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Pricing cloud services—the impact of broadband quality ☆

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ABSTRACT

In the last few years, adoption of cloud computing has shown a marked increase across the world. Moreover, the smaller markets, viz., Asia-Pacific, Latin America, Middle-East, etc., are expected to grow at more than the average rate for the next few years. While this is good news for cloud service providers, significant obstacles to cloud adoption still remain a major cause of concern, for example, the quality of broadband services. As the quality of broadband services is not uniform across the different geographies, pricing of cloud services must take this non-uniformity into account. This paper provides managerial guidelines for cloud service providers on pricing their offerings. We develop optimal pricing strategies for a typical cloud service provider by modeling the utility of a customer of cloud services as a function of two vectors. The first vector is a set of parameters which contribute positively to the utility of a customer, and the second vector is a set of parameters which have a negative effect on the utility. We explore two pricing plans: usage based and fixed fee plan; determine the conditions under which customers would select one plan over another, and discuss the significance of these conditions for cloud service providers.

1. Introduction

Cloud computing is beginning to live up to its promise, the assurance of delivering cutting-edge IT along with the appeal of reduced costs. Organizations are starting to look towards the cloud for their IT needs, and although it is unlikely that customers would abandon the concept of on-premise IT anytime soon, or buy mission critical IT as a service, the gradual movement towards consuming IT as a service cannot be overlooked. According to Gartner, the worldwide market for public cloud services is expected to be around $131 billion, and is forecasted to grow at a compound annual growth rate (CAGR) of 17.7% despite continuing uncertainties in the global markets. Cloud computing is an attractive proposition for businesses because of two main reasons: first, it allows organizations the flexibility to access and to pay for computing resources as and when required, and thus reduces upfront expenditure on IT; second, organizations can scale up operations quickly as access to computing resources is not a constraint. Moreover, an organization can avoid potential losses from capital investments on unused computing resources if market conditions force it to scale down operations.

One of the recent success stories of leveraging the cloud for rapid growth is Pinterest, the content sharing service which was started in 2010. The company registered a phenomenal growth in the number of users – 50 000 to 17 million in a period of 9 months. For a start up like Pinterest, one of the biggest bottlenecks which stifles growth is the massive investments required for computing infrastructure. Pinterest was able to support this rapid increase in users by acquiring computing infrastructure as a service (IaaS). Today, at 48 million users, Pinterest relies on its IaaS provider, Amazon EC2, to provide support for any computing infrastructure requirements. The importance of the cloud is easier to appreciate in the case of online businesses which experience unexpected and massive fluctuations in the number of users, for example, social networking sites, that experience huge surges in users during certain events, for example, natural disasters and political crises.

The convenience of the cloud is also being leveraged to offer gaming as a service. The gamers do not need to invest in sophisticated and expensive hardware to play a game, and can pay according to their usage (playtime) instead of being compelled to purchase an expensive game. For the gaming companies like Gaikai (now Sony) and OnLive Inc., apart from market expansion, cloud gaming opens up new revenue streams for outmoded games which are difficult to sell, as there may be a few gamers who will pay to play the game for a few hours. Also, the company can upgrade its games without worrying about the

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hardware compatibility of its customers. The concept of platform-as-a-service (PaaS) is also gaining rapid traction. BestBuy Co. Inc.'s launch of Giftag using Google App Engine is a fine example of how companies can leverage PaaS to achieve their business goals. Google App Engine helped to reduce the development costs for Giftag and helped it to scale up rapidly without incurring significant maintenance costs. PaaS, of course, has more to offer to cash-starved startups. The Tap series of games which runs on Google App Engine is one of the most downloaded apps in the iOS platform. The phenomenal success of the publisher of the game, Pocket Gems, is one among scores of examples which highlight the potential of PaaS to emerge as a democratizing and indeed, a destabilizing force, in the software development market.

The plethora of success stories of cloud computing in the popular media has conjured images of a giant tsunami about to unleash its fury on the shores of traditional IT organizations. However, there are obstacles to cloud adoption. Indeed, Gartner estimates that the total IT market in 2013 is worth $2.7 trillion, and the cloud at $129 billion has a share of just 4.8%. In fact, even at a more-than-healthy CAGR of 17.7%, the cloud will represent only 7.7% of the total IT market in 2017. There are quite a few concerns regarding the viability of the cloud as an alternate to traditional IT. Although cloud service providers are working towards addressing these concerns, for example, setting up multiple data centers to avoid service disruptions, standardizing APIs to allay the fears of data lock-in, and concerns on security of data being addressed by technologies such as encrypted storage, firewalls, and packet filters, it would take considerable effort on the part of the cloud service providers to allay all the concerns of customers. In addition, the quality of broadband connections remains a significant deterrent to adoption of cloud computing, all the more so, as cloud service providers cannot directly address this concern [3,23,24]. The most affected markets are the small and medium scale businesses, and the personal users of the cloud, who do not have the resources to invest on a very high quality network. If we compare markets across geographies, cloud users from South East Asia, Africa, South America, etc., are likely to have a much poorer experience of accessing the cloud, and hence may not adopt the cloud with the same gutso as other users from developed nations [2].

