A holistic view of information management in Cloud environments

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Abstract— The emergence of Cloud technologies ultimately affected the service computing ecosystem introducing new roles and relationships as well as new architectural and business models. Along with the increase of the capabilities and potentials of the service providers came the increase of the information being available and the need to manage it in an efficient way. To this end, in this paper we present a management service architecture as well as the information model that the solution is based on. The model has been designed to serve a storage service provided by a Cloud infrastructure but the approach is implemented in a flexible and modular fashion in order to support different Cloud situations.

Keywords— cloud, management model, information services, storage Cloud

I. INTRODUCTION

Cloud computing as a whole is rapidly evolving and becoming one of the most challenging paradigms of Information Technology. More and more Cloud providers are appearing forming a quite young, but relatively broad cloud ecosystem. On the other hand, this massive availability of resources and services resulted in an increase in the information generation that the current data models and representations cannot always capture. Notwithstanding, the rapid evolution of the cloud, together with the new and emerging needs of customers, clearly evidences that cloud environments are becoming very complex in terms of dimension and management. Thus, providers of Cloud service models, e.g. Platform as a Service (PaaS) and Infrastructure as a Service (IaaS), can have huge amounts of information to collect, manage and evaluate.

In total, we have seen in the literature that most of the Cloud management solutions are dealing mainly with the resource allocation or a combination of user requirements towards resource management. There is no holistic approach or modeling of the whole Cloud platform lifecycle but individual abstractions of parts of it. In [1] we presented the baseline of the Unified Management model design. To this end, in this paper, an information management system and its corresponding data model that considers all the necessary information flows within a Cloud service platform are presented. The subject of our analysis was a storage service Cloud situation and therefore we have identified the related roles and entities.

II. MANAGEMENT ARCHITECTURE

The topic of management in Cloud environments has several angles to be approached. There is the aspect of resource management that mainly lies on the IaaS Cloud layer and interacts with the infrastructure middleware or hypervisor. On the other hand, the realization of the SaaS stack demands administration and management in terms of applications and high-level requirements. The solution that we present in this section proposes a holistic management architecture that is placed on the PaaS Cloud layer covering the initial management steps of requirement specification and SLA negotiation, to usage modeling and resource management.

Figure 1: Management layer design
The introduced management design describes the following information flows:

- **Initiation and SLA management**: throughout this process a user is requesting a service, defines the high-level application requirement and QoS parameters described in an SLA. The entities involved in that step are the SLA Negotiator, User Manager and SLA Manager.

- **Service instantiation and resource allocation**: The second conceptual procedure is the creation of the actual instance for the requested service. The internal analysis will map the high level requirements captured in the signed SLA to low level resource specification that will result in the physical and virtual resource allocation.

- **Feedback and optimization**: An important feature of every Cloud platform is the collection of information from the infrastructure layer and the utilization of that data for Billing & Accounting, SLA violation detection and optimization (Analyzer) of the resource allocation. In that context, the Usage repository captured that information and provides interfaces towards any consumer entity.

### III. INFORMATION MANAGEMENT MODELS

Based on the previous architectural analysis and the identified information flows, in this section we present several information models that capture the necessary data and create associations between all involved entities. We should also note that apart from the basic Storage service offered in this Cloud, we have incorporated the offering named “Storlet” which represents a computation service over a storage entity [2]. In the rest of this section we list and explain each identified model of the proposed management structure.

- **Requirement Model**: captures the requirements emerging from application attributes modeling and the ones deriving directly from the user needs is necessary. In addition, the model defines structures to describe lower level requirements for the service offerings of the Cloud (in our case Storage and Storlet) as well as Resource requirements that are used for the resource provisioning.

- **SLA Model**: contains the information related to the Service Level Agreement between the customer and the service provider. It is separated into two groups: **context** (metadata of the agreement e.g. participants and dates), **terms** (requirements, conditions and billing policies).

- **Services Model**: captures the information regarding the Cloud offerings: (i) Storage Service, (ii) Computation Storage Service (Storlet).

- **Resource Model**: that model has a hierarchical structure in order to facilitate Cloud federation and in general a distributed Cloud infrastructure management. Therefore, we propose three entities: Node, Cluster and Data Center.

**Usage Model**: Usage characteristics (e.g. geographical access distribution or read / write access frequency) encode the knowledge on the typical application behaviors. Usage models will be automatically harvested. They capture application access patterns with regard to storage.

### IV. CONCLUSIONS AND FUTURE STEPS

Information management of resources and services in Cloud is a challenging task mainly due to the lack of standards and the flexibility of the infrastructure. In this paper we presented a unified management model designed for a storage Cloud situation, extendable though for any kind of Cloud service offerings. By analyzing the information flows of the Cloud service framework we captured the requirements for the management and therefore we defined the core models (requirements, SLAs, services, resources and usage model). The efficient management of the Cloud platform is based on the consistency of the models and the ability to associate information of one model to another. In that context, the whole status of the Cloud platform can be captured effectively as a single unified model and not separate information structures. That capability allows us to store “snapshots” of the system and in order to migrate it or re-enable it in the future. The future step regarding this work is the investigation of ontologies specifications and the possibility of transforming this unified model into a Cloud ontology which could form the management core of a Cloud environment.

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