A Detailed Review on Agent-based Computing in Hybrid Multi Cloud to Handle the Big Data Issues by Improving the Performance of Cloud Management

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ABSTRACT

Today, the cloud computing has been a focus of research. Security and privacy are the key issues for cloud computing applications, and still face some enormous challenges. Agent-based cloud computing is concerned with the design and development of software agents for bolstering cloud service discovery, service negotiation, and service composition. With the advance of cloud computing, hybrid cloud that integrate private and public cloud is increasingly becoming an important research issue. Agents are used in migrating cloud applications from a busy host to an idle host in an efficient way to guarantee the performance in the geographical heterogeneous cloud environment involving Big data. Big data is defined as large amount of data which requires advanced technologies and architectures to extract result of analysis process.. Big data due to its various properties like volume, velocity, variety, variability, value and complexity put forward many challenges. Big data is a recent upcoming technology in the market which can bring huge benefits to the business organizations. To handle the Big data issues Scientific Data Infrastructure (SDI) can be naturally implemented using modern cloud based infrastructure services provisioning model. Since the Big data involves some of the sensitive data of users security issues are important.

Index terms

Agents, Big data, SDI, Service migration, cloud security.

INTRODUCTION

Cloud computing is a business model of computing which follows the pay-per-use strategy. In this environment the business user need not to have their resource at their place. They can simply use the resource of a resource provider in the cloud environment. Based on the services provided, the cloud computing is categorized into three models. They are

1) Software as a service (SaaS),
2) Platform as a service (PaaS), and
3) Infrastructure as a service (IaaS).

Also there are four different deployment models in cloud computing. They are private cloud, community cloud, public cloud and hybrid cloud. Efficient utilization of this cloud environment can be achieved by implementing agents. Agent based cloud system simplifies the job of consumer and provider.

Big data concept is a newly emerging technology which deals with the huge amount of data of heterogeneous type of data. Generally the Big data involves the data from web pages, sensors, social media, and the log information. They may contain some of the confidential data of the firm or individual. An exclusive architecture is needed to address the process of capturing, storing and analyzing the Big data and to arriving at a decision. Security measures also have to be considered.

Since processing Big data is a huge process, if a particular cluster is overloaded then, some of the jobs can be transferred to other clusters in the could system**.**

1. AGENT BASED CLOUD COMPUTING

An agent is an independent computer system that cans take autonomous decisions on the actions to be performed to fulfill its design goals. In agent-based cloud computing software agents bolster the cloud service discovery, service negotiation, and service composition.

1.1. Cloud service discovery

An agent-based cloud search engine module called Cloudle is devised to help in the service discovery by querying against the database of cloud services registered in the search engine.

The Cloudle consists of a Service Discovery Agent (SDA) and a set of cloud crawlers. The SDA composed of

1) Query processor, extracts essential keywords in the consumer's requirements
2) Service reasoning module, find the degree of matching between consumer and provider service specification.
3) Price and time slot matching module, determine the rate of matching between customer and provider specification on the price incurred and time schedule. and
4) Service rating module , rates the services to be provided by different providers relative to the service specifications of the consumer.

SDA refers to the Cloud Ontology to reason about the similarities of the customer's requirements submitted and the provider's specifications. The Cloud Ontology maintains the available cloud services for the customers by storing a set of cloud concepts. The cloud crawlers gather information about cloud service providers by visiting web pages serially.

Thus the SDA gives out a list of services of providers ordered in terms of the service rates.

1.2. Service negotiation

A Cloud-Market model for trading cloud resources consists of providers, consumers and brokers. In order to manage the cloud resources this market-oriented approach,

regulates the supply and demand of services through flexible and dynamic pricing. In the agent-based environment the cloud market is simulated with three types of agents: Consumer agent, Provider agent and Broker agent. The cloud negotiation model provides negotiation between

1) consumer and broker agents and
2) broker and provider agents.

