



# CSPE: Cloud Storage Provisioning Decided by Rate of Return and Workload Characteristics

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## Motivation

The work introduce a Cloud Storage Provisioning Engine (CSPE) to help users rationally evaluate the benefit of purchasing new disk drives and leasing from remote servers offered by Infrastructure as a service (IaaS) providers.

The contributions of CSPE are as follows:

- CSPE evaluates the future storage demand by tracing previous data increment tendency, which is completely customer-made for growth-oriented enterprises.
- CSPE uses the widely-used Internal Rate of Return (IRR) in economics to solve "purchase or not" problem with regard to storage provisioning .
- In regular services stage, we optimize our engine from workload utilization perspective to further complete workload provisioning for the purpose of cost saving.

## CSPE Decision Model

TABLE I  
NOTATIONS OF MODEL

Notations	Description
$C_t$	Initial disk drive investment
$C_0$	Initial disk drive investment
$r$	Discount rate
$t$	Time period (years)
$n$	The life cycle of this project (years)

- The internal rate of return makes the net present value (NPV) of all cash flows (both positive and negative) from a particular investment equal to zero. The simplified standard NPV equation is shown in Eq(1):

$$NPV = \sum_{t \in n} \frac{C_t}{(1+t)^t} \quad (1)$$

- We can infer that IRR of purchasing new disk drives is given in Eq (2)

$$NPV_p = \sum_{t \in n} \frac{C_t}{(1+IRR_p)^t} \quad (2)$$

- Similarly the IRR of leasing over the clouds in the right of Eq (3):

$$NPV_l = \sum_{t \in n} \frac{C_t}{(1+IRR_l)^t} \quad (3)$$

- Using secant method Eq (4), we get  $IRR_p$  and  $IRR_l$  respectively, then we could calculate  $\Delta IRR$  Eq (4) using the equations of next page:

$$r_{n+1} = (1+r_n) \left( \frac{1+r_{n-1}}{1+r_n} \right)^p - 1 \quad (4)$$

$$\Delta IRR = IRR_p - IRR_l$$

Where

$$P = \frac{\log(NPV_{n, in} / |C_0|)}{\log(NPV_{n, in} / NPV_{n-1, in})}$$

## System Framework of CSPE

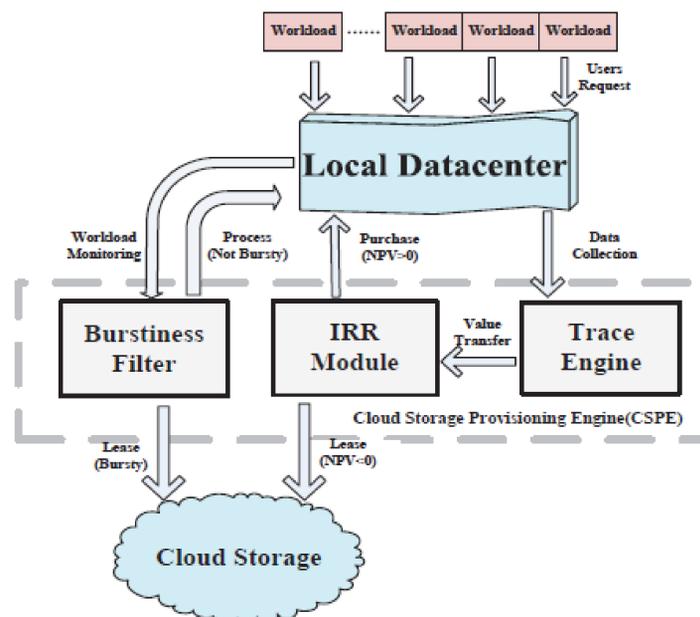


Fig. 1. Framework of CSPE

### Trace Engine

- Analyze previous records in the local datacenter
- Predict data extension tendency and estimate future demand in storage

### IRR Module

- Draw graphic images of calculated IRR values a storage life expectancy from 0 to N years.
- Based on the IRR results, the enterprises can make a quick purchase or lease decision in a more straight way.

### Burstiness Filter

- Monitor users' request (i.e. workloads),
- Detect bursty workloads ,then migrate them to the clouds.

## CSPE Working Flow

We drive our CSPE working by following steps.

- Firstly, we employ **Trace Engine** to predict next future years' demand by analyzing previous records of increasing storage in local datacenter, and transport the predicted results to the **IRR Module**.
- Then, we bring in **Internal Rate of Return (IRR)** Models to measure and compare the profitability of investments in order to help decide whether companies should purchase new disk drives or lease remote cloud computing service. However, merely a solution to "to purchase or not" problem is not enough for practical applications.
- Lastly, we come up with a module called **Burstiness Filter** to identify those bursty workloads and then migrate them to the cloud storage service providers for the benefits of cost savings and risks. Because a bursty (i.e. high peak average utilization ratio) workload actually causes a less dense workload placement possible on the server and hence much lower average server utilization, which renders in deployment of more resources and higher cost.

## CSPE Model Characterization and Preliminary Evaluation

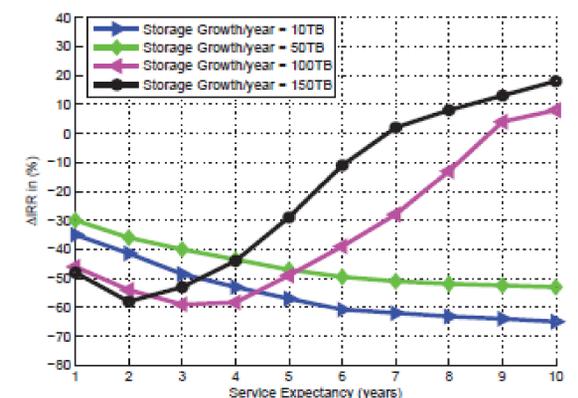


Fig. 2. Preliminary Testing of  $\Delta IRR$  Tendency

- The evaluation shows the approximate  $\Delta IRR$  trend in recent 10 years.
- IRR of leasing over the clouds exceeds that of purchasing new disk drives and human capital for operation and monitoring.
- For the large size enterprises with a datacenter of thousands servers, the investment of purchasing new devices becomes more profitable after 8 years, especially for those far-sighted enterprises with servers of long expectancy.

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