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Use Of Ontology To Secure The Cloud: A Case Study

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Abstract: ***The paper presents layout of secured ontological based cloud computing architecture in order to secure information uploaded by multiple users on cloud storage layer. It provides solution for retrieval of queries and provides fast response to users by using concept of Web ontology language (OWL) and its description logics.***

In addition to this, it also adds flavor of semantic web; discussed its evolution and role of ontology in development of semantic web.

Keywords: Semantic web, Ontology, Cloud computing and Security.

I. INTRODUCTION

The term semantic web was coined by Sir Tim Berners Lee in 1965. It came into existence with aim to abridge gap between humans and machines. Its architecture includes ontology that can be said as spine of semantic web. Ontologies are data models that represent meaning of semantics in expressive way. Ontologies are used to maintain relationship among real world entities belonging to particular domain. It has various definitions like philosophical, formal, explicit, specific, shared and many more. There are notions to express ontologies called as Ontology languages like RDF, OWL. They have predefined syntaxes and logic based semantics that performs reasoning and manipulations with the help of ontologies.

Semantic web is treated as third generation of web (Web 3.0) that focuses on generation of metadata and its annotations are filled in machine understandable form. Difference between current web and semantic web can be illustrated by taking an example of library. An old library with full of books without catalogue is treated as current web while modern computerized library with catalogues is semantic web. Obviously, modern librarians work faster because they have to search catalogues directly rather than searching whole books. In catalogue, results are retrieved / found on basis of author's name, publisher's name, ISBN number etc. The most important feature in modern library is that record field values are ordered and their values are interpreted in international standards like MARC format. It uses vocabularies in form of concept hierarchy like Dewey Decimal Classification System (DDC) or Universal Decimal Classification System (UDC). These standards are very vital for dissemination of information in libraries.

Similarly in web, these standards are used as ontologies to capture values of records. Then, these values acts as metadata to maintain interoperability between standards. If there are multiple standards, then they are to be mapped first before sharing of information.

Semantic web technologies like XML, RDF aims to create ontologies and metadata either from scratch or from existing ontologies. New ontology can be created from existing ontology by performing various ontology evaluation approaches like PROMPT, OntoMetric etc. Thus, it is concluded that semantic web is an application for generation of metadata and enhances the results of current web with the help of ontology.

There are various problems associated with the development of semantic web. According to Kevin Kelly, it suffers from fax effect which means that development of semantic web is costly and its technologies have not been utilized fully. But, still most of researchers are trying their hands on this web technology to achieve machine human interaction.

The following paper is categorized as follows: Section 2 makes readers aware of evolution of semantic web and makes them think to move towards this research area. Section 3 defines concept of ontology as one of research areas. Section 4 describes features and service models of cloud computing followed by recent studies conducted in context of cloud computing as described in section 5. Section 6 presents ontological based secured framework to prevent multiple data from unauthorized access. Finally, the paper is ended with conclusions and references.

II. SEMANTIC WEB

This section let readers think about few questions like why would current web need any extension? Why there are irrelevant results produced while on current web? The reason that is common to both questions is lack of knowledge gap between user and machines. Current web does not offer mechanism to provide deeper understanding of information. Various knowledge management solutions and technologies are there in field of AI to deal with this while missing information can be accessed with the help of ontologies. Ontologies can be social as well as formal. They are formal in such a way that they maintain human-machine interaction to enable knowledge reasoning while social confines maintaining relationships between classes and properties of other ontologies. Semantic web aims to transform web documents to information. Meaningful data is called as information. It involves creation of common framework that leads to sharing of data and its reuse among various applications. Application of semantic technologies covers areas like data integration, knowledge discovery, and resource discovery, classification of data and designing of intelligent systems.

III. ONTOLOGY

Ontology is treated as formal, explicit specification of shared conceptualization [1]. Besides its formal nature, philosophical aspects, handling real world scenarios, it also acts as medium of linking between human and machines. Ontology in itself is a vast research area that includes mapping, merging, extraction, moving and evaluation of ontologies.

Ontology evaluation approaches are classified in following categories [2].

- ✓ On basis of comparing ontologies
- ✓ On basis of usage and application of ontologies
- ✓ On basis of set of documents related to domain ontology
- ✓ On basis of human evaluation in order to meet ontology requirements and compatibilities.

Components of ontology include classes, properties, instances, inheritance functions, slots, frame values and sub classes. Relationship between classes and subclasses is defined by super concept-sub-concept and is defined as isahierarchy. Example: There is class named Institute with its sub classes IIT, IIIT, NIT's. So, it is represented as IIT is a subclass of Institute. There are social ontologies that help to achieve interoperability among social web applications in order to move from social web to semantic web. Some of them include FOAF, SIOC, XFN, GoodRelations, RSS Feeds and many more.

IV. CLOUD COMPUTING

Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. This definition from the National Institute of Standards1 has gained broad support from the industry.

The NIST definition of cloud computing describes five essential characteristics, three service models and four deployment models.

