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Advance Billing and Metering Architecture for Infrastructure as a Service

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ABSTRACT

Billing in Infrastructure as a Service (IaaS) is a complex task that is often compromised due to lack of various interactions (Consumer, Provider, Budget Manager, Agent and Online Payment) simultaneously along with necessary features like discount, tax, plan etc. Until Billing is considered as a last essential ability, appropriate framework cannot be provided to IaaS cloud consumers. In this paper, IaaS Online Billing System (IOBS) has been proposed that describes transparency of consumption, billing and frequency of usage of services for a cloud based pay per use system. This system describes various interactions of network and user interface. The billing rules have been stored in a database. The model has been verified through UML that demonstrates that IOBS is effective in improving user interaction by reducing time and increasing customer satisfaction.

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1. INTRODUCTION

The cloud provides a dynamically scalable, abstracted computing and storage infrastructure that is typically based on a virtualized, distributed, fault tolerant, parallel computing architecture [2]. Via Cloud, users can leverage the power of highly distributed Internet or the high computing power made available by grid engines [3]. IaaS refers to computing infrastructure comprising of networking, hardware, virtualized operating systems and software servers offered as a service. Service Oriented Architecture is a paradigm for organizing and utilizing distributed capabilities that may be under the control of different ownership domains. Service is a mechanism to enable access to one or more capabilities, where the access is provided using a prescribed interface and is exercised consistent with constraints and policies as specified by the service description [1]. Users always want transparency of consumption and billings [4].

IaaS is one of the key components of cloud computing where billing is a challenging task. As Cloud services and infrastructure scales up, billing management complexity increases and efficient billing management technique are required. To increase the efficiency of IaaS cloud, we concentrate on billing. IaaS Online Billing System (IOBS) allows the different collaborations (Consumer, Infrastructure and Service Provider, Budget Manager, Online Payment) to access the specified services available through this. The IaaS Online Billing System is particularly useful for cost estimating and comparing because there is large variability in the cost of various infrastructures provided by different IaaS providers. For example, if there are four different users accessing the billing system simultaneously, it is not possible in traditional billing models. Thus, concurrency is introduced in this system and time is also reduced.

The inspiration of our work trunks from the challenges in estimating and comparing the cost of IaaS cloud resources, services and infrastructure. There are many con-straints including a) user satisfaction b)

reduce the time of execution c) interactive user interface and d) improve security, reliability, flexibility. The system will be changed according to the user requirements through the feedback. The purpose of our effort is to provide the efficient billing model along with constraints pointed out above. This paper presents billing framework and pay per use policy.

This paper is organized as follows: Section 2 presents related work. IOBS Framework along with requirements described in Section 3. Section 4 presents framework execution. In Section 5, verification of IOBS framework has been described .The objectives and guarantees are presented in Section 6. Section 7 describes the performance and results of IOBS. The contribution of proposed solution has been explained in Section 8. Section 9 concludes the whole work and future work has been described in Section 10.

2. RELATED WORK

Billing management is a core component of IaaS in cloud computing. Rajkumar Buyya et. al. [5] have discussed about the illusion of a virtually infinite computing infrastructure. As per Luis M. Vaquero [5] the employment of advanced billing mechanisms allowing for a pay-per-use model for shared multitenant resources, the simplified programming mechanisms (Infrastructure), etc. are some of the most relevant features.

Jean-Paul Smets-Solanes et. al. provides SlapOS Master follows an Enterprise Resource Planning (ERP) model to handle and process allocation optimization and billing of only ERP [7]. Jason Meiers et. al. proposed an approach which estimates cost but does not compare the calculated cost with other cloud provider [16].

The CGI white paper has introduced an approach to describe the advantage of cloud computing in an enterprise paying for use, which translates to accurate usage measurement and billing with a large number of users [10]. According to this paper, flexibility should be the key feature in the billing system. Sushil Bhardwaj et. al. only addressed Utility computing service and billing model as characteristics [11] and components of IaaS but did not describe how it is?

In this approach, the author only focuses on Third Party Cloud Infrastructure [6]. These solutions facilitate the easing of cash-flow management for finance staff as the cloud pricing model has minimal upfront cost and monthly billing, and it also minimizes variability of expenditure on electricity. Ahmed Mihoob et. al. discussed only consumer interaction with the IaaS billing [17] while the CSC white paper focused on only third party interaction with cloud services [18].