A consumer agent may send the request to any number of broker agents and a broker agent can receive request from any number of consumer agents. So a many-to-many negotiation model is employed between consumer and broker agents. Since a cloud service may be dynamically composed of many resources, a single broker agent can do negotiation with many resource providers. Hence concurrent one-to-many negotiation mechanism is to be used between a broker agent and a set of provider agents.

The aspects of the negotiation protocol used are listed below:

- Has a number of rounds
- In the negotiation process an agent propose a deal from the space of possible deals. Eg: List of service prices starting with favorable and ends with unfavorable.
- If an agreement reached between agents, then negotiation process stops.
- If no agreement is reached, next round of negotiation continues.
- The agents follow the market-driven approach to compute the concession amount used for the negotiation using a combination of three negotiation functions.
    - Time function
    - Opportunity function
    - Competition function

1.2.1. Time function

There are three strategies are considered for calculating time-dependent concession.

- Conservative: Maintaining the initial price until an agent's deadline is almost reached. (Time constant $\lambda>1$)
- Conciliatory: Conceding rapidly to the reserve price ($0<\lambda<1$)
- Linear: Conceding linearly to the reserve price ($\lambda=1$)

The calculation of the concession amount using time function at round't' is as follows:

For example consider consumer agent,

$P_{CA}(t)=IP_{CA}+(t/T_{CA})\ \lambda_{CA}\ (RP_{CA}-IP_{CA})$

Where IP_{CA} = Initial price of consumer agent

RP_{CA} =reserve price of consumer agent

$P_{CA}(t)$ = Concession price at round 't'

T_{CA} = Consumer agent's deadline

λ_{CA} = Time constant of consumer agent

1.2.2. Opportunity function

Since a consumer and broker agent can negotiate with more than one agent, they have to consider outside options also. The amount of concession is calculated using O function by considering

- Trading alternations
- Differences between its proposal and the proposals of each of its opponents.

In general, if there are more number of trading alternatives, then less amount of concession should be made and vice versa.

1.2.3. Competition function

This function determines the amount of competition of an agent by considering the number of competitors and the number of available options in the cloud market.

For example consider the negotiation between a consumer agent and a broker agent. Let there are m number of consumers and n number of brokers. A consumer agent C_1 has m-1 competitors $\{C_2,\ldots,C_m\}$ and n trading partners$\{B_1,\ldots,B_n\}$.

- The probability of C_1 is not the most preferred trading partner of any $B_j \in \{B_1,\ldots,B_n\}$ is (m-1)/m
- So the probability of C_1 is not the most preferred trading partner of all the $B_j \in \{B_1,\ldots,B_n\}$ is $[(m-1)/m]^n$
- Hence the probability of C_1 is the most preferred trading partner of at least one of $B_j \in \{B_1,\ldots,B_n\}$ is $C(m,n)=1-[(m-1)/m]^n$

1.3. Agent based cloud service composition

In the service composition model, there are four different agents and a web service module.

