length for constant (**μ=12**), at varying (λ).

It depicts that increase in arrival rate results into an increase in parameter Mean queue length.

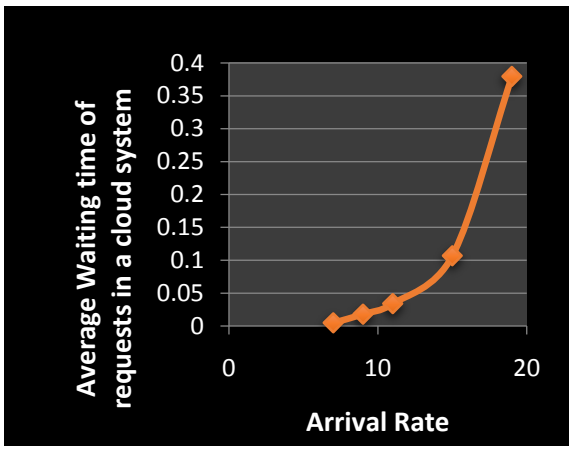


Figure 4 : Analysis of Average waiting time of jobs in a cloud for constant (**μ=12**), at varying (λ).

It depicts that increase in arrival rate results into an increase in parameter Average waiting time of jobs in a cloud

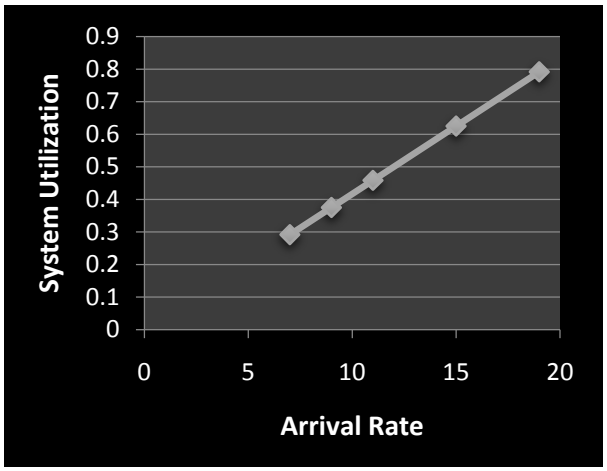


Figure 5 : Analysis of System Utilization for constant (**μ=12**), at varying (λ).

It depicts that increase in arrival rate results into an increase in parameter System Utilization.

In Second part, response parameters are analyzed for constant arrival rate (say, λ=19), at varying service rate (μ). For the following analysis, we assume that 100 jobs are required to run an application and 2 VM's are allocated on which job executes. The resultant values of response parameters on the basis of following assumptions are recorded in table II.

μ	QL	WT	SU
12	7.53	0.379477	0.791667
16	1.86	0.064698	0.593750
20	0.81	0.023105	0.475000
23	0.56	0.012749	0.413043
26	0.49	0.007488	0.365383

Table 2 : Response Parameter values for constant **(say, λ =19)**, at varying **(μ)**.

Graphs representing parameter values recorded in above table are shown below:

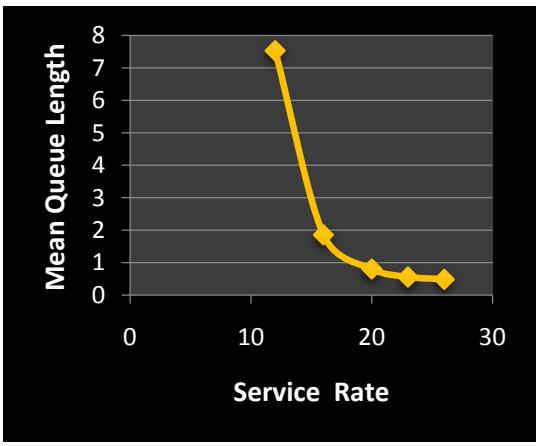


Figure 6 : Analysis of Mean Queue Length for constant (**λ =19**), at varying **(μ)**.

It depicts that boost in service rate lowers the Mean queue length.

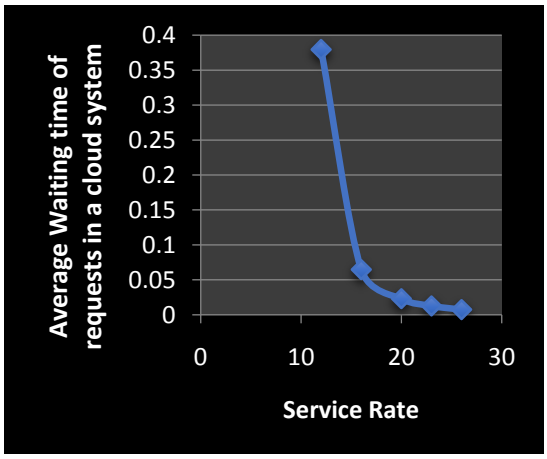


Figure 7 : Analysis of Average waiting time of jobs in a cloud for constant (**λ=19**), at varying (**μ**).

It depicts that boost in service rate lowers the Average waiting time of jobs in a cloud.

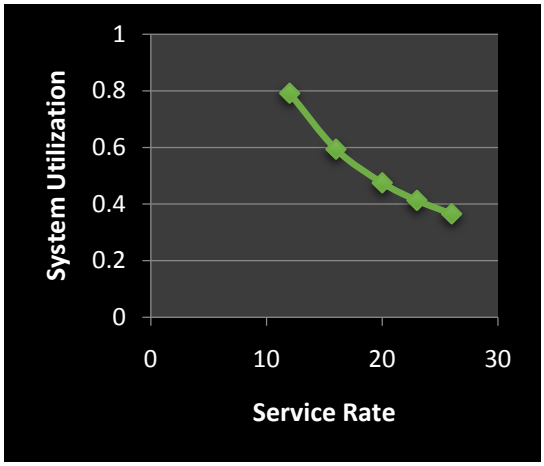


Figure 8 : Analysis of System Utilization for constant (**λ =19**), at varying (**μ**).

