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Using Cloud SaaS to ensure interoperability and standardization in heterogeneous Cloud based environment

Majda Elhozmari[1], and Ahmed Ettalbi[2]

[1 2] University of Mohammed V, ENSIAS, Models and Systems Engineering Team, SIME Laboratory, Rabat, Morocco
([1]elhozmari.majda, [2]ettalbi1000)@gmail.com, [1]majda_elhozmari@um5.ac.ma

Abstract: **During the last years, because of the evolution of Cloud applications and the attractive advantages given to consumers, many companies outsource their data and Information Technology (IT) system to the Cloud based technology. With the growth in the number of Cloud Service Providers, many enterprises and organizations can use and associate services from multiple providers. There may be many Internet protocols for service access standards that are used to ensure interoperability between users browser and Web server, such as Representational State Transfer (REST) and Simple Object Access Protocol (SOAP). Each service has its specific characteristics such as authentication and security requirements. Hence, Cloud providers attempt to lock customers into proprietary interfaces so consumers can find themselves at not expects inevitable vendor lock-in. Therefore, the focus of our paper is to propose a solution to this problem by using Cloud intermediate between Cloud providers and consumer in heterogeneous Cloud environments interfaces. This is to achieve benefits such as standardization and interoperability, minimizing lock-in of Cloud providers. To reach such benefits, we propose a Cloud SaaS based on two interfaces and an interne component. These interfaces are used in Cloud Consumer and Provider sides and therefore guarantee communication between Cloud Consumer and Provider using different Internet protocols for Web service access such as REST and SOAP. Our approach guarantees interoperability and standardization in heterogeneous Cloud based environments because in this case Cloud Consumer and Provider using REST interface can communicate easily with Cloud Provider and Consumer using SOAP interface.**

Keywords: CloudComputing; Heterogeneous Cloud; SOAP; REST; Web Service; Standarization; Interoperability.

I. Introduction

Before Cloud Computing, traditional business applications have always been very complicated and expensive. Nowadays Cloud Computing technology is easier and quicker to integrate with enterprise applications, it can help to eliminate problems of managing hardware and software, also Cloud can respond to customer needs with less cost. Cloud Computing offers business users the chance to immediately implement services with usage-based billing that are tailored to their requirements, often without the need to consult with the IT department.

The Cloud exists in several forms: private Cloud when mutualizes company resources (through virtualization), public Cloud where data will be placed directly at the supplier.

There is a classification of services that can be found in the Cloud. The most popular type of service is SaaS, which is to make available a web application ready for use and can be used directly as soon as the payment has been confirmed. The popularity of these solutions comes from their very low cost of entry and rapid provision users. In addition, these solutions are generally less expensive than traditional applications and do not require technical personnel for maintenance and consumer is not forced to make updated.

While it is easy to get into the Cloud, out is a delicate operation. The Cloud can be used without too much danger to meet a specific need; it will probably be more effective and less expensive than a traditional solution. For long term use, various precautions should be taken under penalty of no longer control the evolution of costs. Anyway, the Cloud has many advantages and deserves that one is interested: whether for Small and Medium Business, large companies or the public sector, there are opportunities to be seized in the Cloud.

Standardization was and still a big problem in the business-to-business segment and also in Business-to-consumer, essentially in service access interfaces Protocol. StoRHm [1] is one of the protocol adapters which guarantee manual process transition from SOAP web services to REST web service, to enable existing SOAP clients to interact with REST services.

In this paper, we focus on interaction between different Cloud providers and consumer, for that we studded an example treat the problems that consumer can find in using different Cloud provider in case of SaaS we'll explain below. Also we propose a global solution guarantees interoperability and standardization in heterogeneous Cloud based environments between different Cloud providers and consumers, and maximizing the level of interoperability and portability.