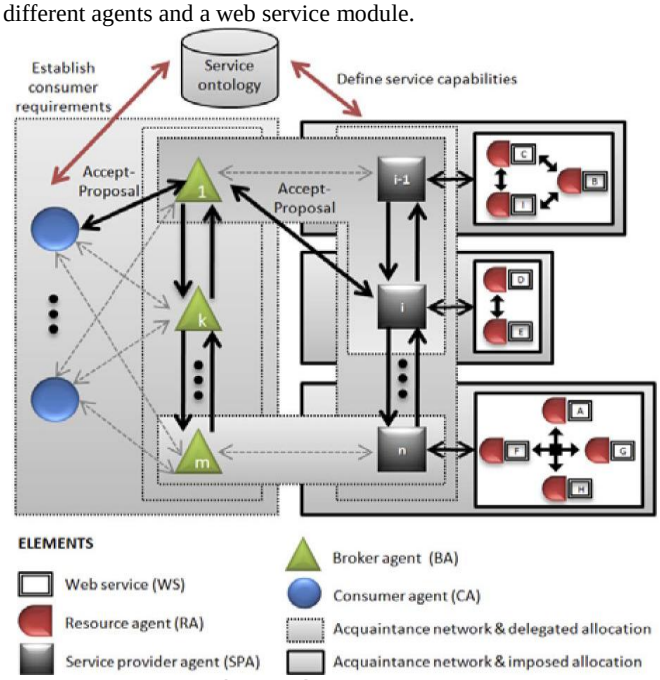

Fig 1 Service Composition

- Web service: An interface to a software application or a resource.
- Resource agent (RA): Manages and controls access to a web service.
- Service provider agent (SPA): Control and organize RAs in order to manage the service provider's resources.
    - SPA delegates the tasks it requires to some of its RAs and even SPA can decompose the task and delegates to a group of RAs.
    - If any RA require some RAs of other SPAs to be referred, to complete its task then, SPA interact with the other SPAs.

- Broker agent(BA)

Collects the resources from multiple SPAs and composes a single virtualized service to consumer agent.

- Consumer agent(CA)
  They submit the request to BAs, which in turn contacts SPAs to acquire a set of resources.

For the service composition done by the broker agent a table called Service Capability Table (SCT) is maintained, where the agents record the cloud services provided by other agents in the cloud system. A new protocol FSCNP [Focused Selection Contract Net Protocol] is used to regulate he interactions of the agents.

1.3.1. FSCNP

The features of the protocol are described below:

- Agents have two roles: Manager and Contractor
- Manager(Client): It requests the other agents, which provide the relevant services, through a message or a call-for-proposal. After receiving the proposals from the other agents, the manager evaluates them and awards the contract to the most appropriate one.
- Contractor (Server): It listens to the call-for-proposals from the managers, evaluates them and submits the bid to them.
- An agent can take up multiple roles at a time
- The service results are propagated through the agents
- Once an agent receive a service result it integrate it with the relevant one in Service Capability Table (SCT)
- When a contract fails, it can be restarted again for a reasonable number of times.

2. AGENT BASED SERVICE MIGRATION

Since public cloud usage is charged in pay-per-use scheme, it should provide sophisticated resources involving computing platforms and required storage. In this system architecture if the private cloud overflows, a service from it is migrated to public cloud at a time. The architecture consists of a set of agents and repositories.

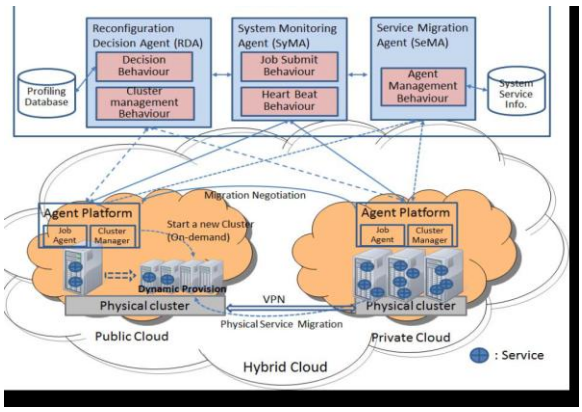

Fig 2. System architecture

2.1. Federated broker

It is responsible for monitoring loads of private and public clouds, reconfiguring the system scale and migrating service, if needed.

- System Monitoring Agent (SyMA)

It collects the load information of each cluster in the cloud system as heartbeat messages from the Cluster Admin Agent(CAA) and logs them in the profiling database and system/service database. With the information gathered it calculated the loads and checks if balanced or not. If there is any imbalance then, SyMA informs about the migration.

- Reconfiguration Decision Agent (RDA)
  SyMA intimates about the unbalanced status of the private and public clouds. RDA can obtain the current status of clusters to decide upon the reconfiguration. If the loads in the private and public clouds are imbalanced then, RDA reconfigures the load information in the repositories and informs the SeMA to start the migration process.

