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Framework Semantic and Standard approaches in Multi-clouds to achieve interoperability: A survey

Zameer Ahmed Adhoni,* Dayanand Lal N,

Department of Computer Science and Engineering, Gitam School of Technology,Gitam University Bangalore, India.

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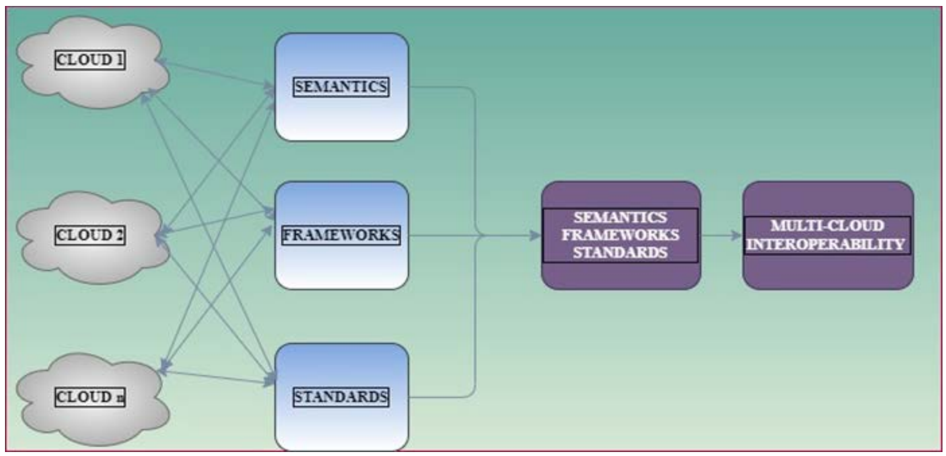
ABSTRACT



Cloud computing being the latest powerful way of storing data and hiring services on a server with no burden of hardware procurement. The facility to access data from the comfort of office without having the server physically has raised huge interest in the industry. Number of new cloud service providers has emerged with their own agreements and business models. Over a period of time clients have showed a proclivity towards switching cloud service providers for various reasons ranging from cost, efficiency, nature of business, operability, services, uptime and so on. There are clients who wish to draw more benefit from having multi cloud operations again due to various business reasons. This leads to need of amalgamation of clouds, interfaces between clouds, Application Programming Interfaces (API), collaboration of services and so on. This paper presents the existing different approaches so far which are popular along with the need for further research with respect to semantics, standards and framework of cloud for interoperability. There are however semantic, standard and Framework endeavors are deficient. The objective of the research is to feature the difficulties changes needed in the semantic of cloud for operating on multi clouds distinguishing semantic, standard and Framework activity that would be expected for relocating and coordinating services in the multi-cloud environment sooner rather than later.

Keywords: Platform-as-a-service(PaaS), Infrastructure-as-a-service(IaaS), Cloud interoperability, Semantics, Framework, Standards

INTRODUCTION

Multi-cloud computing is gaining traction as a means to integrate several services or migrate apps between cloud providers. Multi-clouds boost cloud application performance and cost-effectiveness while also maintaining their flexibility in the case of disruptions.[1] Nonetheless, with the rise of cloud computing, a plethora of cloud companies offering various services have emerged. and (APIs) have created an ambiance of multi-cloud. However, there still exists difficulty for multi-cloud framework development. To address this issue, a few multi-cloud interoperability solutions have advanced. From the available survey, two strategies can be identified: Semantics and Framework. An answer for multi-cloud interoperability, no matter what its abstraction level, should find some kind of harmony between laying out normal cloud standards and supporting any sort of cloud asset. In order to reason about the standard principles that interoperability agreements should follow, this unsatisfying circumstance necessitates a deeper understanding of cloud providers' semantics.

This research might be used as a main basis for subsequent research.into the research topic and the identification of other research projects. We wanted to explore how interoperability has been covered in the literature and provide an updated viewpoint on the subject by identifying the existing body of knowledge addressing cloud computing interoperability with semantic and frameworks for interoperability across Multi cloud services.

Corresponding Author Zameer Ahmed Adhoni
Tel:00918971251590
Email: zadhoni@gitam.in

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The purpose is to synthesize the key ideas presented in previous studies in order to assisting researchers and developers in acquiring a better grasp of the area and encouraging .

