

# Cloud Billing Model: A Review

**Danamma M.Bulla**

*M.Tech in Digital Communication & Networking  
Gogte Institute of Technology, Belgaum,  
Karnataka, India*

**Dr.V R.Udupi**

*Prof & HOD, Dept Of Electronics & Communication  
Gogte Institute Of Technology, Belgaum,  
Karnataka, India*

**Abstract—:** Cloud computing is a promising field that offers a variety of computing services to end users. These services are offered at different prices using various pricing schemes and techniques at different level. The end user expects the QoS with minimal price. Therefore, applying a fair billing model will attract more customers and achieve higher revenues for service providers. In this paper we focus on issues in employed and proposed billing models.

**Index Terms—**Cloud Billing, Pricing, Billing models

## I. INTRODUCTION

Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction[1]. This cloud model promotes availability and is composed of five essential characteristics, three service models, and four deployment models.

Cloud computing is the delivery of computing services over the Internet. Cloud services allow individuals and businesses to use software and hardware that are managed by third parties at remote locations. Examples of cloud services include online file storage, social networking sites, webmail, and online business applications. The cloud computing model allows access to information and computer resources from anywhere that a network connection is available. Cloud computing provides a resources, including data storage space, networks, computer processing power, and specialized corporate and user applications.

## II. CHARACTERISTICS

The characteristics of cloud computing include on-demand self service, broad network access, resource pooling, rapid elasticity and measured service [1]. On-demand self service means that customers (usually organizations) can request and manage their own computing resources. Broad network access allows services to be offered over the Internet or private networks. Pooled resources means that customers draw from a pool of computing resources, usually in remote data centres. Services can be scaled larger or smaller; and use of a service is measured and customers are billed accordingly

## III. TYPES OF CLOUD COMPUTING

The four primary types of cloud models are: Public, Private, Hybrid and Community [2].

**Public Cloud:** Public clouds are made available to the general public by a service provider who hosts the cloud

infrastructure. Generally, public cloud providers like Amazon AWS, Microsoft and Google own and operate the infrastructure and offer access over the Internet. With this model, customers have no visibility or control over where the infrastructure is located. It is important to note that all customers on public clouds share the same infrastructure pool with limited configuration, security protections and availability variances.

**Private Cloud:** Private cloud is cloud infrastructure dedicated to a particular organization. Private clouds allow businesses to host applications in the cloud, while addressing concerns regarding data security and control, which is often lacking in a public cloud environment. It is not shared with other organizations, whether managed internally or by a third-party, and it can be hosted internally or externally.

**Hybrid Cloud:** Hybrid Clouds are a composition of two or more clouds (private, community or public) that remain unique entities but are bound together offering the advantages of multiple deployment models. In a hybrid cloud, you can leverage third party cloud providers in either a full or partial manner; increasing the flexibility of computing. Augmenting a traditional private cloud with the resources of a public cloud can be used to manage any unexpected surges in workload

**Community Cloud :** A community cloud is a multi-tenant cloud service model that is shared among several or organizations and that is governed, managed and secured commonly by all the participating organizations or a third party managed service provider. Community clouds are a hybrid form of private clouds built and operated specifically for a targeted group. These communities have similar cloud requirements and their ultimate goal is to work together to achieve their business objectives.

## IV. SERVICE MODELS

There are three basic kinds of cloud service models. Each share similarities but have their own distinct differences as well. These service models are Infrastructure-as-a-Service, Software-as-a-Service and Platform-as-a-Service. It helps to think of these services in layers[2].

**Infrastructure-as-a-Service (IaaS):** Infrastructure-as-a-Service is the first layer and foundation of cloud computing. Using this service model, you manage your applications, data, operating system, middleware and runtime. The service provider manages your virtualization, servers, networking and storage. This allows you to avoid expenditure on hardware and human capital; reduce your

ROI risk; and streamline and automate scaling. According to a 2011 article released by Venture Beat, "Some of the biggest names in IaaS include Amazon, Microsoft, VMWare, Rackspace and Red Hat."