- Service Migration Agent (SeMA)
  It is responsible initiating and managing the service migration between private and public clouds. If RDA sends a message to SeMA stating that a job from private cloud to public cloud, SeMA starts the migration process using the migration policy.

- Profiling database
  It stores the profile of public and private cloud including the resource information of the public cloud.

- System/Service repository
  It stores the system and service related information such as location of private and public cloud, information of services running,etc.

2.2. Agents in the public and private cloud

There are two agents deployed in public and private cloud, namely Cluster Admin Agent (CAA) and Job Agent (JA).

2.2.1.CAA

It is the main component of the cluster. It manages the whole cluster and negotiates the actions with gents in federated layer. It periodically collects the cluster information and sends to SyMA as heartbeat message. And also guides and manages the JAs.

2.2.2.JA

Before initiating the job migration, the job is encapsulated in the JA. This includes service execution file, input data, location to be migrated, etc.

2.3. Service migration

The flow of service migration is described below:

SyMA SeMA RDA CAA_{PR} CAA_{PU}

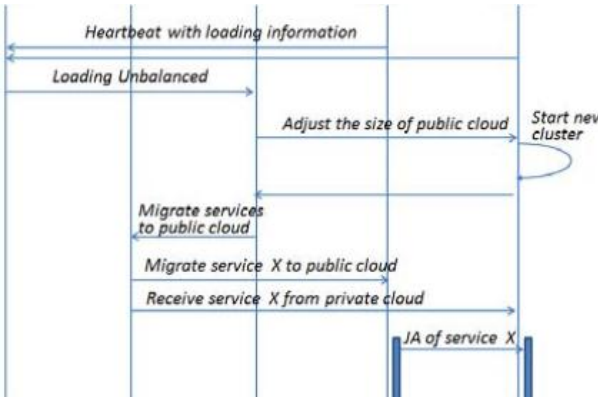

Fig 3 Service migration flow

1)The CAAs periodically send a heartbeat message that contains the loading information to SyMA.
2) The SyMA computes the loading according to the loading information to checks the loading of the clouds is unbalanced or not.
3) If it is unbalanced considerably, the SyMA will inform the RDA to adjust the size of public cloud. The RDA based on its decision to send a request to CAA of public cloud.
4) The CAA of public cloud will start new cluster for accepting and deploying migrated service, and respond the result to RDA.
5) The RDA proceeds to inform the SeMA to migrate service to public cloud.
6) The SeMA is than to compute which service will be migrated to public cloud according to migration policy, and inform both private and public cloud.

2.4. Service migration policy

Here three different strategies are used. They are as follow:

2.4.1.Job count JC

In this the job to be migrated is selected depending upon the number of jobs in the private and public cloud. The strategy is JC_{PR}-JC_{PU}>=T_C , where
JC_{PR} is job count of private cloud,
JC_{PU} is job count of public cloud,
T_C is threshold job count in private cloud

If the strategy becomes true then, SeMA will pick the $(JC_{PU}+T_C +1)^{th}$ job in the private cloud job queue for migration.

2.4.2. Size of job SJ

Here the sizes of the jobs present in the private and public clouds are considered for job migration.
Let $\sum SJ_{PR}$ be the sum of sizes of jobs in private cloud, $\sum SJ_{PU}$ be the sum of sizes of jobs in public cloud and T_S be the threshold job size. When the strategy

$$\sum SJ_{PR}-\sum SJ_{PU}>=T_S$$

becomes true then, [upperbound($\sum SJ_{PU}+T_S$)+1]th job in the queue of private cloud is selected for migration.

2.4.3. Estimated finish time EFT

In this case the migration decision is done depending upon the EFT of the jobs in clouds.

Let $\sum T_{PR}$ be the sum of EFT of jobs in private cloud, $\sum T_{PU}$be the sum of EFT of jobs in public cloud and T_t be the threshold EFT.