Stefan Tai et. al. introduced that the consumers of Cloud services are charged based on actual service usage. But what are appropriate costs, pricing and billing models both from a consumer and a service provider viewpoint? How do we calculate costs, compare alternatives, estimate risks and determine value of traditional versus Cloud Computing solutions? With the help of this approach we cannot estimate the cost [8].

Georgios Gousios et. al. proposes the design and implementation of Aquarium, an extensible billing service software [9]. This approach provides portability but desired performance cannot be achieved. CISCO white paper presented that the service should be provided through fixed billing price [12], this is expensive for short term use. In this approach, the consumer is billed the same amount every month without consideration for actual usage.

Ang Li et. al. [14] proposed an approach in which the cost should be calculated per operation only not pay per use. Matthew Wachs et. al. addressed the method that generates bill only for storage resources [15]. Maik Lindner et. al. describes an approach in which only service and infrastructure can interact [13].

Yousef et al. [23] described the three pricing models that are used by cloud service providers for billing used resources, namely tiered pricing, per-unit pricing and sub-scription-based pricing. Aquarium's cost policies that are assigned to resources map exactly to Yousef's pricing models. In fact, most offerings by public IaaS providers, including Amazon and Azure, offer services charged according to Yousef models. Work on resource accounting and billing has been carried out in the context of cloud federation [19, 20, 21] and (earlier) grid federation projects. The Reservoir project investigated the use of service level agreements [19] for resource provisioning in federated cloud scenarios.

On the cloud computing front, vendors such as VMware, Microsoft and IBM pro-vides a full stack solution, which also include resource accounting. Usually, such systems connect to existing enterprise resource planning systems. U bersmith has developed an engine dedicated to resource accounting. Much like Aquarium, it tracks resource usage and applies accounting policies to it. Ruiz-Agundez et al. [22] pro-posed an accounting model for cloud computing based on Internet Protocol Detail Record (IPDR) and the jBilling platform. To the best of our knowledge, the Aquarium is the first working open source system to offer declaratively configurable charging and accounting services for IaaS deployments.

We had conducted a survey on the number of approaches existing for billing and price plan for Iaas individually, but the proposed architecture combines [1] both into a single approach for achieving an

efficient billing according to pay per use along with some other important features. Presently there is no such approach as presented in proposed model which combines billing and price plan management.

However there are different techniques which tried to solve the billing problem but unable to provide interaction of all the different collaborations simultaneously. In this paper user interaction has been designed and presented in UML and thus the verification of this model and interaction has been done using the Unified Modeling Language. The interactions are better represented and validated through the objects and dependencies.

3. IOBS FRAMEWORK

We have proposed an IaaS Online Billing System (IOBS) where the cloud providers give the facility of estimation and comparison of cost according to specified billing rules. The implementation of IOBS enables the customer, provider, budget manager, agents and payment requirements. This framework improves satisfaction of various collaborations and contributes directly to organization development.

3.1 Requirements

IaaS billing system is required to fulfill the demands of various customers, providers and agents.

i. Requirements of Cloud User (RCU)

For corporate cloud user rate, discount, plan and tax may change in a short time. Cloud users may require adjustments in the services from time to time and user expects easy access to IaaS cloud services from various locations, quick response to their billing queries, any time availability of the system, no loss and secure handling of their data and transactions.

ii. Requirements of Aggregated Budget Management (RABM)

Budget manager needs to upgrade their infrastructure time to time for fulfilling the requirements of every cloud user and provider and attract the customers by giving a discount based on usage.

iii. Requirements of Infrastructure Provider (RIP)

The service or cloud provider is interested in ensuring cloud user satisfaction by offering a billing system that acts as an easy to use one stop shop for IaaS services that allow estimation of cost with a discount and taxation. The billing system should be able to handle the corporate cloud user organization or "tenant" specific requirement variations without having to maintain separate application per tenant in storage management. The billing system should be able to interoperate with heterogeneous systems of cloud user, budgeted management, third party engagement and net banking and be able to withstand technology advances.

iv. Requirements of Third Party Engagement (RTPE)

The agents are interested to keep the latest details of tenants and services, they are estimating their intermediate commission based on these details and pay per use and type of customer, whether it is regular or not.

v. Requirements of Banks (RBN)

The bank needs the automation system for calculation of estimated total cost instead of manual like drafts or cheques. Online payment automation calculates total estimated cost based on the pay per use and adds the tax according to type of customer. The cloud user should pay through net banking only to avoid the unnecessary calculations as well as maintenance of manual records. This service provides quick verification of payment and user will be able to use services immediately.