The remainder of this paper is organized as follows: Sections Two presents the definition, characteristics, some benefits of

SOAP and REST. Section three defines Cloud Computing and explains different types of Cloud. Section Four explains the problematic of the article between Cloud providers and consumer. In section Five, we propose an architecture that resolves the problem. We conclude this paper by presenting our further works.

II. Definition and characteristics of SOAP and REST

A. Definition of Web Services

Web service is a technology allowing applications to interact remotely over the Internet, irrespective of platforms and languages for such decisions. To do this, Web services are based on a set of ubiquitous Internet protocols (XML, HTTP) to communicate. This communication is based on the principle of requests and responses, made with XML messages. This interoperability is due to the use of open standards [2].
In general a Web service is a method of communication between two applications or electronic devices via the Web. There are two types of Web services: Simple Object Access Protocol and Representational State Transfer.

B. Definition of SOAP

SOAP is a messaging protocol based on XML for the exchange of information in a decentralized environment. SOAP is commonly used to establish a communication channel between web services. It defines a set of rules for structuring messages that can be used in simple way transmissions, but it is particularly useful for performing RPC request-response dialogues (Remote Procedure Call).

C. Benefits of SOAP

SOAP is a messaging protocol based on XML to exchange information between different applications. SOAP is commonly used to establish a communication channel between web services and brings benefits, such as [3]

- **Operations are defined as WSDL ports**
- **Unique address for every operation**
- **Multiple process instances share the same operation**
- **Tight coupling of components**
- **Debugging is possible**
- **Complex operations can be hidden behind faade**
- **Wrapping existing APIs is straight forward**
- **Increased privacy**

D. Definition of REST

REST [4] is not a protocol (such as HTTP). This style of architecture is particularly well adapted to the World Wide Web but is not addictive. Constraints, as defined by Roy Fielding, can be applied to other application as HTTP protocols.

E. Benefits of REST

This architectural style is not limited to performing application to a human user. It is increasingly used for the realization of SOA (Service Oriented Architecture) using web services for communication between machines and brings benefits, such as [3]:

- **Operations are defined in the messages**
- **Unique address for every process instance**
- **Each object supports the defined (standard) operations**
- **Loose coupling of components**
- **Late binding is possible**
- **Process instances are created explicitly**
- **Client needs no routing information beyond the initial process factory URI**
- **Client can have one generic listener interface for notifications.**

III. Cloud Computing technology

A. Cloud Computing Definition

NIST [5] defines Cloud Computing as ”a model for allowing ubiquitous, convenient; on-demand network access to a shared pool of configurable computing that can be rapidly provisioned and released with minimal management effort or service provider interaction”.

B. Essential Characteristics of Cloud Computing

According to NIST [5], Cloud Computing has five essential characteristics mentioned below:

- **On-demand self-service :**Cloud consumer can provision computing capabilities, and using Cloud services as needed automatically from service provider[5].
- **Broad network access :** features are available through the network and accessible via standards that mermit the use of services by platforms [5].
- **Resource pooling :**The Cloud providers resources are common to serve multiple consumers, with different virtual and physical resources. The customer generally has no control or knowledge over the exact location of the provided resources due to the independence location. [5].
- **Rapid elasticity :**Capabilities to request for extra resource is automatic and self-managed,on the consumer demand , the capabilities available to provide computer resources often appear to be unlimited and can be offer at any time with good quantity [5].
- **Measured service :**Cloud resource providers automatically control and optimize infrastructure by leveraging a metering capability appropriate to the consumer [5].

C. Service models

Cloud Computing is divided on three Service model mentioned by NIST [5]:

- **Software as a Service (SaaS):** In this case, consumer can use provider applications running on Cloud. The services are accessible from different Client devices interfaces such as a web browser or a program interface.
- **Platform as a Service (PaaS):** Consumer can create applications using Platform onto Cloud infrastructure which contains services, libraries, and different tools supported by the Cloud provider.
- **Infrastructure as a Service (IaaS):** Consumer has the capability to provision processing, networks, storage, and infrastructure computing resources where the consumer is able to deploy and run any software, operating systems or applications.

