Synopsis of Cloud Broker Models

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Abstract—The advent of Cloud computing & the rapid adoption of Cloud services (IaaS, PaaS, SaaS) by the consumer to fulfil their business requirements has flourished the market with various Cloud Service Providers (CSP). Cloud service providers are developing the desired environment and tools to serve the consumer's needs. The consumers are facing the problem of selecting the appropriate Cloud service provider which can fulfil their need. This scenario which requires fast and controlled mechanism of managing resources, cost, capacity etc gives rise to the Cloud brokering system. The Cloud broker offers the opportunity to the consumer to get the best service as per service level agreement. In this paper, we are providing an overview of few Cloud brokerage models and there techniques used to select the best CSP from the pool of CSPs.

Keywords— Brokerage, Broker Model, Broker Service, Cloud, Cloud Computing .

I.   Introduction

Cloud computing has emerged out to be one of the fastest, promising and challenging technology in the present era offering expandable and scalable IT task force in terms of storage space and computing resources (e.g., networks, servers, storage, applications, and services).The essential characteristics of Cloud computing are on-demand self-service, broad network access, resource pooling , rapid elasticity, measured service[1].These characteristics make Cloud computing attractive service delivery model for users (individuals, Small and medium Enterprises) in terms of services offered by Cloud computing [2].

II.   Cloud Architecture

As shown in Fig1, NIST Cloud Computing Reference Model includes five main actors: Cloud consumer, Cloud auditor, Cloud provider, Cloud broker and Cloud carrier, depicting a generic high level architecture [3]. Each actor play a vital role in the transaction or process or performs any task in cloud computing. A cloud consumer represents an organization or user that maintains a business relationship with the CSP and uses their services in terms of software, infrastructure and platform. cloud provider is a person or organization which offers the computing services to the consumers.

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A cloud auditor is a party or organization that performs the assessment of cloud services provided by the cloud service providers. A cloud broker is an intermediary between a cloud provider and cloud consumer, providing consumer the needed services at an affordable rate from the cloud service provider. Cloud carrier is also an intermediary between consumer and provider, providing connectivity and transport of cloud services from CSP to consumer.
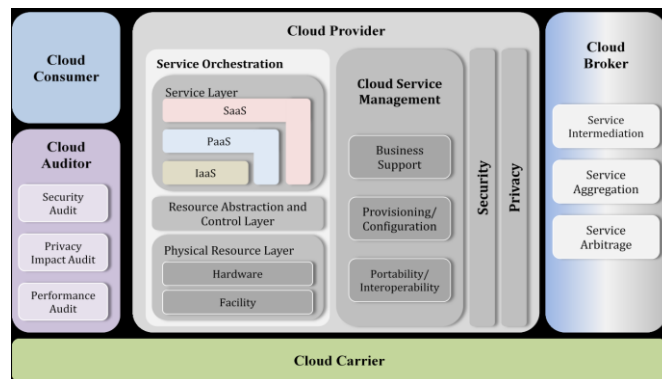

Fig 1: NIST Cloud Computing Reference Model [3]

From the architectural point of view Cloud computing offers the following service models:
Software as a Service (SaaS): This model provides the users, the ease of accessing user's application on Cloud infrastructure through various devices using interface such as web browser or program interface. For examples Salesforce.com [4], Oracle.com [5].
Platform as a Service (PaaS): This model enables the user to deploy user created or acquire application created using programming languages, services, libraries and tools supported by the provider on Cloud infrastructure. For example Microsoft Azure Platform [6], Google App Engine [7].
Infrastructure as a Service (IaaS): This model facilitates the user to process, store, network and other fundamental computing resources where the user is able to deploy and run arbitrary software, which can include operating systems and applications   [1].For   example   Amazon   Web Services (AWS) [8], AT&T Cloud Services [9].
Rest of the paper is organised as follows. Section 3 describes the role of the cloud broker and reviewing the broker models. In Section 4 discussion and analysis of these models is done and section 5 compromises of the future work.