LITERATURE SURVEY

Cloud Interoperability

Interoperability in the cloud sector means migration of data and its workload from one cloud service provider to another with little or no effort or from public to private cloud or visa-versa[2]. The standards needed have been defined and are being amended from past ten years. The prominent standard bodies are (NIST),[3] (OMG)[4] and Distributed Management Task Force (DMTF).[5] It is seen that all these bodies came together to form a use case which had workload transfer, Authentication, management of work load, migration of data with independence of not affecting one another.

Interoperability approach

Interoperability with regards to cloud computing might be portrayed to provide capability to produce services which incorporate assets which cooperate or coordinate between different organizations of cloud, permitting clients to utilize explicit capacities given by every supplier [6]. Open ideas, semantics, (MDE), and open libraries and services are at the forefront of cloud interoperability. As a result, a diverse range of techniques to go with the various categories has emerged. The most suitable method for interoperability is to provide flexible standards for cloud operation. Despite the fact that several standards have been suggested (for example, the absence of widely recognized standards demands the investigation of alternative interoperability solutions. Semantic interoperability is involved in circumstances where provider of cloud uses multiple APIs and data models to display the same functionalities.

Semantic and frameworks to achieve interoperability

Semantic technologies make it easier for services to communicate and comprehend data. As a result, they were frequently employed in order to achieve multi-cloud interoperability. Due to the lack of globally approved standards, examining other ways to ensure inter-cloud compatibility is required. When various cloud suppliers use distinct models and notations, semantic interoperability comes into play.[7]

The two most regularly used procedures for establishing semantic interoperability are Standardized APIs and data models. They are key methodologies of various cloud principles/standards like Cloud Data Management Interface (CDMI),(OGF), and (OASIS).

To effectively deal with the PaaS layer, semantic interoperability concerns might be employed. It enables the management and migrating of apps and their data between multiple PaaS providers. The scenery should be similar amongst these services, but the APIs and data formats used may change. Application and data portability are enhanced when semantic interoperability is appropriately addressed. A major worry has been identified as an absence of interoperability, which results to vendor lock-in.[8]

The application to be compatible to work on different clouds needs the analysis of semantic information to ensure correct and accurate execution of needed service. Thus there is a need for portability among different clouds for interoperability to be effective.[9] For all applications I cloud, rework of semantic metadata is easier.[10]

Semantics of a cloud meta data is made up of libraries, Service-level agreements (SLAs), physical resource usage, background processes, key performance indicators (KPIs), real service descriptions, service profiles, procedures. Various research papers currently employ semantic technologies to represent the cloud domain, allowing for the expansion of the cloud notion using OWL and the formation of cloud ontologies.

RASIC is a lightweight semantics for annotating cloud resources. RASIC On semantically compatible clouds, it makes it easier to build, deploy, and operate SOA services. A paradigm for a typical cloud API has been suggested by the authors. Supporting the creation of semantically compatible Cloud systems based on RASIC, as well as RASIC definition and implementation of a standard Cloud API, would considerably reduce switching costs and eliminate vendor lock.[11]

PSIF a framework of the cloud4SOA project, a Framework (PSIF) has been proposed.[12] During application deployment or migration, the proposed framework supports in the resolution of semantic interoperability difficulties at the PaaS layer. Any PaaS dispute is recorded and mapped to the appropriate PaaS entity. PaaS designs must be improved with a semantic layer to link diverse PaaS solutions, which involves the construction of standardized management interfaces and standard PaaS models. PSIF, on the other hand, is exclusive to the PaaS model.