D. Deployment models

Deployment models of Cloud Computing are mentioned below :

- **Private Cloud :**The Cloud infrastructure is provisioned for exclusive use by a single organization comprising multiple consumers (e.g., business units). It may be owned, managed and operated by the organization, a third party, or some combination of them, and it may exist on or off premises ;[5]
- **Community Cloud :**The Cloud infrastructure is provisioned for exclusive use by a specific community of consumers from organizations that have shared concerns. It may be owned, managed and operated by one or more of the organizations in the community, a third party or some combination of them, and it may exist on or off premises ;[5]
- **Public Cloud :**The Cloud infrastructure is provisioned for open use by the general public. It may be owned, managed and operated by a business, academic, government organization, or some combination of them. It exists on the premises of the Cloud provider [5];
- **Hybrid Cloud :**The Cloud infrastructure is a composition of two or more distinct Cloud infrastructures that remain unique entities, but are bound together by standardized or proprietary technology that enables data and application portability[5].

E. Advantages of Cloud Computing

Cloud Providers aim to growing the level of their Cloud Services by increasing the number of advantage and attracting the customers. Some o these advantages are:

- **Scalability :**The cloud offers a range of services available to anyone with the business knowledge and financial means.[6]
- **Efficiency :**Because of the huge scale of the cloud, Cloud Providers are obliged to manage their extremely efficiently infrastructure[6]
- **Oriented Service :**Service-oriented computing together with Web services as its most important implementation platform has become the most important paradigm for distributed software development and application for a number of years now.[7]
- **Flexibility and manageability :**Time-To-Market often means a higher yield. The high flexibility and manageability of cloud computing are therefore one of the major advantages[6]

F. Cloud Computing challanges and limitations

Cloud Computing has a lot of advantages, but also still some pitfalls such as :

- **Security and privacy :**Public cloud providers form an attractive target for hackers because of the number of users[6]
- **Portability** Many customers are attracted by the public cloud because of its attractive cost, but to recover Data may even be impossible, Consumers can find themselves in vendor lock-in situation [6]
- **Stanrdadization :** Absence of standardization. Essentially to relate different Cloud Providers. Even if it is possible to provide service for diverse Cloud interfaces through a middleware, there is no rules that can be supervised Cloud providers [8].

IV. Problematic

A. Heterogeneous protocols used in Cloud environments

Before Could Computing, traditional business applications have always been very complicated and expensive. Nowadays Cloud Computing technology is much easier and quicker to integrate with enterprise applications. It can help to eliminate problems of managing hardware and software, because provider is the responsible of managing and maintaining Cloud infrastructure. Also Cloud gives to consumer what he need with less cost, upgrades are automatic, and scaling up or down is easy. Cloud Computing offers business users the chance to immediately implement services with usage-based billing that are tailored to their requirements, often without the need to consult with the IT department.
Sky computing [9] model tends to evolve Cloud Computing towards more efficient IT architectures, more flexible and open. It also aims to manage the complexity and heterogeneity of Cloud Computing solutions transparently to the user. However, there may be many Internet protocols for service access standards used to permit interoperability between users browser and Web server, such as Representational State Transfer (REST) and Simple Object Access Protocol (SOAP).
However, everything good by side is bad by another side. So using multiple Clouds has a lot of benefits such as high availability, cost optimization, Quality of Service improvements,

Table 1: Comparison of Box, AWS and Azure [11]

Service feature	Box	AWS	Azure
Protocols supported	REST, SOAP	REST, SOAP	REST

avoiding vendor lock-in, disaster recovery by decentralization of data. But there are some drawbacks like aspects including security, architecture, availability, and standards that are often not evaluated. Therefore, Cloud consumers find themselves at lock-in of the Cloud provider by many ways, some of them is service access standards.
In the case where web browsers are consuming SaaS applications, there are a number of standards that are used to achieve interoperability between users browser and web server, such as Internet Protocol (IP) (v4, v6), Transmission Control Protocol (TCP), HyperText Transfer Protocol (HTTP), Extensible Markup Language (XML), REST, SOAP, Really Simple Syndication (RSS), JavaScript/JSON, and JavaScript/JSON; There is no standards cloud-specific [5].
One of the greatest challenges here is the communication between Cloud consumer and Cloud provider, even if they dont have the same service access.