3.2 Structural Design

This section explains the architectural details of the cloud based Billing and Metering Architecture IaaS (BMAIaaS) for the system stakeholder requirements.

3.2.1 Design Intentions

The system is needed to accomplish various design objectives. The system should be designed for reliability, security, flexibility and usability. The various organizations like customers, providers, budget management, third party and payment system should interact concurrently in an efficient manner and regularly update the databases with concurrency control.

3.2.2 Logical Aspect

Figure 1 shows Billing and Metering Architecture of IaaS (BMAIaaS) along with logical components.

- Cloud User Organization
- Aggregated Budget Management Organization

- Website
- Price Plan Management
- Storage Service Management
- Billing Process Provision and Policy Based Services
- Infrastructure Provider Organization
- Third Party Engagement
- Online Payment Automation
- Feedback

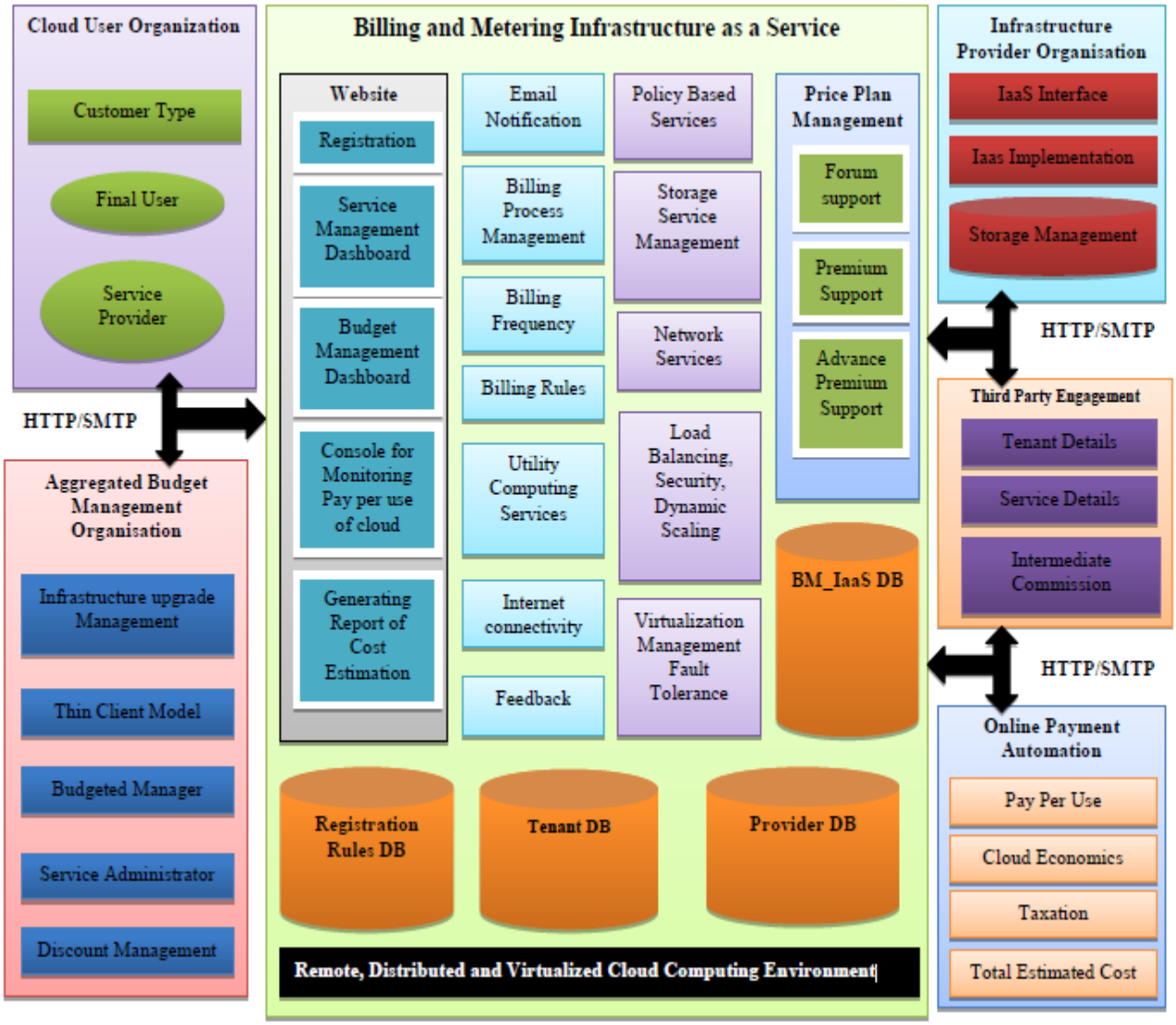

Figure 1. Logical components of IOBS

3.2.3 Roles and Collaborations

The various organizations like customers, providers, budget management, third party and payment system interact through IOBS. The roles of various people interacting in IOBS have been summarized in Table 1. The Figure 2 shows the survey conducted by us that explains the ratio of collaborations of various organizations with IOBS.

Table 1. Various roles according to organization

Organization	Roles
Aggregated Budget Management	Budgeted Manager, Service Administrator
Cloud User	Final User, Service provider
Infrastructure Provider	Cloud Provider, DBA
Third Party Engagement	Agent
Online Payment Automation	Fully Automated

3.2.4 User Interface

IOBS provides well defined user interface for every type of user. The cloud user selects the various services managed by service management dashboard according to the requirements after registration. Budget manager manages all the discounts on current services and resources and upgrade the infrastructure as technology changes and feedback provided by billing system stakeholders. The user selects the services and generates the report consist of the total estimated cost along with services, tax, discount and other expenditures, also mailed to the respective user.

