

## Integrating User Roles with Cloud Interfaces

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**Abstract.** Cloud Computing is high on the agenda of the industry and research community from developer as well as from end-user perspective. The basic promise of cloud computing, that is, access to data anytime, anywhere, on any device is already a reality. However, for a successful user adoption of the cloud, we believe that user interface plays an important role in effective and efficient use of the various cloud services offered. There is a lack of proper understanding of the cloud users, their roles and how they contribute towards successful cloud interfaces. As a first step towards addressing these issues, this paper proposes a model that integrates user-roles with cloud interfaces. The paper illustrates the model through case examples and demonstrates how different user-roles should be linked with the design and development of cloud interfaces. Such an integrated user model provides a collaborative vision for a better cloud interface of the future.

**Keywords:** cloud services, user-roles, cloud interfaces, interface model

### 1. Introduction

Cloud computing is a phenomena that is set to grow. The idea of a centralized service that can be tapped into whenever, wherever, and with whatever (device) promises great benefits for users who often have more than one device at hand - a desktop, a laptop, a PDA, a smart-phone - all capable of storing media collections, crunching numbers, posting status, photos and tweets, and blogging content – with access anywhere and everywhere. However, there are many challenges relating to policy, technology, security, guidance, interoperability and standards that have not matured enough for the long-term advancement of cloud computing [1][2][3]. We believe that the common denominator for all these challenges comes from the perspective of user adoption, and the cloud user interface plays an important role to address these challenges.

In general, the slowness in cloud acceptance is due to lack of proper knowledge on the user-roles that impact the cloud interface [4][5]. Hence, the aim of this paper is to define user-roles and user characteristics and these can be integrated with the cloud interfaces. Through the literature review of the research and practice taking place around cloud computing, we have identified a number of questions related to cloud user and interfaces that play an important role but still remain unanswered. Some of these unanswered questions are listed below:

How do we model a cloud user?

What are the cloud user-roles?

How can we integrate the user-roles with cloud interfaces of a cloud service in order to achieve a positive impact on a user's experience while interacting with the service?

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The aim of this paper is to address the above questions as a modest step towards improving the cloud diffusion. The paper first focuses on identifying user-roles of a cloud service at SaaS, PaaS and IaaS levels in section 2. In section 3, we propose an integrated cloud user interface model that identifies the user-roles in the design and development of cloud interfaces for cloud services. Section 4 illustrates the proposed model using case examples showing how cloud user-roles could be defined and integrated with cloud interfaces. Finally, section 5 provides conclusions and future work.

## 2. Cloud User-roles

‘Know Thy User’, a mantra or an essential principle in any service design today, involves understanding of the skills, goals, primary tasks, and responsibilities of the user. It is important to model users and roles [6]. It is noted [7] that a mismatch of user-roles and the heterogeneous requirements of technology inherently leads to systems that are more difficult to manage.

There are various types of cloud users and National Institute of Standards and Technology (NIST) has defined five major actors as key players of a cloud architecture, namely cloud consumer, cloud provider, cloud carrier, cloud auditor, and cloud broker [1]. Their roles are defined based on the transaction process associated with the cloud. However, other consortiums have combine the terms of actors along with their roles into a common term as user-roles and IBM has recently formulated a set of three user-roles, namely cloud service creator, provider, and consumer. [4]. These user-roles are not comprehensive. We believe that there is a need to have a term that includes developers of cloud service as well as policy and standards regulators and auditors who can impact on the creation and life-cycle development of a cloud service. Hence, we have combined these players and call them as Cloud Architects, who are responsible for the design architecture of the cloud. Typically, these Cloud Architects are responsible for creating the three main cloud service levels, namely Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS). The organisations that offer these cloud services are called Cloud Service Providers and the customers of these services are called Cloud Consumers, and they would include individual users, businesses, government bodies, and the like.

There are various user-roles that could be assigned to each of the three cloud users we have categorised based on the cloud service levels they are associated with [6][7]. We have identified selected roles for the three major categories of users modelled in this paper and these are provided in Table 1.