B. Problem presentation

Large companies for which IT plays a central role or represents a competitive advantage often build internal company Cloud solutions in their own data centers. Small and medium enterprises frequently use public Cloud services. A further distinguishing feature is the applications focus. In the business-to-business segment, private Clouds are predominantly used, while the majority of the business-to-consumer segment uses public Clouds [10].
The key challenges of a Cloud Computing solution are security and quality aspects, including performance, latency, and availability. Integration, adaptation, agility, and the possible relocation of the solution play a major role during and after the implementation phase [10]. Wherever data is acted on by several services, Cloud or consumers, there are multiple standards enable interoperability; some of these standards are REST and SOAP. Table[1] shows Web service protocols used by Cloud Providers. The National Institute of Standards and Technology (NIST) [5] is the leading organization to define Cloud standards. The integration challenge between Clouds can help consumers to choose the web service technology used to interact between other heterogeneous environments such as Clouds.
Multiple Standards that exist correspond to various application domains. The most important of these standards is the SOAP because it is an independent platform and language protocol.
Standards are the principal key to enable portability. They are based on existing standards that enable using documentation to show how standards can be implemented, to permit to developers to use their chosen development language as their program used in Cloud systems. The main objective is togrant maintaining migration and risk cost. Examples of Internet protocols service access standards which are common in the Cloud system are: REST, SOAP, and XML.
There is no web Standards that are specific to Cloud and these standards are used in many Web browser interfaces. Some of Cloud consumers and providers use SOAP, other ones use REST. Each service has its specific characteristics such as authentication and security requirements. Hence, Cloud providers attempt to lock consumers into proprietary interfaces. So consumers can find themselves at not expects inevitable vendor lock-in.
As indicated on figure[3], consumers C1 C2 and C3, want to outsource a part of their system application in Cloud Computing. So, consumers must choose the Cloud providers that have the same service access standard interface. As shown in the example, C1 and C2 with REST interface have two choices of Cloud providers with specific characteristics; C1 and C2 can choose CP1 or CP3, andC3 can choose CP2.The same thing with Cloud providers, the compatibility of service access interface between Cloud providers and consumers is mandatory. On the side of the consumers and

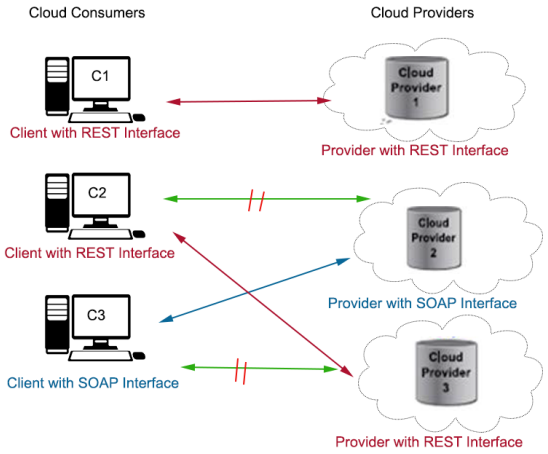

Figure. 1: Challenge in service access standards SOAP REST

Cloud providers, some questions are raised through programming system application that communicates with other environments. One of these questions is: which service access interface has to choose REST or SOAP?

C. Problematic challenges

This example brings benefits but still some drawbacks that we describe below.