**Platform-as-a-Service (PaaS)** : This cloud service model could be considered the second layer. You manage your applications and data and the cloud vendor manages everything else. Benefits for using Platform-as-a-Service include streamlined version deployment and the ability to change or upgrade and minimize expenses. One popular Platform-as-a-Service is the Google app engine. **Software-as-a-Service (SaaS)** : This is the final layer of the cloud services model. This allows your business to run programs in the cloud where all portions are managed by the cloud vendor. Your users will have assured compatibility and easier collaboration because all will be using the same software. Your company won't need to pay extra licensing fees and you can easily add new users. As consumers we interact with Software-as-a-Service based applications everyday without even realizing it. Examples of this are online banking and email such as Gmail and Hotmail.

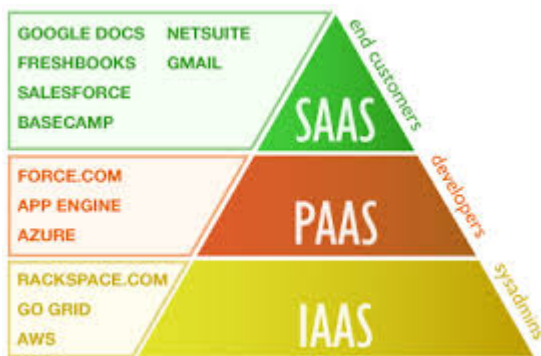


Figure 1 : The Cloud Service Models

## V. IMPORTANCE OF CLOUD BILLING

Billing is the process of determining what a service provider will receive from an end user in exchange for providing their services. The billing process can be as follows: fixed, in which the customer is charged the same amount all the time; dynamic, in which the price charged changes dynamically; or market-dependent, in which the customer is charged based on the real-time market conditions [3]. Fixed pricing mechanisms include the pay-per-use model, in which the customers pay for the amount they consume of a product or the amount of time they use a certain service. Subscription is another type of fixed pricing, in which the customer pays a fixed amount of money to use the service for longer periods at any convenient time or amount. A list price is another form of fixed pricing, in which a fixed price is found in a catalog or a list. On the other hand, differential or dynamic pricing implies that the price changes dynamically according to the service features, customer characteristics, amount of purchased volumes, or customer preferences. Market-dependent pricing, however, depends on the real-time

market conditions such as bargaining, auctioning, demand behavior, and yield management. The following are the most pertinent factors that influence pricing in cloud computing :

- A. **Initial costs**: This is the amount of money that the service provider spends annually to buy resources.
- B. **Lease period**: This is the period in which the customer will lease resources from the service provider. Service providers usually offer lower unit prices for longer subscription periods.
- C. **QoS**: This is the set of technologies and techniques offered by the service provider to enhance the user experience in the cloud, such as data privacy and resource availability. The better QoS offered, the higher the price will be. International Journal of Grid and Distributed Computing[6].
- D. **Age of resources**: This is the age of the resources employed by the service provider. The older the resources are, the lower the price charged will be. This is because resources can sustain wear over time, which reduces their financial value.
- E. **Cost of maintenance**: This is the amount of money that the service provider spends on maintaining and securing the cloud annually[4].

**Requirements of Effective billing**: A truly cloud-centric billing system needs to support the following services:

- A. **Complex products** : cloud computing products can be as simple or as complex as the customer requires. Cloud service providers need a system that can support as much complexity as they choose to provide.
- B. **Scalability** : the sheer volume of individual items that a cloud service provider needs to bill is significant. It will also continue to grow rapidly as each new service is brought to market and the customer base expands[5].
- C. **Real-time** : if the cloud can provision new services in seconds, then the billing system needs to keep up. And with new products, prices, cross-product promotions, introductory offers or new packages to consider, the billing system needs to maintain real-time data on all prices at the time of billing. One way to ensure an unhappy customer (and consequently unhappy support staff) is to generate an invoice that doesn't reflect the promotion the customer thought they were taking advantage of.
- D. **Self-service provisioning** : customers need to know what they're going to pay up-front, and your billing system needs to be able to track every time they provision a new service, check it against current prices and any joint promotions, and generate an invoice accordingly.
- E. **Visibility & control** : in a public, private or hybrid cloud environment, service providers need complete visibility over how their resources are being used, so that they can bill or monitor effectively. Prior to the cloud, how your resources were being used was generally much more invisible to you, but this was not an issue as customers agreed to pay fixed amounts per month. With cloud billing, you can take the utility model and transparency of the cloud and make it profitable[4].