Table 1. User-roles associated with the cloud service levels (Adapted from [1])

User-roles	SaaS	PaaS	IaaS
Cloud Provider	Manage the cloud applications, security, and infrastructure. Deploy, configure, maintain, and update the operation of the software applications on a cloud infrastructure.	Manage the computing infrastructure & run the cloud software e.g. databases, middleware components. Support the development, deployment, and management process of the PaaS cloud consumer.	Acquire physical computing resources , e.g. servers, networks, storage, hosting infrastructure. Run service interfaces and computing resource abstractions, e.g. virtual machines & virtual network interfaces.
Cloud Consumer	SaaS cloud consumer has limited administrative control of the applications.	Control the hosting environment, applications. Limited access to the infrastructure, eg. network, servers, operating systems or storage.	Access to more fundamental forms of computing resources & control over software components in an application stack.
Cloud Architect	Make specific applications accessible via a network to the consumers. Cater to varying degrees of functional standards: Web browser, Web service, mobile.	Create applications, connect parts of one application to parts of another application from different vendors & physical environments using common PaaS facilities.	Create, install, monitor, and manage services and applications. Develop flexibility in billing based on amount/ duration of the resources consumed.

### 3. Integrated Cloud User Interface Model

One of the gaps found in literature and in industry practice is the lack of a comprehensive model that integrates user-roles with the design requirements of cloud interfaces [8]. We propose such an integrated cloud user interface model as shown in Fig. 1. Each user-role is associated with many cloud interface challenges. For example, standard metadata format and APIs are needed to describe and generate eDiscovery metadata for emails, document management systems, financial account systems, etc., that will help government consumers to leverage commercial off-the-shelf (COTS) and government off-the-shelf (GOTS) software products to meet eDiscovery requirements [1][9]. User interfaces for eDiscovery are especially important when email messaging systems, content management systems, or Enterprise Resource Planning (ERP) and financial systems are migrated to a SaaS model [10][11]. One of the main roles of Cloud Consumers that is seldom practised would be to identify their requirements for user interfaces to provide various configuration options for a scalable cloud, to facilitate integration with existing systems, and to provide training and ROI reporting features.

The Cloud Architect has a major role to design and develop interfaces that could facilitate in scalability [12], fault-tolerance and recovery mechanisms [13], in adopting different privacy and security as well as data governance and control options, and more importantly in providing multi provider support functionalities. This is very much essential with a recent trend towards a federated multi-cloud environment having diverse cloud implementations and policies [9]. Currently, manual intervention by Cloud Architects is required for these to function together. Technical policies, credentials, namespaces, and trust infrastructure must be harmonized by standards regulators to support a Community Cloud that spans multiple service providers.

The Cloud Service Providers should allow for user interfaces to be made available anywhere anytime in multiple device platforms [5]. Their role should include provision of cloud interfaces for user-centric pricing and support as well as performance monitoring and maintenance features. Cloud Consumers could be billed according to the amount or duration of the resources consumed, such as CPU hours used by virtual computers, volume and duration of data stored, network bandwidth consumed, or the number of IP addresses used per time interval. System developers, system administrators, and IT managers would be interested in creating, installing, monitoring, and managing services and applications deployed via IaaS cloud interfaces.