1) Challenges on Interoperability Standard

Interoperability is one of the important challenge axes that exist in IaaS, PaaS, and SaaS levels. Every one of these levels, which may joint in any particular product or Cloud services, presents special considerations, and as a result, the standards landscape will be unique and specific to each level. In this case, Interoperability is a property of Consumer system, whose interfaces are completely understood, to work with other Cloud provider, present or future, with restricted access.
Two systems in heterogeneous environment using different service access SOAP or REST cannot communicate with each other, because of that consumer can fall in interoperability challenge.

When a provider pretends compliance with any other standard, he has to cite the specific version, publish implementation, and testing notes [5].

- **Environment heterogeneity:** Enterprises think that it is simple to add one Cloud service at a time and they do not expect the inevitable complexity of multiple Cloud providers for integrating their applications running on different Cloud platforms which end up with a traditional way of point-to-point integration approach. So, enterprises need to think about the complexity on integration of multiple applications on different Cloud platforms along with on premise applications and also think about service access technology used [12].
- **Standardization:** Is one of the most problems in the Cloud environment, many of their interfaces offered are unique to a particular provider, also the risk of provider lock-in is raising [10]. Simon Wardley writes in [13], "The ability to switch between providers overcomes the largest concerns of using such service providers, the lack of second sourcing and the fear of vendor lock-in (and the subsequent weaknesses in strategic control and lack of pricing competition)."
- **Complexity of multiple Clouds:** The use of multiple Cloud providers in big systems increases the level of communication complexity between Cloud providers, also choosing the technology service access compatible with technology used increase the level of complexity, for example like in case of health center using Multiple Cloud [14] and Using a central private Cloud to improve a complex system in multi-cloud environment [15].

2) Challenges on Portability standard

Cloud portability [5] means that consumer can move his own data from one cloud system to another.
The migration of Information Technology (IT) system from one Cloud system to another is a biggest consumer challenge. This challenge is concentrate on standards because there are the keys to success portability. The consumers can find themselves at not expected lock-in to Cloud providers because of heterogeneous service access interfaces of Cloud providers and consumers.
One of portability constraints is the lack of standardization of Cloud services access protocol, which can be an obstacle to Cloud consumers to easily migrate to a new Cloud service provider when availability requirements are not same [5].

V. Our proposed solution

A. Discription of our solution

Our proposal solution (Figure[6]) consists on adding a Cloud intermediate to the (figure[3]) between Cloud provider and consumer in heterogeneous Cloud environments interfaces. The objective is to remove the direct communication between interfaces. This approach guarantees interoperability and standardization in heterogeneous Cloud based environments. In this case Cloud consumer and provider using REST interface can communicate easily with Cloud provider and consumer Using SOAP interface.

This solution is essentially Cloud SaaS based on three principal components (Figure[6]):

1) Interface with Cloud consumer

As mentioned in (Figure[4]), an interface is related directly to the consumer. The objective is to processing consumer request messages and response.
This Interface allows the interaction with different services access standards REST and SOAP. It can deal and differentiate between SOAP and REST messages coming from Cloud consumers. This interface has an auto detect service access and can make a compatible environment of standards that help an easy communication between service access interfaces. Also response of the request coming from the consumer can be compatible with service interface technology used by consumer.

The Cloud interface adapts service access message with

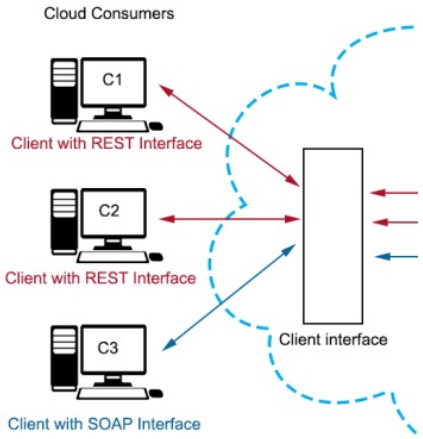

Figure. 2: Interaction between consumers and Cloud interface

the service using by client. The services standards used are SOAP and REST.
In this case consumers can outsource their IT or applications without thinking about witch technology used by side of Cloud providers.