F. **Granular billing** : with so many components making up a cloud service, the billing system needs to be granular enough to drill down into each component or service and report this back to the customer as and when they need it[10].

## VI. TYPES OF BILLING MODEL

Different service providers employ different schemes and models for pricing. However, the most common model employed in cloud computing is the “pay-as-you go” model. Customers pay a fixed price per unit of use. Amazon, considered the market leader in cloud computing, utilizes such a model by charging a fixed price for each hour of virtual machine usage. The “pay-as-you-go” model is also implemented by other leading enterprises such as Google App Engine and Windows Azure. Another common scheme employed by these leading enterprises is the “pay for resources” model. A customer pays for the amount of bandwidth or storage utilized. Subscription, where a customer pays in advance for the services he is going to receive for a pre-defined period of time, is also common [7].

Nevertheless, many useful theoretical studies for cloud computing pricing have been introduced. Sharma et al., proposed a novel financial economic model capable of providing a high level of QoS to customers. They employed the financial option theory and treated the cloud resources as assets to capture their realistic value. The price determined using this model represented the optimal price that the service provider should charge its customers to recover the initial costs. The financial option theory gave a lower boundary on the price that should be charged to customers. The upper boundary of the price was determined using a proposed compounded Moore’s law. This law, presented by the authors, combined Moore’s law with the compounded interest formula. The authors claimed that, if the price was set between these two boundaries, it would be beneficial for both customers and service providers. This approach was interesting; however, it did not take into consideration the maintenance costs. The authors also assumed that the initial costs would be the same for clients and providers, which is not true. Service providers get discounts for buying a larger amount of assets.

Macias and Guitart, proposed a genetic model for pricing in cloud computing markets [8]. Choosing a good pricing model via their genetic algorithms involved three main steps: define a chromosome, evaluate it, and finally select the best pairs of chromosomes for reproduction and discarding those with the worst results. The results of the simulation illustrated that genetic pricing acquired the highest revenues in most of the scenarios. Service providers employing genetic pricing achieved revenues up to 100% greater than the other dynamic pricing strategies and up to 1000% greater than the fixed pricing strategy. The proposed genetic model with a flexible genome was proven to be more stable against noise and earned more money than the one with the rigid genome. The proposed genetic model is easy to implement, flexible, and easily adapted to a set of various parameters that influence pricing. The

genetic pricing approach can be further explored by defining relations between the parameters that influence pricing.

Mihailescu and Teo introduced a dynamic pricing scheme for federated clouds, in which resources are shared among many cloud service providers [8]. Federated clouds are implemented to improve reliability and scalability for both users and providers. Users in the federated environment were assumed to be capable of both buying and selling resources. In the case of high market demand, fixed pricing would minimize seller welfare because he would not be capable of raising his price. Similarly, when demand was low, user utility would be minimized because he would be charged more than the market price. Therefore, dynamic pricing would be beneficial in such environments because it would set the price according to the levels of supply and demand. It would also allow the offering of many types of resources to end users.

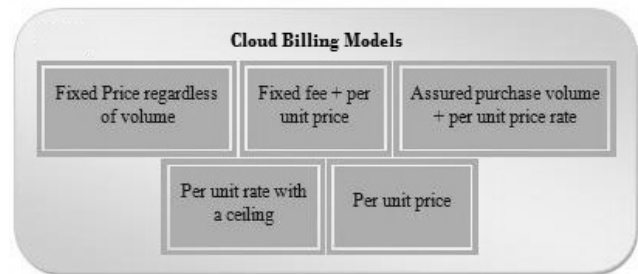


Figure 2 : Cloud Billing Models

## VII. ISSUES IN CLOUD BILLING

**Malicious Insiders** : Malicious insider is a current or former employee, contractor, or other business partner who has or had authorized access to an organization's network, system, or data and intentionally exceeded or misused that access in a manner that negatively affected the confidentiality, integrity, or availability of the organization's information or information systems.