III.   Cloud Broker

Cloud broker acts as a link between the Cloud service provider and consumer. As the number of Cloud service providers are rising it has become difficult for the consumer to find the

appropriate CSP who can fulfil his need at a competent price ,thus instead of contacting a CSP, a consumer contacts to the Cloud broker. The cloud broker finds the provider as per to the consumer's demand, negotiates with it for additional services and provides it to the consumer with a nominal fee. As per to National Institute of standard and technology, "a Cloud broker manages the use, performance and delivery of Cloud services and negotiates relationships between Cloud providers and Cloud consumers" [10]. This need of additional layer in Cloud computing give rise to the Cloud brokerage system. The three roles of a Cloud broker are as follows

Intermediation: When a consumer requires a cloud service , the broker negotiates with the provider by enhancing some specific capability and providing value-added services like identity management or access management, performance reporting, enhanced security etc .For example eyaktek.com [11].

Aggregation: The broker aggregates multiple services into one or more. Data integration and secure data movement between multiple Cloud providers and Cloud consumer is also a vital role played by a Cloud broker. Examples of some aggregators are BlueWolf [12], HP Aggregation Platform for Software as a Service [13].

Arbitrage: The broker has the flexibility to customize the services provided by various Cloud providers. For example, a broker can buy a large block of bandwidth in a wholesale amount and offer it in a small amount.

A Cloud Services Measurement Initiative Consortium (CSMIC) has launched Service Measurement Index (SMI), it includes critical characteristics (both business and technical), measures, and associated attributes that provide a standardized method for measuring and comparing a business [14]. Few services of Cloud service provider which a broker should keeps in mind while finding the suitable provider are accountability, performance, assurance, usability, service type, security and privacy, cost, interoperability, agility, Service level agreements, technical support, customer reviews, User Interface, scalability etc [15]. Few Cloud broker models have been discussed below depending upon the clarity of their architecture and increased citation count in the research industry.

A. *The Compatible One Broker*

CompatibleOne is an open source project which presents a model, Compatible one resource description system (CORDS) and a platform ACCORDS for the explanation and alliance of different Clouds comprising resources provisioned by varied Cloud service providers.

CORDS is an object based description model utilizing Cloud resources. It is an open source broker system [16]. It takes the consumer requirement and does not change anything from the Cloud provider's side. It operates on the three primary roles: aggregator, integrator and customizer identified by Gartner [17]. Using it the broker can also switch the consumer from

one Cloud to another. CORDS model acts as an important element for interpolation and federation in Cloud providers. Advance capability of CORDS (ACCORDS) is the execution platform for the CompatibleOne software.

Based on Open Cloud Computing Interface (OCCI) standards that defines a meta model for Cloud resources and Representational State Transfer protocol (RESTful) with flexible API and a strong interoperability feature, CORDS is suitable to serve IaaS, PaaS and SaaS [18]. CORDS model is designed to be consistent and complaint with OCCI interface. In IaaS CORDS model, nodes define a unit in terms of its infrastructure and services image. In accordance with OCCI IaaS extensions, the infrastructure unit provides Network, Storage and compute. The image unit provides the operating system. In CORDS, PaaS demonstrates an application and its environment in which it is hosted.

ACCORDS offer services of resource provisioning from different IaaS and PaaS providers through four steps:
1. Managing user's requirement.
2. Provisioning and Validation on plans.
3. Execution of the validated plan.
4. Providing the Cloud service.