3.2.5 Billing Process Management

All the information regarding the bills will be managed and updated time to time. The frequency of billing should be maintained according to the use of services and resources for further interpretation regarding updates or addition of existing or new services. The billing rules should be displayed to each stakeholder along with discount, tax and intermediate charges. The billing system displays Policy Based Services along with the cost, rules of use and instructions: The services like storage service, network services with some other issues: load balancing, fault tolerance, dynamic scaling, Virtualization management and internet connectivity. The system provides all types of support like forum, premium and advance premium underprice plan management.

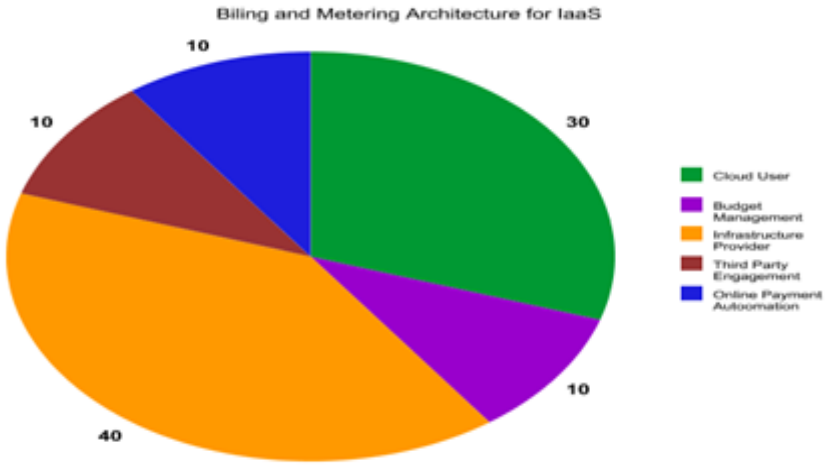

Figure 2. The various collaborations in IOBS

3.2.6 Security

The billing system provides the login option for each stakeholder and it asks the user for username and password. Every stakeholder is provided with a particular fixed set of user privileges for viewing, updating, deleting services as well as users, every customer is authorized to perform these tasks and also every cloud provider is authenticated by username and password given to stakeholder and provided with each and every right like viewing, updating, deleting and creating services. It's being shared faster and more widely than in the past. A more responsive, more integrated, analysis-driven approach to security is provided. The explosion of data presents inevitable challenges for data security and privacy. Billing system security intelligence approach can help organizations assemble a more complete picture of their security posture. The integration isn't just about technology, it's about understanding your business processes, and how security can derive and support innovative and transformative initiatives.