FIVE ESSENTIAL CHARACTERISTICS

- ✓ *ON-DEMAND SELF SERVICE:* Users are able to provision, monitor and manage computing resources as needed without the help of human administrators
- ✓ *BROAD NETWORK ACCESS:* Computing services are delivered over standard networks and heterogeneous devices
- ✓ *RAPID ELASTICITY:* IT resources are able to scale out and in quickly and on an as needed basis
- ✓ *RESOURCE POOLING:* IT resources are shared across multiple applications and tenants in a non-dedicated manner
- ✓ *MEASURED SERVICE:* IT resource utilization is tracked for each application and tenant, typically for public cloud billing or private cloud chargeback

THREE SERVICE MODELS

- ✓ *SOFTWARE AS A SERVICE (SAAS):* Applications delivered as a service to end-users typically through a Web browser. There are hundreds of SaaS service offerings available today, ranging from horizontal enterprise applications to specialized applications for specific industries, and also consumer applications such as Web-based email.
- ✓ *PLATFORM AS A SERVICE (PAAS):* An application development and deployment platform delivered as a service to developers who use the platform to build, deploy and manage SaaS applications. The platform typically includes databases, middleware and development tools, all delivered as a service via the Internet. PaaS offerings are often specific to a programming language or APIs, such as Java or Python. A virtualized and clustered grid computing architecture is

often the basis for PaaS offerings, because grid provides the necessary elastic scalability and resource pooling.

- ✓ *INFRASTRUCTURE AS A SERVICE (IAAS):* Compute servers, storage, and networking hardware delivered as a service. This infrastructure hardware is often virtualized, so virtualization, management and operating system software are also part of IaaS as well. An example of IaaS is Amazon's Elastic Compute Cloud (EC2), Simple Storage Service (S3) and Rackspace.

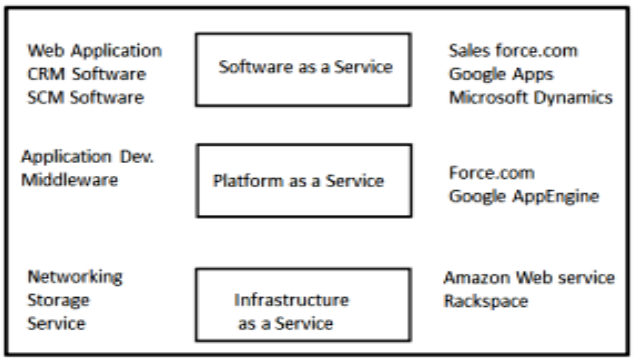

Figure 1: Service Models [3]

V. LITERATURE SURVEY

Several studies have been performed by researchers, scientists, programmers in context of cloud computing. Youseff et al. [4] clearly describes aspects of cloud computing like migration of data from cloud to cloud, setting cluster nodes theoretically only. Lee et.al [5] proposed an algorithm for handling and managing distribution of resources. The work covers processing of user requests not only in terms of processor size but also in accordance with service level agreements (SLA's). Fujiwara et.al [6] led to development of framework for cloud forensic environment. Sim et.al [7] introduced ontological based retrieval method for accessing information from cloud. Khafagy et.al [8] proposed development view of ontological based file system for accessing and sharing of information from multiple cloud service providers. Aforementioned studies depict role of ontology in acquiring secured cloud architecture. Parkin et al [9] devised a secured ontology layout that looks after implications caused due to human behavioral interactions while dealing with management services.

VI. SECURITY WITH ONTOLOGY IN CLOUD COMPUTING

This section presents layout of secured ontological based cloud computing architecture to secure information uploaded by multiple users on cloud storage layer. Fig 2 depicts schematic presentation of it.

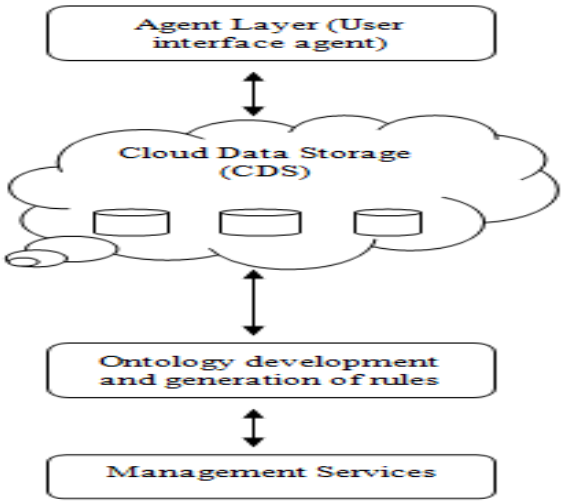

Figure 2: Security Framework

Description of modules is as follows:

- ✓ Agent Layer: - It involves user interface agent that acts as interface between user and multiple agents. Various agents can be used like Communicating agent, flow agent etc.
- ✓ Cloud Data Storage (CDS):- It is used to manage data flow sent by multiple cloud users by taking services from various cloud service providers (CSP's) on PAY PER USE policy. It holds database in which all queries and related information are stored. This information is used further.
- ✓ Ontology Development and Generation of rules:- On basis of queries and information stored on cloud server, ontology is being developed with the help of various ontology development tools like Protégé[10], WebODE[11] and many more.
- ✓ Then, rules are developed to derive inferences from given query. It can be done by using OWL and its description logic foundations [12].
- ✓ Management Services: - Above produced rules are useful in handling management services like billing, usage of data, payment details etc.

VII. CONCLUSION AND FUTURE SCOPE

The paper presents secured ontological based cloud computing framework that includes four modules viz. Agent layer, CDS, Ontology development and Management of services. It provides solution for retrieval of queries and provides fast response to users by using concept of OWL and its description logics. Ontology can be developed in formats like OWL-DL, OWL LITE and OWL FULL.

As future work, a feedback framework can be developed that incorporates use of various agents to gather knowledge from various cloud service providers in order to provide recommendations to cloud users on basis of their interests.

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