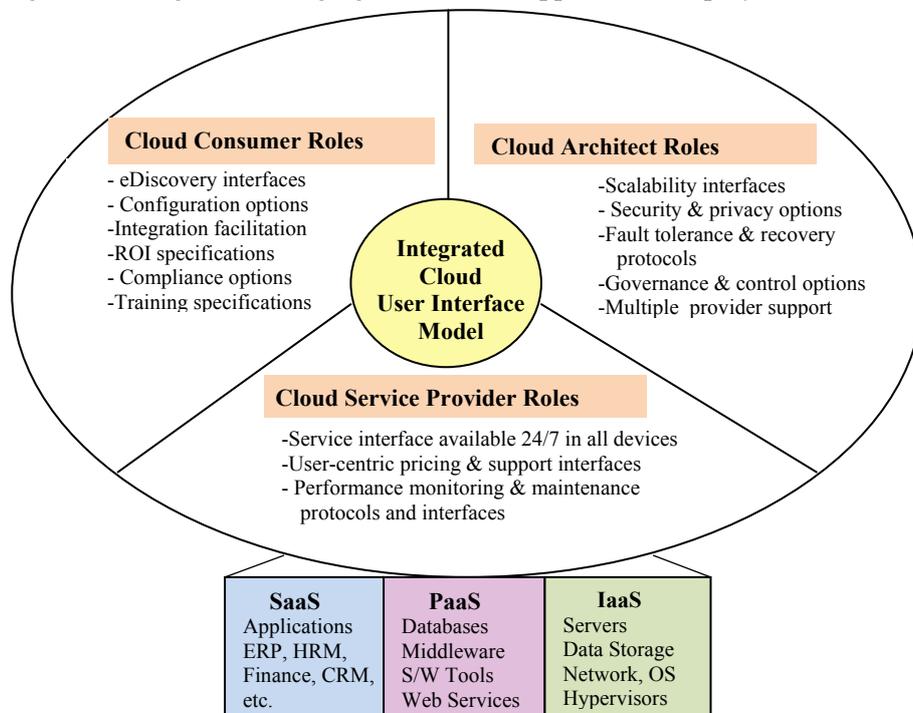


Fig. 1: Integrated cloud user interface model

### 4. Case Examples of Cloud Interfaces



Account Activity Welcome Akash Nemani | Sign Out  
Account Number 8926-4157-2108

[View Previous Statement](#)

**This Month's Activity as of November 7, 2011**  
This report is for activity between November 1 - November 30, 2011. The AWS service usage charges on this page currently show activity through approximately 11/07/2011 04:59 GMT.

Expand All Services   Collapse All Services		Printer Friendly Version
		<b>Totals</b>
<input type="checkbox"/> Amazon RDS Service	<a href="#">Download Usage Report »</a>	<b>19.03</b>
<input type="checkbox"/> Amazon Elastic Compute Cloud	<a href="#">Download Usage Report »</a>	<b>120.36</b>
<input type="checkbox"/> Amazon Simple Storage Service	<a href="#">Download Usage Report »</a>	<b>0.61</b>
<input type="checkbox"/> AWS Data Transfer (excluding Amazon CloudFront)		<b>0.06</b>
		<b>0.06</b>
<b>Bill Summary</b>		
Usage charges and monthly recurring fees during this billing cycle† <small>(More Info)</small>		<b>\$140.06</b>
One-time fees during this billing cycle <small>(More Info)</small>		<b>\$0.00</b>
<input type="checkbox"/> Taxes (Estimated Taxes)		<b>\$0.00</b>
<b>Total new charges for AWS Account #8891-0311-9983</b>		<b>\$140.06</b>

Fig. 4. Example cloud face showing account usage

## 5. Conclusions and Future Work

Cloud provides the future of the way we use computers. It is well understood that cloud computing is based on the ‘pay for what you use’ principle. However, with different types of mobile devices having various display options that are being used in the cloud, web applications delivered through the browser suffer from non-unified, heterogeneous interfaces and security risks that lead to user acceptance issues. For a successful cloud adoption, the cloud user interface plays an important role that requires to be shouldered by the key players of the cloud adoption value chain. This paper has aimed to address this. It has achieved its first goal by modeling what a cloud user is and in defining the cloud user-roles under three categories, namely Cloud Architects, Cloud Service Providers and Cloud Consumers. Secondly, we proposed an integrated cloud user interface model that relates user-roles with cloud interfaces for the three main cloud service level offerings, namely SaaS, PaaS and IaaS. Finally, the paper also illustrates how the model could be applied using three case examples.

Our premise is, with multi-tenant resource sharing facility of the cloud anywhere anytime, where data of one business consumer and another competing business consumer reside on the same server, security risks and privacy concerns become much more complex than traditional security concerns. In addition, interoperability issues among various platforms and multi service providers are of growing concerns. Using our proposed integrated cloud user interface model, the security and standards provisions, protocols and preferences could be viewed with appropriate user interfaces and understood by all cloud users as these could have an impact on their roles. In a nutshell, our model promotes the design and development of cloud interfaces from the perspectives of all the three user-roles with an objective to facilitate interoperability, flexibility and scalability that are warranted for a successful user adoption of the cloud. This paper is a valuable exercise providing a further step towards achieving successful cloud interfaces of tomorrow. We plan to investigate the effectiveness of our proposed integrated cloud user interface model and its refinement.

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