

CS591 Research Proposal: Secondary Markets for Cloud Computation

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Abstract

In this research I will investigate cloud computing economics, in particular the sale and resale of computational resources by Infrastructure as a Service (IaaS) providers.

My goal is to demonstrate the market properties necessary to support a sustainable secondary marketplace for computational resources.

To accomplish this, I will create a market model that incorporated key elements from present day IaaS markets. With this model I will attempt to simulate the conditions in which a secondary marketplace will fail, and those that create an equilibrium in which both the producer and consumers benefit optimally.

Introduction

Over the past five years, the sale of cloud-based computation resources has created a multi-million dollar industry and is well on the way to transforming the paradigm of computation.

Infrastructure as a Service (IaaS) providers offer the "lowest level" of cloud services where the resource resembles actual resource hardware. In an IaaS exchange, a consumer is given access to a "bare-metal" computation resources and billed by usage. Typically usage is billed "on-demand, requires no down payment and the consumer pays for only the resources they used. Some IaaS providers (e.g., Amazon, Microsoft) offer the ability to prepay (or lease) a "reserved" amount of resources that are billed at a discounted usage rate for the duration of the lease.

Depending on the length of the project and the

amount of anticipated usage, prepaying for the reserved resources can be a better deal than purchasing on-demand. However, since the incentive to prepay is based entirely on the consumer's projected usage, it is possible that resources are overprovisioned and remain unused, and the consumer is unable to recover any portion of their down payment.

On Amazon's Elastic Cloud Compute (EC2), on-demand resource usage is billed by the hour and "Reserved Instances" are available through 1 or 3 year lease agreements. Computation rates on reserved instances are typically less than 50% that of the corresponding on-demand rate. In September 2012, Amazon Web Services (AWS) announced the Reserved Instance Marketplace, a online marketplace that allows the resale of Reserved Instances. Amazon is the first IaaS provider to offer their customers this degree of flexibility.

An additional recent expansion in IaaS features has been a shift in the granularity of the computational units offered. Similar to cellphone providers shift from pay-per-minute to pay-per-second methods, IaaS providers continue to offer smaller instances of consumption and more flexible ways of packaging them. A notable example of this is ProfitBricks, a "next-generation" IaaS provider that offers the ability to "vertically scale" their resource allocation size by elastically adding/removing "physical" cores, memory and disks to individual instances.

Research Question

IaaS providers sell a commodity, a unit of computational resources, that has the potential to be bought,

sold, resold, shorted, and arbitrated in the same way as other commodity-driven marketplaces.

However, it isn't immediately clear what benefit an IaaS provider would receive for allowing such an exchange on their resources. Wouldn't the provider prefer all consumers to purchase computation from them directly? It seems that if a robust secondary marketplace were to develop, the provider could change the properties of their services offered to convert more consumers directly, naturally putting an end to the secondary marketplace. Even the website for the AWS Reserved Instance Marketplace seems to imply that it exists only to motivate consumers to buy larger quantities of reserve instances.

Through simulations of secondary marketplaces, I will attempt to demonstrate the points where there is no longer incentive for the provider to support a secondary marketplace (i.e., the secondary market has failed) and under what circumstances can a secondary market exist where both consumer and provider benefit optimally.

Proposed Methodology

Hypothesis: There exists an equilibrium that allows for a rich and sustainable marketplace for the resale of computation. However, its existence depends on the willingness of the underlying IaaS providers. By changing the properties of the services offered (computation unit size, prepay 'lease' durations, secondary market exchange "fees") the provider has the ability to minimize the incentive for consumers to compete in an secondary marketplace while maintaining or exceeding their existing levels of income.

Market Model

I will attempt to confirm this hypothesis through the use of simulations run on top of a market models that implements actors and incentives reflective of a simple single-provider cloud computing economy.

Supplier: A single supplier provides resources in fixed computational units (i.e., max CPU frequency over unit time). Consumer have the

ability to prepay for limited-time access to discounted unit rates. Supplier has unlimited resources available.

Consumers: Multiple consumer bid for CPU resources to process sequential "batch" computation jobs. Each consumer has an individual arrival time, budget, project deadline and work amount required. Consumer data will be generated from a normally distributed random data set.

The Game: Each consumer will attempt to complete their job within their individual budget and deadline by purchasing units of computation. To the consumer, all computation units are equivalent in value regardless of source (i.e., primary or secondary marketplace.)

Simulations

Two simulations will be run for each test. Each test defines the following values of services offered by the provider: consumption billing rates, consumption unit size, billing durations, prepay durations, secondary market exchange fees.

No Resale: All consumers purchase computation direct from the provider at the rate that best fits their budget and deadline. This simulation will show the income the provider gains in the case that no secondary market exists, as well as the overall efficiency of the clients and the percentage of pre-purchase computation that goes unused.

Secondary Marketplace: A consumer who pre-paid to access the discounted rate can sell the remainder of their access to another consumer. An exchange fee is paid to the provider by the seller. Resell price is set by the seller and is motivated by the need to undercut the provider rates while minimizing overall cost.

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