3.2.7 Databases

BMAIaaS segregate the supplier data, consumer tenant data, budget process data, commissions, taxes and discount details into different databases: Registration DB, Tenant DB, Provider DB and BMIaaS

DB. Additional data stores are provided for BMAIaaS internal processing data, and for metadata that also serves as a service registry. Data Services are used for uniform access, manipulation of data across multiple data sources.

4. THE FRAMEWORK EXECUTION

The framework executes the requests as follows:

(i) In IaaS Online Billing System, first of all users tries to access the services through the user interface (website). After that the task of the user's authentication and authorization is performed.
(ii) After authentication, users select the currency then select the services and the time for particular services.
(iii) IOBS generates the cost estimation report after including tax and commission and deducting discount in a required currency and mail the same report to user mail id.
(iv) The user can compare the calculated cost with the cost of other cloud provider.
(v) The user can update, save and search the report from the database and provide feedback.
(vi) After that user checks all the services shown on the report then the user will pay the required amount through net banking, after payment confirmation the ordered services will provide to the user through the internet.
(vii) The Budget manager manages the discount, tax and plan policy and cloud provider update, delete and extend the service. Agent manages commissions and other policies.

Thus, this framework exhibits how IaaS based billing can be done in a cloud environment.

5. VERIFICATION OF IOBS FRAMEWORK

Unified Modeling Language can serve as a single, reliable reference point for those who investigate the customer requirements, those who implement programs to satisfy those needs and who test the results. UML diagrams used to describe both the static aspect with Use Case Diagram as shown in Figure 4 and dynamic aspects with Sequence Diagram as shown in Figure 5.

5.1 Component Diagram

The component view of BMAIaaS is as shown in Figure 3 in the form of Meta model. There are two main components: cloud user and provider, interacting with each other. In cloud provider node there are some commonalities which are common for every user and variability's are the options for each user according to their requirements. The cloud users interact with the system through a browser and sessions for each user should be maintained for any issues regarding the services.

6. OBJECTIVES AND GUARANTEES

The objectives of the IaaS Online Billing System are to ensure that cost estimates and compares in an efficient manner. It helps to:

1. Clearly understand the current and potential future requirements and expectations of all the users, who interact with this framework.
2. Delivers services and other features with highest quality, reliability and consistency that meet user's requirements.
3. Establishes and measures performance and user satisfaction against appropriate goals with security and reliability.