It depicts that boost in service rate lowers the System Utilization.

In Second part, response parameters are analyzed for constant arrival rate (say, λ=3) and service rate (say, μ=4), at varying number of allocated VM's (N). The resultant values of response parameters on the basis of following assumptions are recorded in table III.

N	QL	WT	SU	TH
1	6.31	1.886198	0.75	3.0
2	0.5	0.053900	0.375	1.5
3	.02	0.000530	0.25	1.0

Table 3 : Response Parameter values for constant arrival rate (say, **λ=3**) and service rate (say, **μ=4**), at varying number of allocated VM's (N).

Graphs representing parameter values recorded in above table are shown below:

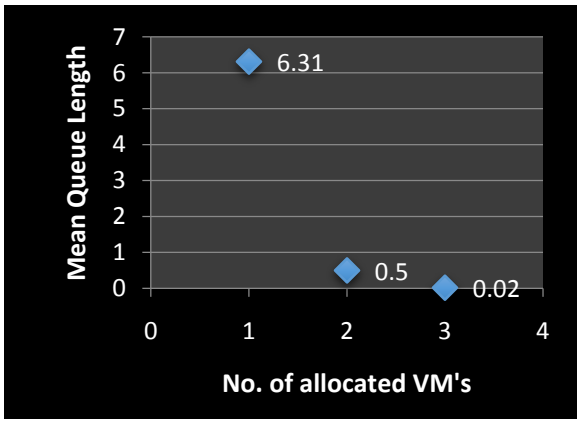


Figure 9 : Analysis of Mean Queue Length for constant arrival rate (**λ=3**) and service rate (**μ=4**), at varying number of allocated VM's (N).

It depicts that as the number of allocated VM's increases, Mean queue length decreases.

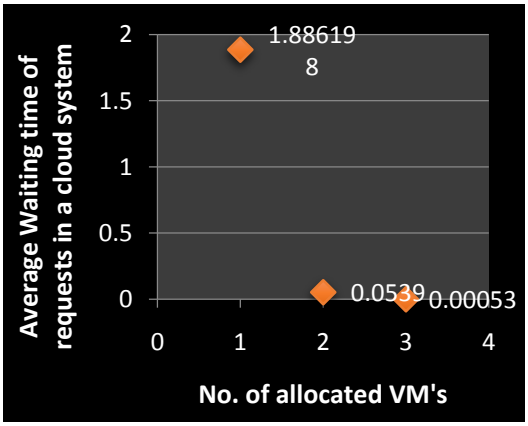


Figure 10 : Analysis of Average waiting time of jobs in a cloud for constant arrival rate (**λ=3**) and service rate (**μ=4**), at varying number of allocated VM's (N).

It depicts that as the number of allocated VM's increases, Average waiting time of jobs in a cloud decreases.

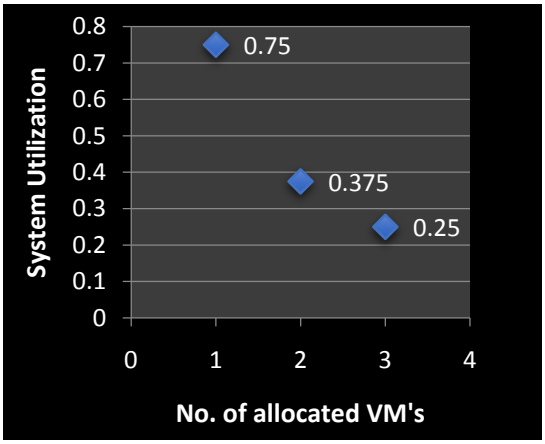


Figure 11 : Analysis of System Utilization for constant arrival rate (**λ=3**) and service rate (**μ=4**), at varying number of allocated VM's (N).

It depicts that as the number of allocated VM's increases, System Utilization decreases.

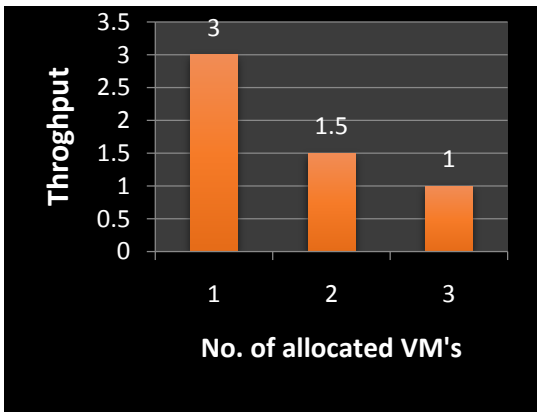


Figure 12 : Analysis of System Throughput for constant arrival rate ($\lambda=3$) and service rate ($\mu=4$), at varying number of allocated VM's (N).

It depicts that as the number of allocated VM's increases, Throughput decreases.

VI. Conclusion

The simulator "CLOUD_SCH_SIM" is designed and implemented successfully in this paper to schedule the jobs arrive at a cloud over suitable virtual machine to make them run so as to make effective resource utilization. In this paper, the performance parameters of the scheduling clouds such as throughput, utilization are also evaluated in Virtual Machine Environment. This simulator will be an asset for cloud service providers/ software development houses to analyze the performance of clouds and thereby in managing the resources in various computing environment particularly in clouds.

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- Significant conclusions or questions that track from the research(es)

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What to keep away from

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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
- In spite of position, each table must be titled, numbered one after the other and complete with heading
- All figure and table must be adequately complete that it could situate on its own, divide from text

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."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- 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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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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