2) Interface with Cloud provider

As shown in Figure[5], an interface related directly to the Cloud provider, the objective is to process provider response messages and request.
This Interface allows the interaction with different services access standards REST and SOAP by the side of Cloud provider. It can deal and differentiate between SOAP and REST messages coming from Cloud consumers. The interface has an autodetect service access that can make a compatible environment of standards that help an easy communication between service access interfaces. Also response of the request coming from the consumer can be compatible with service interface technology used by Cloud provider.
Cloud provider doesnt think about service access interface technology used by consumer. The Cloud interface adapts service access message with the service using by Cloud provider. The services standards used are SOAP and REST.

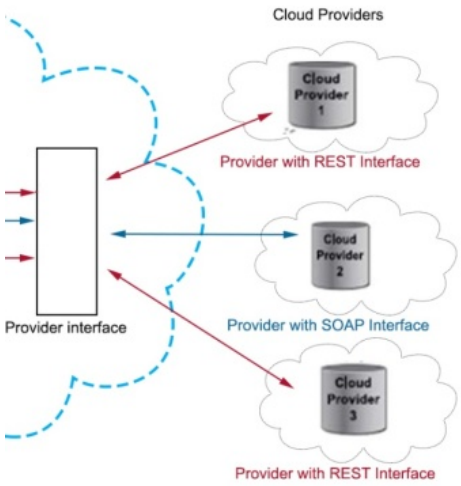

Figure. 3: between Cloud providers and Cloud interface

B. Interne component

SOAP and REST Converter is an intern component in our proposed solution that ensure standardization and interoperability in heterogeneous Cloud based environments. Using this component, Cloud consumer and provider using REST interface can communicate easily with Cloud provider and consumer Using SOAP interface, by converting SOAP to REST and vice versa.

C. Benefits of this solution

Proposed solution shows the main features and benefits of the whole process. Some of these benefits are:

1) Benefits on Interoperability

Systems in heterogeneous environment using diverse interface service access SOAP or REST fall in interoperability challenge.Our solution gives some benefits of interoperability level as mentioned below.

- **Standardization:** The big problem in Cloud provider is standardization. Many of the interfaces offered are unique to a particular vendor, thus raising the risk of vendor lock-in. For that, our Cloud solution can be able to communicate with both of REST and SOAP interfaces by using a central component that can make a translation from SOAP to REST interfaces and vice versa.
- **Environment heterogeneity:** Cloud consumers and providers can communicate even if they use different service access interface technologies. The Cloud solution simplifies deployment of existing applications and services without thinking about technologies used by Cloud consumers or providers.
- **Using multiple Cloud:** In case of using multiple cloud environment, Cloud consumers can use heterogeneous Cloud environment. REST client can interact with REST or SOAP Cloud provider by using Cloud service interface standardization.
- **User benefits:** Reduces development cost and time of new applications and services compatible with a specific Cloud provider.
- **Management of access user:** Management of users also is controlling by the Cloud service standardization and every access to the data by Cloud providers is controlled by Cloud system. All of that for not lousing the control of interaction between Cloud providers and consumers.
- **Availability of data:** In this case data is available with both technology REST and SOAP thanks to Converter component, which can translate REST message to SOAP message and vice versa, adapted to Cloud consumer and provider.

2) Benfits on Portability

Cloud consumers who wish to migrate to another Cloud provider find themselves in not expected vendor lock-in. Our proposed solution brings some benefits in this level such as minimising vendor lock-in and make maintenance more easy.