Infrastructure cloud management taxonomy, examined cloud computing interoperability challenges and compared cloud deployment strategies to commercial services. In addition, they researched and created an infrastructure cloud management taxonomy, which was used to map with existing APIs. The recommended techniques for avoiding potential interoperability issues were described. Addressing interoperability difficulties minimizes the risks of adoption.[13]

Tensor Flow-Based Semantic Techniques is used for tackling application portability and interoperability, two models were developed: the semantic-based method and Tensor Flow. The semantic-based solution leverages WSDL at the parameter and operational levels, and OWL at the service and infrastructure levels to discover a specific cloud service provider. Tensor Flow addresses the issue of portability. Tensor Flow is a statistical computation tool This tool is trained to predict the request of a specific service and its portability issues. If the service portability is dim it is referred to high-end services, which provides the needed service.[14]

Cloud resource orchestration (CRO) Frameworks investigated the cloud orchestration environment in depth, mapping and evaluating many cloud resource orchestration frameworks against it after building a taxonomy of fundamental traits and dimensions, with a focus on multi-cloud capabilities. In the cloud orchestration scenario, this comprehensive investigation allowed for the identification of key open research difficulties as well as the construction of a list of future research priorities.[15]

The ServiceSs programming model, which consists of a Framework, Standards, and Guidelines, is presented. ServiceSs offers a basic programming paradigm as well as an execution

Table 1. Outlines of the efforts made in a framework interoperability.

Interoperable Framework	Technique used			Description
	OWL	WSDL	RDF	
Framework for PAAS Semantic Interoperability (PSIF)	√	x	x	Semantic issues are resolved in the interoperability layer.
Inter Cloud Topology	x	x	√	Inter-cloud semantic information sharing
PaaS API Ontology	√	x	x	Semantic information resources for PaaS API's
Cloud4SOA	√	√	x	PaaS API semantic information resources
Ontology recommendation framework	√	x	x	Validation and assessment of semantic ontologies
Tensor flow	√	√	x	Interoperable and portable cloud services using a semantics-based technique

framework for abstracting programs+ from their actual execution environment. They demonstrate how ServiceSs interacts with diverse providers in a transparent manner by building the appropriate interfaces for scientific applications to function on Francesc Lordan federated clouds.[16]

The Hybrid MCDM Method for Cloud Service Evaluation integrates the hierarchical analytical process (AHP) and the Technique for order preference by approximating ideal solution to give a computational framework for picking the best candidate cloud service. (TOPSIS).[17]

The author suggests a semantic-based paradigm with a total of five conceptual layers. They are the parameters, operations, service, cloud patterns, and application patterns levels. The paradigm allows for the discovery and construction of application patterns and cloud services using a graph-based representation. For designing services and the APIs that access them, the solution creates a knowledge base with an OWL ontology collection.[18]

A strategy for detecting cloud resource links and potential inconsistencies is given. Using cloud description standards, the Framework offers a unified semantic knowledge base for cloud resources. like TOSCA. (Cloud application topology and orchestration standards),[19] (OCCI),[20] and CIMI.[21]

In their research, the authors applied standard-specific ontologies as well as linked cloud resources. Using inference rules, the common ontology enables for automatic translation of one resource description to another in accordance with a set of guidelines.[22]

Interoperability on a technical and semantic level to improve, a cloud broker should be used. On the technological side. On the technological side, the authors used a federated security scheme. They introduced a dynamic service management solution to address semantic interoperability, this enables the a cloud broker to provide critical services to users without requiring the user's involvement.[23]

Provided a semantic definition of cloud services, patterns, appliances, and their combinations that is standard, integrated, and machine-readable. Their approach intends to aid the creation of new Cloud-based apps to improve portability and interoperability by employing semantic models and autonomous reasoning across several platforms. With the suggested reasoning approach, automated identification of Cloud services and Appliances, It is possible to link between agnostic and vendor-dependent Cloud Patterns and Services, as well as to automatically enhance the semantic knowledge base.[24]

FCLOUDS, has been developed to quantitatively describe cloud APIs in a neutral and transparent manner. A collection of formal models is included in the proposed system, which may be utilized in two phases to align and formalize API notions.[25]

Shade masks the incompatibilities and variability across OpenStack providers. By abstracting vendor protocol and data format options and employing a normalization technique that translates the features of the JSON combines several data representations into a single data format, In OpenStack deployments, Shade fills in syntactic gaps. Shade, on the other hand, is incapable of filling up semantic gaps.[26]

In the PaaS market, PaaSport was proposed as a platform for addressing application and data mobility challenges. Under the pretext of a PaaS Marketplace, PaaSport provides a thin, non-intrusive cloud broker.[27]

Service provider-based interoperability relies on standardised APIs, middleware, and protocols in order to focus on service client interoperability for solutions, a cloud broker, model-based solution, and semantic technologies were included.[28]