Rather than brokering, ACCORDS offers services like CompatibleOne Security Service (COSS), CompatibleOne MONitoring Service (COMONS), CompatibleOne Placement Service (COPS), CompatibleOne Energy Efficiency Service (COEES), CompatibleOneOrdering, Billing and Accounting Service (COOBAS), CompatibleOne Network Service (CONETS) , CompatibleOne Image Production Service (COIPS) and CompatibleOne Elasticity Service (COES for short).
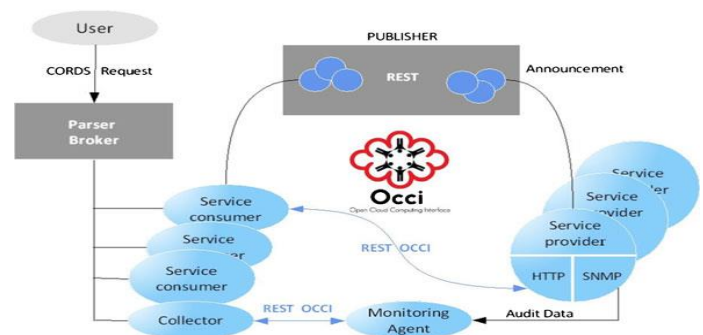

Fig 2: ACCORDS communication architecture overview [19]

ACCORDS communication architecture
The consumer submits their requirement to the Parser and Broker. The Broker finds the service providers through the central ACCORDS Publisher. The consumer interacts to the provider through REST OCCI interface to get the result. The monitoring agent is controlled by consumer or monitoring collector collects various audit and monitoring data to make sure that results achieved are as per to the terms in the CORDS manifesta or SLA[19].

B. *A Financial Brokerage Model*

Financial Brokerage Model is an extension of an approach given by Wu, Zhang, & Huberman, which is referred as WZH model [20]. In the first stage, each consumer has to presume the resource consumption for the next stage [21]. On the basis of the assumptions made by each consumer, broker anticipates the requirement for the next stage. Further, broker has to choose either to take the risk and spend in reserving the instance or to linger on till the subsequent stage and opt for on demand instance. Broker makes the choice by weighing the earlier achievements of the requests being made with that of presently available capacity for the equivalent stage as per the future perspective. It takes ROI (Return on Investment) into account while making the decision, which in turn is done by taking a threshold, variable. Investment is made only if utilization of resources exceeds the threshold value (θ). Marginal resource utilization (MRU) is the ratio of articles available in "Deficit profile" (D). Deficit profile is obtained by subtracting future capacity (F) from previous demand profile (P) [21].

$$D=P-F$$

Here, investment is done only if MRU$> \theta$.

In second stage, if consumer desires they give the amount or pay to access the resource. Broker provides the access for the full calendar month. Broker may also provide the access partially over the months; however this model considers only full month resources.

C. *STRATOS: A Cloud Broker Service*

In STRATOS model, when an application provider wants to deploy its application into the Clouds [22]. A RAD problem is encountered in two situations:

1. As soon as the initialization of the application environment takes place.
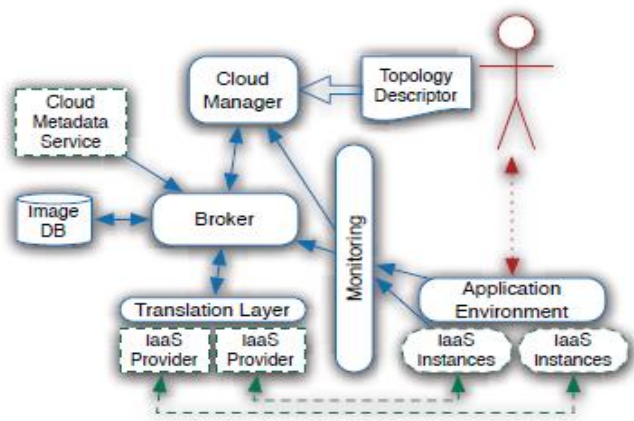2. While a change in resource allocation takes place.

Fig 3: STRATOS architecture [22]

In its architecture a Topology descriptor file (TDF) is used which defines the application topology which needs to be deployed on the Cloud. The application deployer gives all the details of its application which include structural concerns, monitoring, management policies, and deployer's objective. The Cloud manger decides to add or remove the resource .The application manger manages the runtime management of the application according to the model. When the manager receives this topology document, it contacts the broker. The broker solves the above said RAD problem by connecting to the selected providers and acquiring the resources. The resources are instantiated through a translation layer. The Cloud manager and broker monitors the information to make the ongoing elasticity decisions and then to assist in decisions.