When the strategy $\sum T_{PR}-\sum T_{PU}>=T_t$ becomes true then, [upperbound($\sum T_{PU}+T_t$)+1]th job in the queue of private cloud is selected for migration.

3. CHALLENGES AND ISSUES OF BIG DATA

Handling huge amount of data efficiently for arriving at a decision is called Big data management. The exact definition of Big data can be given using its properties.

i) Volume – The amount of data is characterized by volume.
ii) Velocity – It represents the speed of data coming from various sources.
iii) Variety- Different categories of data like traditional, structured , semi structured and unstructured data from web pages, sensors, social media, etc. are be handled in Big data.
iv) Variability – It refers to the inconsistency of the data flow.
v) Value – Efficient handling and filtering of data for a query adds value to the business.
vi) Complexity – It measures the difficulties in linking, matching, transforming, correlating relationships and hierarchies of the data coming from various sources.

3.1. Issues and challenges of Big data

3.1.1. Privacy and security

When personal data are to be combined with large data set, new inferences about that person can be done by the data owner. In order to analyze and to take a decision the information about users are to be collected and stored. This may not be known to the users. Literate people may take advantage of Big data analysis and decision making, whereas under privileged cannot do that.

3.1.2. Data access and sharing information

Since Big data is used for making decision on accurate results in time, it is necessary to make the data available in accurate, complete and in time. Also sharing of data in time may decrease the degree of completeness and accuracy.

3.1.3. Storage and processing issues

The classical storage used is not enough for Big data. Uploading this large amount of data in **cloud** is not feasible, since it will take more time and data will grow rapidly. At the same time analysis requires complete data. Hence these **cloud issues** with Big data are categorized into capacity and performance issues.

Transportation of Big data over the net is also cumbersome. Two ways to avoid transportation only the n are 1) processing the Big data at the storage itself and 2) transport only the data need to be processed, instead of complete data. Even processing of these data takes huge time.

3.1.4. Analytical challenges

We need to formulate the analyzing procedure, if the volume and variety of data rapidly increases. Decision has to be made whether all the incoming data have to be stored or not and whether all the stored data need to be analyzed. Finding the important part of Big data for analysis and how to

get best advantage of Big data are the few challenges ahead in this field.

3.1.5. **Skill requirement**

Since it is an emerging technology, it is not employed in most of the industries and many people are not aware of it. So the the required number of experienced and skilled people are not available to solve the difficulties in Big data field.

3.1.6. Technical challenges

Complete fault tolerance is not possible in an feasible way. So the main task is to reduce the failure to an 'acceptable' level. Scalability issue of Big data has lead towards **cloud computing**, since high level of sharing of resources with least expense is required.

Big data basically focuses on quality data rather than having very large irrelevant data. Analyzing and mining of heterogeneous data is a challenging task for the solution developers.

4. SCIENTIFIC DATA INFRASTRUCTURE (SDI)

The SDI architecture proposed will support long running experiments and huge data generated at varying speed. The Big data exist in distributed manner and to ensure fault tolerance replication is employed.

This architecture supports virtual scientist communities and user trusted environment for data storage and processing. This architecture ensures data integrity, confidentiality, privacy and accountability