Interoperability issues at the service level were resolved. They used Protégé and OWL to develop an ontology that semantically annotated the PaaS's API activities. The authors have designed a one-of-a-kind technique for identifying the source of interoperability issues.[29]

The authors suggest two ontologies to define functions, features, and interoperability concerns in distinct PaaS APIs: one for PaaS resources, remote operations, and data kinds, and another for detecting PaaS provider interoperability difficulties. Only the most well-known PaaS providers (Google App Engine, Salesforce, and Microsoft Azure) were included in the proposed ontologies[30]

Cloud4SOA is a broker-based platform which provides PaaS interoperability and portability by combining cloud computing, SOA, and semantics. Based on ontologies, the proposed technique provides platform-independent management and monitoring methods for semantic matching across a number of PaaS services. The architecture is split into 5 layers: front-end, SOA, semantic (including Cloud4SOA semantic model), governance, repository, and Cloud4SOA harmonized API.[31]

For complete cloud service operation specification, a service management operation semantic description framework was designed. Ontological modelling methods such as entity Cloud service operations were represented using categorization, attribute assertion, connection assertion, and annotation assertion. The use of operation reasoning is advantageous in the proposed framework. It offers extensive support for a variety of operations planning and execution activities.[32]

Provide an event-driven and reactive real-time data integration and sharing framework. Connecting searching, connecting, and transferring data from many locations, as well as subscribing to notifications regarding the timeliness of dynamic data, are all made simple using this Framework. By employing atomic data storage to detect content changes and enabling agent-based intelligent extract, convert, and load activities, the Framework makes it easier for developers to build integrative and interoperable bioscience applications.[33]

A consumer-driven technique was presented in which cloud services are chosen from a single registry that acts as a database for all existing cloud service information. Service discovery does not use semantic technology or semantic service representation; instead, (WSDL) and (RDF) are used to describe services, and the service broker implements the service discovery process using machine learning techniques.[34]

Standards of semantic interoperability, such as ontology driven interoperability, were developed using an ontological recommendations framework, ontology professional establishment, and ontology standards, including domain and generic ontology. Syntactic, semantic, and evolution-based techniques were used to verify an existing ontology. Once it had been evaluated, the ontology for compatible cloud services was published.[35]

The goal of the research was to identify the obstacles of semantic cloud interoperability in a multi-cloud environment, as well as the standards work that would be required in the near future for moving and collaborating services in a multi-cloud environment.

Standards to achieve interoperability

The most apparent way for establishing interoperability and portability in Multi clouds is to develop cloud computing standards. Cloud standardization initiatives invest a lot of time and effort to the creation of cloud standards that include development, deployment, security, management, storage, and other topics. The extent to which standardization provides benefits is determined by the type of service model and deployment methodology selected[36]

Despite the fact that a number of standards have been developed and new ones are being developed all the time, there is no widely acknowledged consensus on the standards for tackling the many issues that are hindering Cloud Computing adoption. This is because of the following reasons.[37]

The most of them focus on a single issue and aim to outperform each other in certain aspects of interoperability.

- Many hosting providers are reluctant to reveal the specifics of their work that give their firms a competitive advantage over their market competitors.
- Because of the diversity of languages, services, applications, and platforms, no standards have emerged that address all elements of migration and portability

Current standards and proposals have been gathered in studies to discover the specific cloud challenges that they can answer or specify how such standards may be utilized to develop a cloud infrastructure. At this time, no global standard has been established to definitively resolve interoperability difficulties. Instead, other efforts have been undertaken to define such a standard, each tackling the problem from a different perspective.

Table 2 outlines the many efforts made in a Standards that is interoperable

Standards	Semantics Interoperability
mOSAIC	Yes
SITIO	Yes
PSIF	Yes
Cloud4SOA	Yes
REMICS	Yes
ARTIST	Yes
TOSCA	Yes
COAPS API	Yes
Cloud SME	Yes

mOSAIC: For Service Discovery Framework offers IaaS and PaaS APIs.

SITIO: Offers Business user interface for Applications of cloud.[38]

PSIF: Framework for connecting diverse clouds.