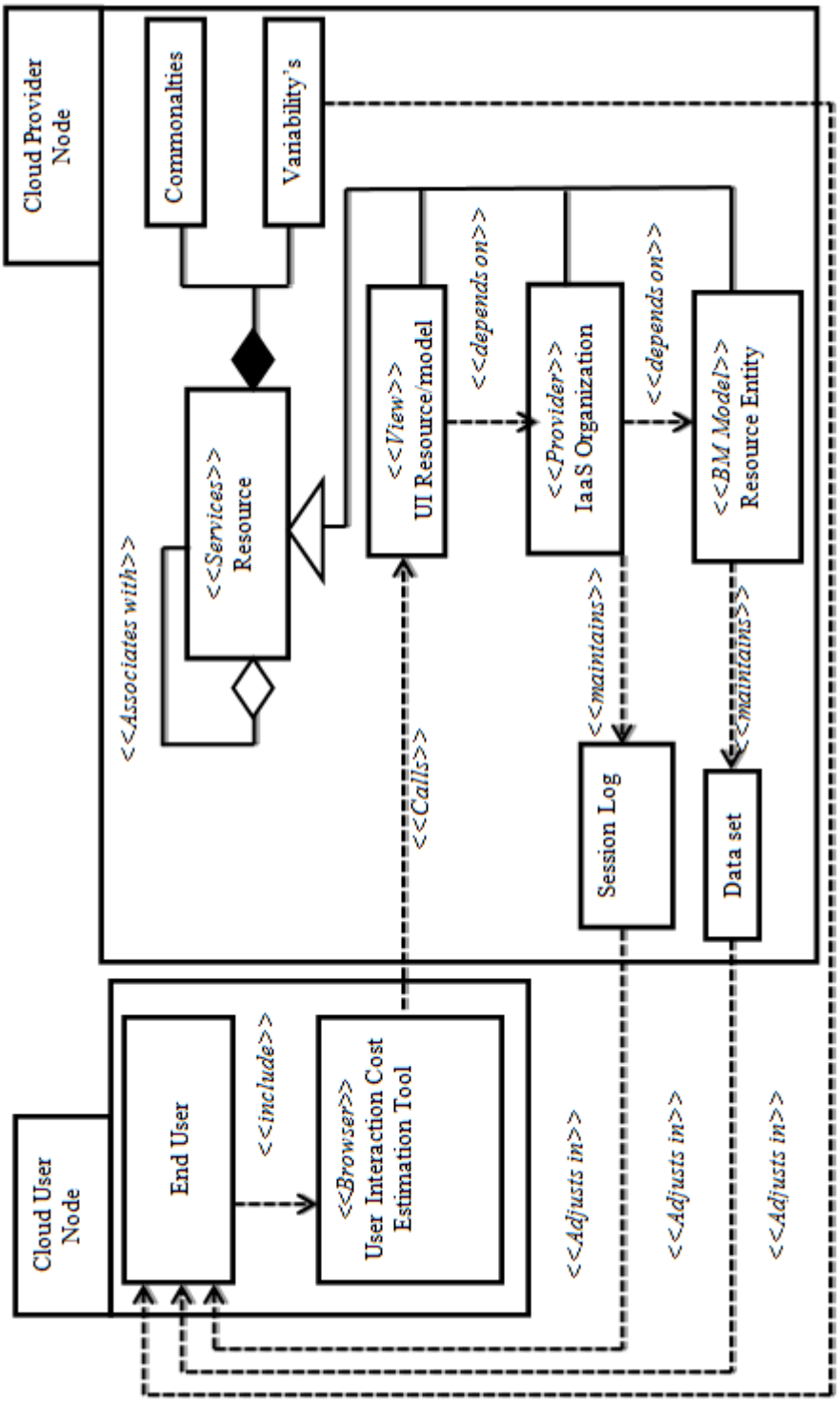

Figure 3. Meta model of billing and metering Architecture for IaaS

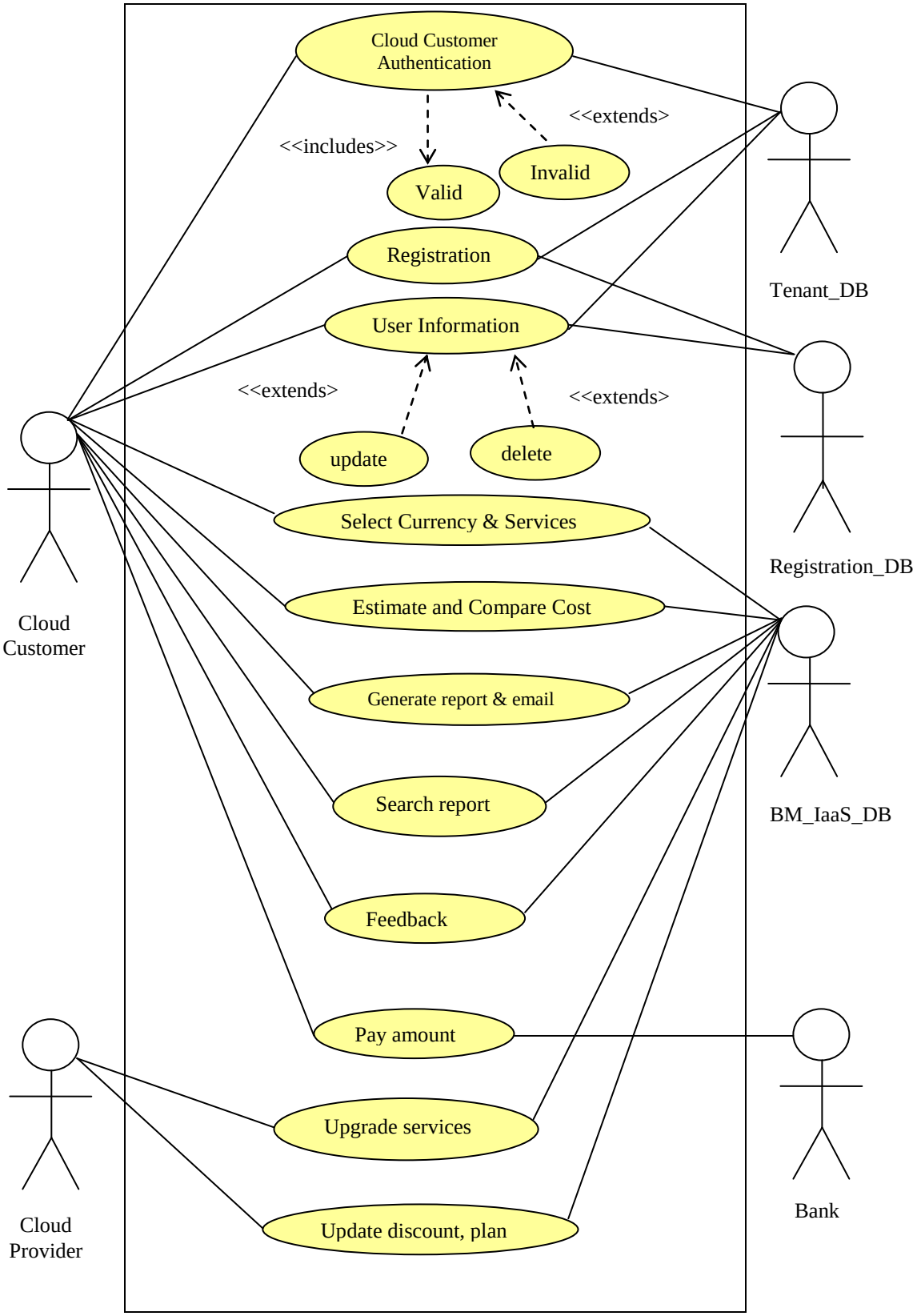

Figure 4. Use Case diagram of billing and metering Architecture for IaaS

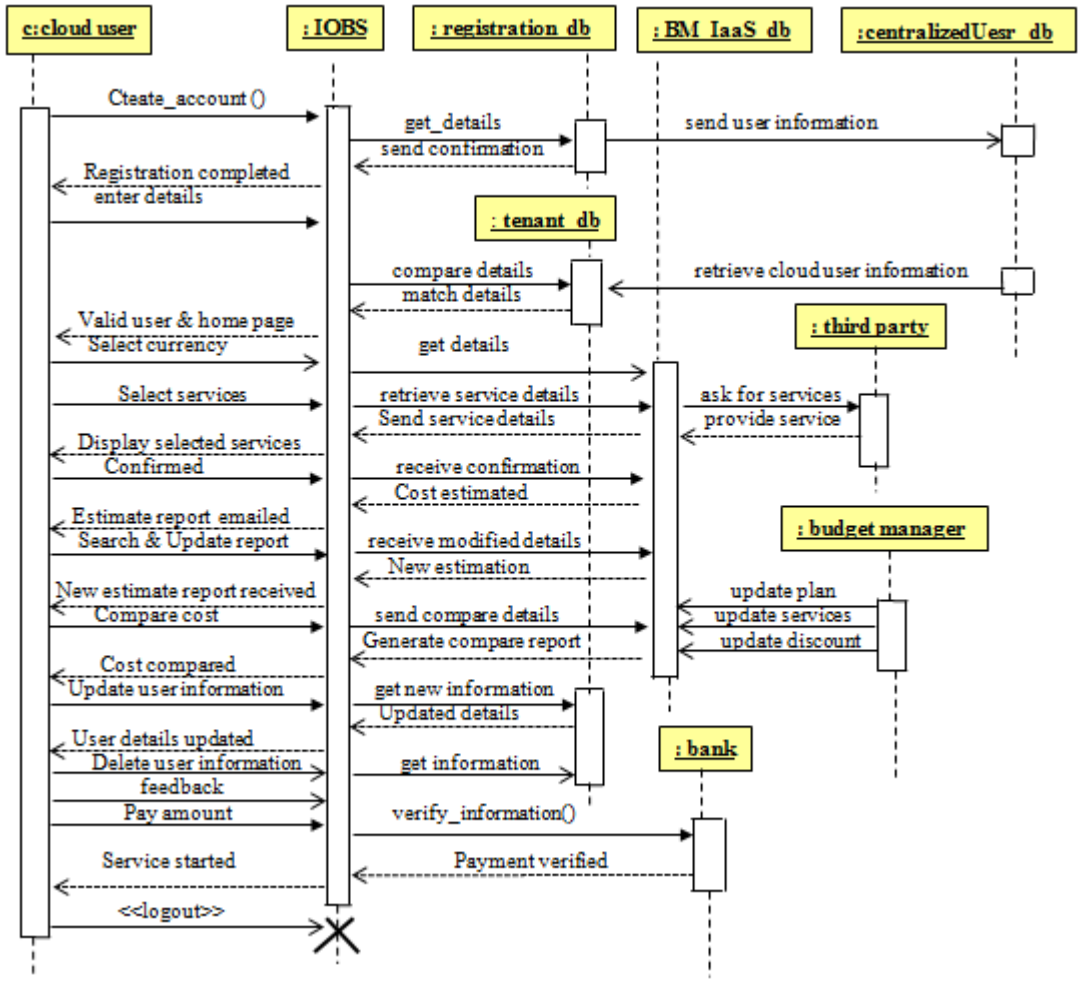

Figure 5. Sequence diagram of billing and metering Architecture for IaaS

7. PERFORMANCE AND RESULTS

The result of IaaS Online Billing System (IOBS) has been validated with existing traditional billing systems like eVapt's Billing Solution [25] and IBM Smart Cloud Enterprise [24] described in the Table 2. Initially, the services were provided through the email, gradually the system evolved to IOBS. There are new features in IOBS: feedback, rapid response, plan selection etc.

8. CONTRIBUTION OF PROPOSED MODEL

IOBS offers a unique cloud billing service that takes the complexity out of Iaas billing and enables cloud providers to bill accurately, consistently and competitively. This framework delivers a comprehensive solution for convergent billing across cloud services, account types and billing environments, helping providers to achieve the full promise of cloud computing and provide an estimation to user through email. The solution provides an efficient automated billing process, easy to use anytime access from anywhere. The automation model reduces the cost of billing function, efforts, human intervention, billing delays and improves customer satisfaction, service quality, scalability and control on investments. This model offers an uninterrupted service with payment