**Multi-cloud offerings**: Managed cloud services can help with other requirements as well. The key is to find a managed cloud provider that can provide a single point of management for multiple clouds. This requires applications that hide the implementation details of key functionality, like account management and access control enforcement. For example, a **managed cloud provider** that can integrate with your on premise Active Directory or LDAP service and apply that to applications running in multiple clouds can save you a significant amount of management.

**Authentication and data encryption**: The Authentication and data encryption depend on users having and managing encryption keys. A managed cloud provider can help maintain security and reduce the risk of losing data with key management support. Remember, if you encrypt your data and lose the encryption key then your data is essentially inaccessible. If a number of different employees share responsibility for storing encrypted data then a centralized key management service can help maintain consistent practices with regards to protecting encryption keys[4]. PKI based authentication mechanism

are too costly, so light weight authentication mechanism are preferred for authentication.

**Integrity in Billing Transaction:** For transparent billing of the cloud services, each billing transaction should be protected against forgery and false modifications [4]. Although commercial CSP, provide users with service billing records and while several researchers have presented resource usage processing systems that record the use of grid resources, they cannot provide a trustworthy audit trail. It is because the user or the CSP can modify the billing records even after a mutual agreement between the user and the CSP, leading to the dispute between them. In this case, even a third party cannot confirm that the user's record is correct or that the CSP's record is correct. Therefore, a trustworthy audit trail is important for resolving disputes, and the billing record in the billing transaction must be assuredly incorruptible per mutual agreement

**Computation efficiency of a billing transaction.:** Cloud service users and CSPs can generate a vast number of billing transactions because on-demand cloud services dynamically scale their capacity upwards or downwards. For example, in the case of iCubeCloud [5] (which is the underlying cloud computing platform of this study), the billing frequency per user of the top 15 percent heavy users is typically about 4,200 billing transactions per day. They occasionally generate more than 200 billing transactions per second (e.g., when starting a Hadoop cluster), as they usually invoke massively parallel processes in a busy manner. The frequent billing transactions lead to excessive computational overhead for both the CSP and the user when the above mentioned security feature is involved in the billing transaction. Consequently, the overhead imposed by the billing transaction should be within acceptable limits so as to be applicable to a wide spectrum of computing devices, such as smart phones, tablets, notebooks, and desktop PCs.

**Trusted SLA monitoring:** Once a cloud service user and CSP agree on an SLA, the service quality should be monitored in a trusted manner[4]. A CSP may deploy a monitor and make the monitor's functionality available to its users. However, the presence of the monitor itself is insufficient because the monitors are deployed on cloud resources that are not operated by users. The CSP may deliberately or unintentionally generate incorrect monitoring records, resulting in incorrect bills. To provide an SLA monitoring mechanism, several studies have made great efforts to design solutions that meet various requirements, including scalability with distributed resource monitoring, data-flow monitoring, and predictions of SLA violations, rather than addressing security concerns such as the integrity and trustworthiness of the monitoring mechanism. Thus, they are not fully supportive of the security issues.

**Scalability:** Scalability is a key requirement for CSPs in today's market, whether it is to support the number of new subscribers and devices that are launched or the number of new partners, content and business models that will monetize these or the networks that are supporting them. Redknee sees that in order to maximize this new era of scalability, CSPs must also be equipped with greater agility, which is where we see the cloud playing a greater role. With the cloud, service providers can scale as required with a 'pay as you grow' commercial model and minimize risk. In addition, it gives CSPs, such as group operators, Tier 1 sub-brands, MVNOs, and MVNEs greater agility to support their various growth strategies by enabling them to reduce CAPEX, standardize their billing operations, and launch into new markets quickly and effectively. Together with Microsoft, Redknee sees that CSPs can have the scalability and agility, through a public, private or hybrid cloud environment, in order to best suit their business requirements.

## CONCLUSION

In our work, we have reviewed cloud computing key concepts and attributes and provided a thorough background of pricing in businesses. We also noted that most pricing models in cloud computing are biased toward the service provider. Most of them aimed to increase the service provider's revenues and decrease its costs. A better pricing approach would include attributes regarding the end user, such as user satisfaction level, QoS, end user utility, and so on. We have given various issues in cloud billing model.

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