D. *OWL-S Based Semantic Cloud Service Broker*

The OWL-S based semantic Cloud service broker is based on Semantic web rules (SWRL) to represent complex service constraints. This model embraces the OWL-S service description [23]. OWL-S follows W3C recommended OWL ontology language and supports industry and research community. It consists of three parts:

1. Service profile – for advertisement and finding service capability.
2. Service Model – providing the thorough description of the service operation.
3. Service grounding – describe the interoperability with a service.

The service profile supplies both the functional and non-functional information needed by the broker to discover a service. Service model along with the service ground supplies enough information to a broker to use a service. OWL-S supports SWRL, SWRL-FOL, DRS, KIF, SPARQL and RDQL and can be extended for providing other logical expressions. Reasoning support is limited.
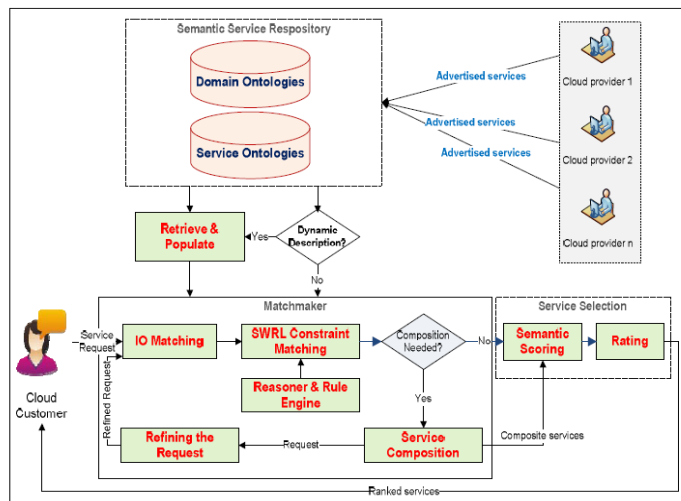

Fig 4: System Architecture of OWL-S [24]

The architecture of the model operates as follow. The Cloud service provider (CSP) provides product to the system. The entire product information is clustered into service repository.

The CSP has to provide the domain ontology as well. The crucial part of the system is match making engine which matches the consumer service request with the services in the repository and results the best match. Input output matching is performed first followed by constraint matching. It is checked that best match obtained is Invert-Subsume.

IV. Discussion and Analysis

As found on the availability, the Compatible one is a model as well as an execution platform. The software can be downloaded from the website and installed using configuration as mentioned on the site. It is a free and open source project. The CompatibleOne is an object based description model using ACCORD platform. Along with the execution platform, CompatibleOne offers other services like security , monitoring, efficiency, billing etc. CompatibleOne works for the services like SaaS, PaaS, IaaS.

Financial Brokerage Model is an assumption based mathematical model and an extension of WZH model. No architecture is specified in the model. This model depends upon the skills and experience of the broker forecasting when to buy the resources in advance and to sell them to their customer depending upon the need. The broker can buy resources directly from the provider for the customer or sell the resources available with him on low profit ratio.
No specific services which can be offered are specified.

The STRATOS broker model solves the RAD problem by connecting selected providers and acquiring the resources. It facilitates the runtime management and deployment of cloud application topology using cloud services provided by the CSPs. Evaluation can be performed through the set of experiments although this model is yet not implemented. High level architecture is well defined in the model. No specific services which can be offered are specified .The model allows the application developer to specify the needs in the form of key performance indicators, so that if a request is made for resource allocation it can be performed against all the service providers and the best matched can be choosen.

The OWL-S is based on semantic cloud service discovery and selection system to represent complex service constraints .This model holds the OWL-S service description. This model is defined and implemented using OWL-API, a Java API.

V. Future Work

Future work will be proposing a new broker model taking the best logical features from the other systems, combining them introducing new features and implementing it through programming language.

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