collection through multiple modes of payment like net banking by pay per use policy. IOBS cloud billing service simplifies, streamlines and optimizes cloud billing processes, enabling cloud providers to competitively monetize their offerings and increase profits. The key features of this service include:

1. High flexibility, including the ability to bill for IaaS cloud computing, support for sophisticated cross-discounting, and support for both customer, provider, third party, budget manager and partner account balance types
2. Definition of cloud products, services and pricing models by IaaS cloud provider.
3. Strong systems integration capabilities and support

4. Database management, Email notification and Price Plan management.
5. Tax and commission details.

Table 2. Comparison of IOBS with traditional methods

Criteria	IOBS	Traditional Methods
Methodology	Adaptive	Predictive
Interaction	More	Less
Response	Rapid process (email)	A slow process
Plan selection	Forum/Premium/Advance	No
Perspective To Modification	Change Adaptability	Change Sustainability
Policy Plan	Pay per use	Fixed
Documentation	Less	Heavy
Feedback	Yes	No
Quality aspects	Yes (Usability, security etc.)	No
Maintain records	Yes (DBMS)	No
Requirements	Excitation & Expected	Only Expected
Payment	By net banking	By banks
Tax, Discount & Commission	Automatic	Conversation
Flexible & reliable	Yes	No
Consumption	Transparent	No
Report generation	Automatic	Manually
Budget Management	Yes	No
Compare cost	Yes	No
Accuracy	More	Less

9. CONCLUSION

In this paper, we have presented an IaaS Online Billing System for cloud computing. The objective is to minimize the complexity and improve user interaction and response time along with user satisfaction. Through this work we demonstrate the usefulness and effectiveness of services provided by IaaS cloud. The Unified Modeling Language verified the proposed framework as we can easily find the object interaction through UML and describe the IOBS based billing is effective in improving interaction and response time that can easily estimate and compare the cost by automatic adjustment of commission, discount and tax. Through this system cloud customer can pay within seconds by using online net banking. Through IOBS framework, billing management becomes considerably easier and better user satisfaction can be attained. Cloud economics have encouraged future in the cloud computing industry that is capable of fulfilling the requirements of the current industry. The model offers the transparency of consumption, billing and frequency of usage of services.

10. FUTURE WORK

In future, the framework can be extended by adding advanced features through user feedback. The future scope of this work is to analyze the critical success factors of the IaaS Online Billing System and identify the various risk factors using risk analysis of introducing pay per use and send notifications regarding the discount and various other offers through mobiles. The automated model solves the problems of cloud economics to a large extent.

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