Although standardization of broadband quality around the world seems improbable in the near future, it is unlikely to dampen the efforts of cloud service providers to venture into the markets of South-East Asia, Africa or Latin America. In fact, according to Gartner, the highest growth rates of cloud computing have been reported from the regions of Asia/Pacific, Latin America, North Africa, Eastern Europe and Middle East. It is equally important to note that these regions are also the smallest overall markets. Therefore, the main challenge that the cloud service providers face today is to sustain the high growth rate under the constraint of variable quality of broadband services. One of the most effective mechanisms for addressing this challenge is to consider the broadband quality while pricing cloud services. The need to consider quality of broadband services adds to the complexity of the pricing mechanism for cloud services. However, this added complexity is unavoidable as the design of pricing plans which can correctly factor in the effect of the quality of broadband service is essential for the success of the cloud computing business model.

There are two major concerns that are central to the discussion on cloud pricing: the design of pricing plans by the cloud service provider and the selection of the appropriate pricing plan by the consumer. In the case of the cloud, these two aspects of pricing become all the more tricky because of the fluctuations in broadband speeds, and therefore these frequent fluctuations must be considered in the design of pricing plans. In addition, the other deterrents to cloud adoption should also be included in the design of pricing plans. At the same time the customer must also reflect on the effects of the obstacles she faces and accordingly select an appropriate plan. This paper attempts to provide a better understanding of the process of pricing cloud services, both in terms of design of pricing plans as well as the selection of an appropriate pricing plan. We look at two different pricing options – a fixed-fee pricing plan independent of usage and a pure usage-based pricing plan. The quality of broadband services has two different aspects: the speed of the broadband service, i.e., the data transfer rate and the change in the data transfer rate over time – broadband non-uniformity. In the case of cloud computing, the latter is a more serious problem as it is unlikely that one will subscribe to a cloud service if her broadband speed is not sufficient. It is the fluctuations in broadband speed that lead to a reduction in utility for the consumer as the experience of accessing the cloud is adversely affected.

The objective of this work is to model heterogeneous customers who are interested in acquiring cloud services in order to develop a pricing schedule. A customer can be characterized by a number of attributes, for example, two relevant attributes could be – propensity to acquire cloud computing resources – the customer type, and the quality of a customer's broadband services. However, instead of restricting our model to only two attributes, we have generalized our model to include two vectors of customer attributes. The first vector represents a set of attributes which contribute positively to the utility of the customer. The second vector represents a set of attributes which have a negative effect on the utility of the customer. This will help different cloud service providers to adapt our work according to their business models and implement the optimal pricing structure that we propose in this paper. For example, let us look at the specific domain of IaaS providers. One of the largest customers of these service providers is social networking websites which experience rapid changes in user activities over a period of time. Thus, in addition to customer type, the variation in number of users will be a key attribute of a social networking website when we consider the utility that it derives from the services of an IaaS provider. Similarly, other business domains may have other attributes over and above customer type and broadband quality.

We first determine the conditions under which customers opt for different pricing plans, viz., usage-based pricing plans and fixed-fee pricing plans. These conditions provide a guideline for cloud providers on pricing their offerings to customers. It provides a clear understanding of pricing related issues for both incumbents and new entrants in this field, and offers a mechanism for designing optimal tariff structures. Our findings on the fraction of adopters of usage-based and fixed-fee plans will help cloud providers segment customers, and target them with appropriate offers. We also demonstrate that the introduction of a fixed-fee plan improves profits for the cloud service providers if we consider a transaction cost associated with administering usage-based plans.

Shapiro and Varian [30] define an information good as "anything that can be digitized – encoded as a stream of bits". In line with this definition, here we categorize cloud services as an information good, and consider cloud computing usage to be the amount of computing resources used per unit time. Cloud computing resources, like any other information good, exhibit zero marginal cost as the cost of providing an additional unit of computing power for a unit time is essentially zero. However, cloud service providers have to incur a cost to keep track of the usage of the consumer, which is best expressed as a transaction cost. Pricing information goods generally involves non-linear price structures [4,30,38,39], which we observe in the pricing schemes