- **Vendor lock-in:** Is a situation in which a consumer using a Cloud provider service cannot easily migrate to a competitors Cloud provider. Our solution minimizes the lock-in of Cloud providers to consumers by minimizing problem of standardization of service access interface technology between SOAP and REST.
- **Outsourcing applications easily:** As Cloud systems are typically external components in a consumer organizations overall IT system, especially in the outsourced deployment models, the need to have seamless security integration calls for interoperable standard interfaces for authentication, authorization, and communication protections by [5]. Our Cloud solution can give service interface standardization and simplify the interoperability, and have a secure integration.
- **Easy Maintenance:** Maintainability is one of the main advantages of a centralized system, in our case, the proposed cloud solution is located between Cloud Provider and Cloud Customer.

VI. Conclusion and perspectives

Currently, the public SaaS is the service model of the most popular Cloud that consists of making available ready applications to the world. At this level, the offer is very rich: it is now possible to find solutions for SaaS almost all traditional needs (email boxes, CRM, storage, video editing ...). There are real opportunities there are not to be missed. But users should be careful to not fall into a loss of control problem and enter in not expect inevitable complexity of multiple Cloud providers for integrating their applications.
In this paper, a thoughtful description of SOAP, REST and different types of Cloud Computing, and shed light on a problem of interoperability specially on standardization between REST and SOAP technology. Case study solution between Cloud providers and consumers has been suggested in order to eliminate lock-in Cloud provider. Our proposed solution to this problem is by using Cloud intermediate between

Cloud providers and consumer in heterogeneous Cloud environments interfaces. This is to achieve benefits such as standardization and interoperability, minimizing lock-in of Cloud providers. To reach such benefits, we proposed a Cloud SaaS based on two interfaces and an interne component called Converter. These interfaces are used in Cloud consumer and provider sides and therefore guarantee communication between Cloud consumer and provider using different Internet protocols for service access such as REST and SOAP. The interne component in our proposed Cloud enables transformation of services based on SOAP technology into services based on REST technology and vice versa. Our approach guarantees interoperability and standardization in heterogeneous Cloud based environments because in this case Cloud consumer and provider using REST interface can communicate easily with Cloud provider and consumer using SOAP interface. In perspective, we will fix the methodology of communication between Cloud providers interface and our Cloud solution and consumers too. We will also propose a methodology to translate message REST to SOAP and there implementation. Another perspective is to study the possibility of a "Backup Cloud" to avoid system failure if the proposed central cloud breaks down.

References

[1] S. Kennedy, R. Stewart, P. Jacob, and O. Molloy, "Storhm: a protocol adapter for mapping soap based web services to restful http format," *Electronic Commerce Research*, vol. 11, no. 3, pp. 245–269, 2011.

[2] J. Gregorio, "How to create a rest protocol," 2004. [Online]. Available: http://www.xml.com/pub/a/2004/12/01/restful-web.html

[3] M. Zur Muehlen, J. V. Nickerson, and K. D. Swenson, "Developing web services choreography standards-the case of rest vs. soap," *Decision Support Systems*, vol. 40, no. 1, pp. 9–29, 2005.

[4] R. T. Fielding, "Architectural styles and the design of network-based software architectures," Ph.D. dissertation, University of California, Irvine, 2000.

[5] M. Hogan, F. Liu, A. Sokol, and J. Tong, "Nist cloud computing standards roadmap," *NIST Special Publication*, vol. 35, 2011.

[6] G. O. Johan Loeckx, "Cloud computing concept vaporeux ou relle innovation?" 2011. [Online]. Available: http://documentatie.smals.be

[7] K.-K. Lau, W. Lamersdorf, and E. Pimentel, *Service-Oriented and Cloud Computing*. Springer, 2013.

[8] I. Chana and S. Singh, "Quality of service and service level agreements for cloud environments: Issues and challenges," pp. 51–72, 2014.

[9] K. Keahey, M. Tsugawa, A. Matsunaga, and J. A. Fortes, "Sky computing," *Internet Computing, IEEE*, vol. 13, no. 5, pp. 43–51, 2009.