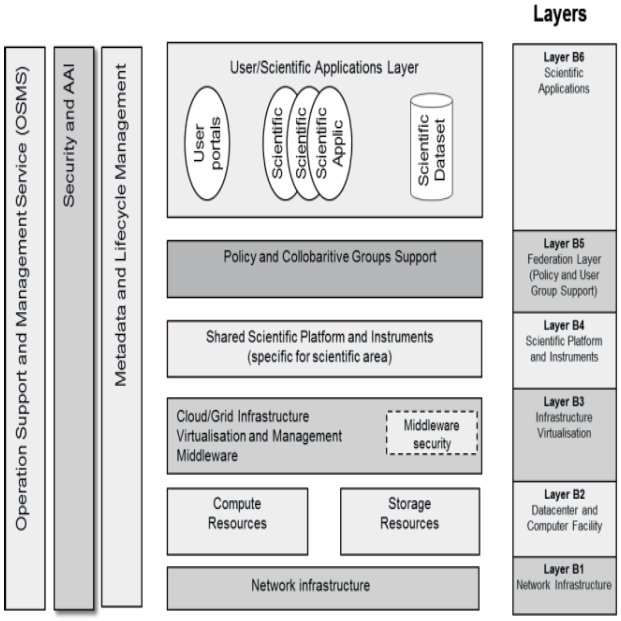

Fig 4. The proposed SDI architecture model

Layer B1 – The underlying network architecture. i.e. the internet

Layer B2 – Data centers and computing resources where the usual cloud data and resources reside.

Layer B3 – Cloud / Grid infrastructure, responsible for the computing.

Layer B4 – This layer is more specific to scientific area, which produce the Big data and is dedicated to processing Big data.

Layer B5 – This is to collaborate and integrate the different collaborative groups for handling the Big data.

Layer B6 – This layer is dedicated to the Big data users and includes scientific applications and user portals.

5. CLOUD COMPUTING SECURITY

5.1. Problems and issues

Traditional security problems such as security vulnerabilities, virus and hack attacks, etc can make threat in cloud environment also. If the cloud system meets failure, fast recovery of the resource is an essential one. Cloud systems do not disclose the details of service implementation technology and management.

So the users do not have the control over the progress of the service and can't make sure of the security of their own data.Data security audit can improve the cloud system quality. Data movement in cloud environment must be done only by authorized uses, to the authorized location and by authorized applications.

Cloud computing involves different network architectures with different security policies. So the overall security of the data entered in the cloud systems is a big challenge.

5.2. Strategies

Data can be encrypted before storing in cloud system. But if the data size is large i.e **Big data** then, encryption and decryption will require more time and computing resources. Asymmetric key encryption may provide higher security than other schemes. Security authentication uses PKI technology, X.509, X.500 certificate standards. Access control policies like network access control and directory level security control can avoid illegal usage of **Big data** and other cloud resources.

The confidential data of an user must not be misused by other cloud providers and operation and maintenance people, since the data once stored in cloud system, the user does not have control over it. Malicious and unidentified programs must be isolated.

Real time monitoring will be useful in detecting and fixing any abnormal action in the cloud system. Cloud service can be considered as a web service and hence the web service mechanisms such as WS-Security, WS-Reliability, WS-Trust, WS-Authorization, WS-Secure, etc can be used as a reference.

6. CONCLUSION

Agent based cloud computing system enhances the entire functioning of the cloud system. Since the consumer and the provider cannot look over the exact matching of their service specifications, some entity (Agents) can do these things, so that overhead of the consumer and provider will be reduced.

This is necessary for the applications involving the Big data. A dedicated architecture SDI for handling Big data can be much useful in the cloud environment. Since the Big data may involve sensitive information about a company or customer, authorized access to the Big data is more essential.

As the user once enters the data into the cloud system, he/she does not have control over the data. A data security confirmation should be offered to the customer who pays for the cloud usage.

7. FUTURE DIRECTIONS

Along with the service negotiation, price and time slot negotiation and QoS can also be focused. A more sophisticated service selection mechanism may be needed to deal with changing consumers' requirements. In the federated layer of the service migration model also cost and QoS improvement can be done.

Failure of any agent system should be addressed immediately. In case of any failure gradual degradation of the system is expected.

Application specific software for processing Big data can be developed. Access control strategy implementation in applications will improve the quality of the Big data system.

Authentication system can employ bio-metric passwords which improve the robustness of the cloud data security system.

New algorithms for filtering the Big data for processing have to be developed, since the whole data cannot be transported and even cannot be processed.

Analyzing different varieties of data attract a wide scope of research.

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