Cloud4SOA: Within all PaaS Services, there is a degree of abstraction.[31]

REMICS: Migration from a legacy application to a SOA Web Service application and then to a cloud-based application.

ARTIST: Moving of a SME's legacy application to the cloud.

TOSCA: PaaS Interoperability Standard.

COAPS API: Packing and deploying applications to a multi-cloud environment using a generic API.

Cloud SME: Framework for simulating application hosting in a multi-cloud scenario.

Enabling Standards to achieve interoperability

It is feasible to achieve interoperability without using Open Standards.[39] There is no one cloud standard that governs all elements of cloud computing. Nonetheless, there are a number of well-established standards that address some of the unresolved challenges, which were designed before to the rise of cloud computing and may be easily reused, changed, or updated to fill in the gaps. On top of that, a number of new standards are being created to address more particular aspects of cloud computing.

Many organizations and standardization groups have been working on cloud management standards from the early phases of cloud computing. Presently, a very well IaaS computing and storage management examples are OCCI, CIMI, TOSCA and CDMI:

Table 3 outlines the Standards description.

Standards	Description
OCCI	The Open Grid Forum (OGF) have suggested the Open Cloud Computing Interface (OCCI), which aims to make IaaS cloud services more interoperable to access and control. OCCI provides a variety of HTTP renderings, resulting in a RESTful API implementation.
CIMI	DMTF proposed the CIMI, which was recently recognized as an ISO/IEC standard. CIMI focuses on managing the flow of IaaS resources by providing a RESTful API via HTTP with many renderings.

TOSCA	OASIS developed the TOSCA. TOSCA is a language for describing cloud composite services and applications, as well as its linkages (i.e. the topology), as well as regarding management elements (i.e. the orchestration). Although TOSCA is a higher-level standard than merely managing IaaS resources—it is primarily focused on resource orchestration—it should be seen as a complementing standard for resource management.
CDMI	CDMI has been suggested by the Storage Networking Industry Association (SNIA), which defines an interface for performing various actions on cloud data.

Standardized APIs to achieve interoperability

A cloud API facilitates the creation and delivery of cloud services, as well as allowing consumers to access providers' services. A standardized API allows consumers to access numerous providers' platforms via a single API. There are numerous (IaaS management APIs, cross-platform APIs, SaaS APIs, and so on) and provide compute, storage, and provision services, while also access to a variety of resources. APIs that are standardized also offer architectures for developing apps. The APIs provide common features for resource governance (create, delete, start, stop, restart). The proposed API is intended to be used to administer IaaS services.[38,39] The authors suggested a standardized API for working with PaaS services.[40] The authors proposed to provide a management REST API[41]. The authors proposed storage APIs.[42,43] As well as open APIs, have been proposed.[44] API allows users to engage with providers.[45] The disadvantage of a standardized API, on the other hand, is that it only provides interoperability among services using same API. As a result, there will be no compatibility between services that employ various standardized APIs.

Challenges

Many examination exercises have involved semantic innovation in cloud computing, yet to this day, however it can be seen that there does not exist a standard and accepted way for cloud administrations and management of assets, helping clients utilize typical and comfortable method to interoperability among clouds. Despite the fact that the quantity of cloud interoperability studies has decreased in recent years, it is still regarded a hot research topic since no overarching and general cloud interoperability solution has yet been provided

Future Work

Our goal is to provide a semantic interoperability framework to work in environment where there exist data and services on more than one cloud. By interoperability with semantic, we mean the capacity to detect and reason about the similarities and differences across cloud API concepts. Our Framework includes a collection of well-described cloud APIs. It will assist cloud customers in understanding how to transition encouraging semantic interoperability from one API to another.

Conclusion

On-demand plug and play cloud services have evolved from the mere storage of data to the present days requirement of client researching for cheap and efficient cloud provider for storage and an efficient cloud provider of services. This change in the attitude of the client requesting for multi-cloud operations and services across cloud providers has led to production of meta data, background process strategies, development of methods for quick and efficient means of processing. This survey on the semantic and framework level interoperability of services for migrating and collaborating services has been presented, would encourage better directed research in the area of multi-cloud operation environment by appropriately dealing with SaaS and PaaS. There will be multi fold increase in the demand for cloud in the near future.

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