[10] J. Kress, H. Normann, D. Schmiedel, G. Schmutz, B. Trops, C. Utschig-Utschig, and T. Winterberg, "Industrial soa blueprint: A toolbox for architects," 2013. [Online]. Available: http://www.oracle.com/technetwork/articles/soa/ind-soa-cloud-2190513.html

[11] S. Srinivasan, *Cloud Computing Basics*. Springer, 2014.

[12] N. V. S. Kolluru and N. Mantha, "Cloud integrationstrategy to connect applications to cloud," pp. 1–6, 2013.

[13] S. Wardley, "Cloud recap the cloud today," 2008. [Online]. Available: CloudToday(http://blog.gardeviance.org/2008/10/cloud-recap.html)

[14] M. Elhozmari and A. Ettalbi, "Using a software architecture based on a private central proxy cloud to improve a health center system," conference on Software Architecture CAL2015 13 - 15 Mai Hammamet, Tunisie 2015, to appear in RNTI review.

[15] M. ELhozmari and A. Ettalbi, "Using a central private cloud to improve a complex system in multi-cloud environement," third World Conference on Complex Systems WCCS2015 23 - 25 November Marrakesh, Morocco 2015.

Author Biographies

ELHOZMARI Majda PhD student in the IMS (Models and Systems Engineering) Team of the SIME(Mobile and Embedded Information Systems) Laboratory AT the Higher National School for Computer Science and Systems Analysis (ENSIAS), Rabat, Morocco. Her research interests include Cloud Computing interoperability.

ETTALBI Ahmed Professor at Software Engineering Department and member of the IMS (Models and Systems Engineering) Team, SIME (Mobile and Embedded Information Systems) Laboratory of the Higher National School of Computer Science and Systems Analysis (ENSIAS) Rabat. His main research interests include Cloud Computing, Web-Services, Object Modeling with Viewpoints and Software Oriented Architecture.

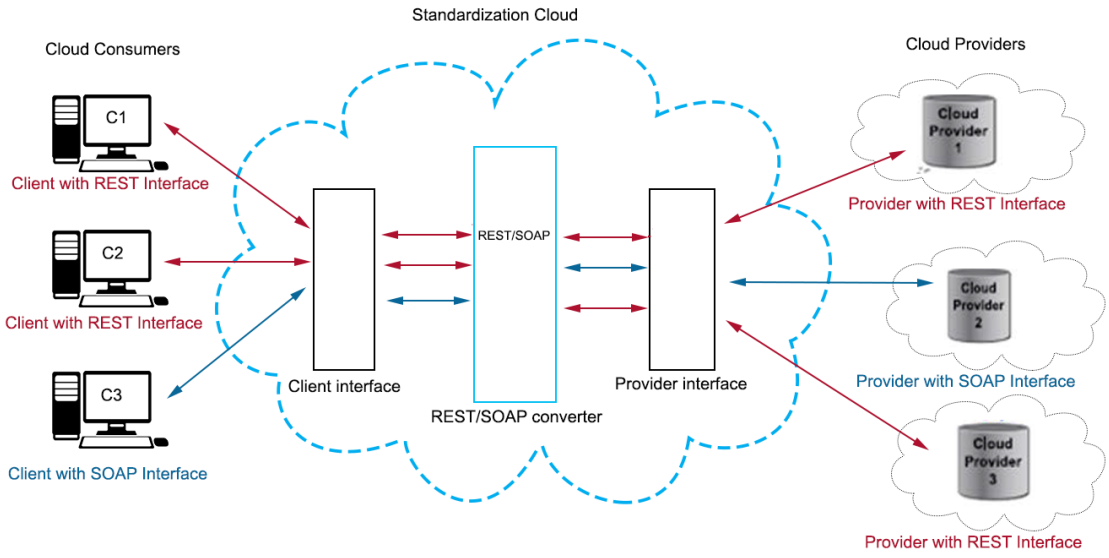

Figure. 4: Our proposed solution for Cloud standardization