

Cost Metrics and Pricing Models

Business Cost Metrics

- ❖ Up-front costs (CAPEX) are associated with the initial investments that organizations need to make in order to fund the IT resources they intend to use.
 - ❖ Up-front costs for the purchase and deployment of on-premise IT resources tend to be high.
 - ❖ “Up-front costs for the leasing of cloud-based IT resources tend to be low.
- ❖ On-going costs (OPEX) represent the expenses required by an organization to run and maintain IT resources it uses.
 - ❖ On-going costs for the operation of on-premise IT resources can vary. Examples include licensing fees, electricity, insurance, and labor.
 - ❖ On-going costs for the operation of cloud-based IT resources can also vary, but often exceed the on-going costs of on-premise IT resources (especially over a longer period of time). Examples include virtual hardware leasing fees, bandwidth usage fees, licensing fees, and labor.

Business Cost Metrics (2)

- ❖ Additional costs - to supplement and extend a financial analysis beyond the calculation and comparison of standard up-front and on-going business cost metrics, several other more specialized business cost metrics can be considered. Examples include
 - ❖ Cost of capital – cost incurred during raising funds.
 - ❖ Sunk costs – prior investment in IT resources (Sunk vs. Up-front)
 - ❖ Integration costs – to ensure compatibility in a new cloud environment (or new IT premise in foreign environment).
 - ❖ Locked-in cost – cost incurred by port (move) IT resources from one cloud to another.

Total Cost of Ownership (TCO)

- ❖ What are the decisions for TCO of
 - ❖ Dependent on enterprise's policy, budget, performance required, etc.
 - ❖ Typically, 3 years, 5 years or probably more.

Case Study Example

ATN performs a total cost-of-ownership (TCO) analysis on migrating two of its legacy applications to a PaaS environment. The report produced by the analysis examines comparative evaluations of on-premise and cloud-based implementations based on a three-year time frame.

The following sections provide a summary from the report for each of the two applications.

Product Catalog Browser

The Product Catalog Browser is a globally used Web application that interoperates with the ATN Web portal and several other systems. This application was deployed in a virtual server cluster that is comprised of 4 virtual servers running on 2 dedicated physical servers. The application has its own 300 GB database that resides in a separate HA cluster. Its code was recently generated from a refactoring project. Only minor portability issues needed to be addressed before it was ready to proceed with a cloud migration.

The TCO analysis reveals the following:

On-Premise Up-Front Costs

- Licensing: The purchase price for each physical server hosting the application is \$7,500, while the software required to run all 4 servers totals \$30,500
- Labor: Labor costs are estimated as \$5,500, including setup and application deployment.

The total up-front costs are: $(\$7,500 \times 2) + \$30,500 + \$5,500 = \$51,000$

The configuration of the servers is derived from a capacity plan that accounts for peak workloads. Storage was not assessed as part of this plan, since the application database is assumed to be only negligibly affected by the application's deployment.

On-Premise On-Going Costs

The following are monthly on-going costs:

- Environmental Fees: \$750
- Licensing Fees: \$520
- Hardware Maintenance: \$100
- Labor: \$2,600

The total on-premise on-going costs are: \$750 + \$520 + \$100 + \$2,600 = \$3,970

Cloud-Based Up-Front Costs

If the servers are leased from a cloud provider, there is no up-front cost for hardware or software. Labor costs are estimated at \$5,000, which includes expenses for solving interoperability issues and application setup.

Cloud-Based On-Going Costs

The following are monthly on-going costs:

- Server Instance: Usage fee is calculated per virtual server at a rate of \$1.25/hour per virtual server. For 4 virtual servers, this results in: $4 \times (\$1.25 \times 720) = \$3,600$. However, the application consumption is equivalent to 2.3 servers when server instance scaling is factored in, meaning the actual on-going server usage cost is: \$2,070.
- Database Server and Storage: Usage fees are calculated per database size, at a rate of \$1.09/GB per month = \$327.
- Network: Usage fees are calculated per outbound WAN traffic at the rate of \$0.10/GB and a monthly

volume of 420 GB = \$42.

- Labor: Estimated at \$800 per month, including expenses for cloud resource administration tasks.

The total on-going costs are: \$2,070 + \$327 + \$42 + \$800 = \$3,139

The TCO breakdown for the Product Catalog Browser application is provided in [Table 15.1](#).

| Up-Front Costs | Cloud Environment | On-Premise Environment |
|-----------------------------|-------------------|------------------------|
| Hardware | \$0 | \$15,000 |
| Licensing | \$0 | \$30,500 |
| Labor | \$5,000 | \$5,500 |
| Total Up-Front Costs | \$5,000 | \$51,000 |

A comparison of the respective TCOs over a three-year period for both approaches reveals the following:

| Monthly On-Going Costs | Cloud Environment | On-Premise Environment |
|-----------------------------|-------------------|------------------------|
| Application Servers | \$2,070 | \$0 |
| Database Servers | \$327 | \$0 |
| WAN Network | \$42 | \$0 |
| Environment | \$0 | \$750 |
| Software Licensing | \$0 | \$520 |
| Hardware Maintenance | \$0 | \$100 |
| Administration | \$800 | \$2,600 |
| Total On-Going Costs | \$3,139 | \$3,970 |

- On-Premise TCO: \$51,000 up-front + (\$3,970 x 36) on-going = **\$193,920**
- Cloud-Based TCO: \$5,000 up-front + (\$3,139 x 36) on-going = **\$118,004**

Based on the results of the TCO analysis, ATN decides to migrate the application to the cloud.

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- On-Premise TCO: \$51,000 up-front + (\$3,970 x 36) on-going = \$193,920
- Cloud-Based TCO: \$5,000 up-front + (\$3,139 x 36) on-going = \$118,004

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Client Database

The Client Database application is deployed in a virtual server cluster comprised of 8 virtual servers running on 2 dedicated physical servers, with a 1.5 TB database on a HA cluster that is coupled with another system database. The application code is old, requiring considerable effort to port to the PaaS environment.

The TCO analysis reveals the following:

On-Premise Up-Front Costs

- Licensing: Each physical server that is used to host the application costs \$7,500, while the software that

is required to run all 8 virtual servers costs \$15,200.

- Labor: Estimated at \$5,500, the labor cost includes expenses for setting up the new environment and deploying the application on the new servers.

The total up-front costs are: $(\$7,500 \times 2) + \$15,200 + \$5,500 = \$35,700$

On-Premise On-Going Costs

The following are monthly on-going costs:

- Environmental Fees: \$1,050
- Licensing Fees: \$300
- Hardware Maintenance: \$100
- Administration: \$4,500

The total on-going costs are: $\$1,050 + \$300 + \$100 + \$4,500 = \$5,950$

Cloud-Based Up-Front Costs

There are no up-front hardware or software costs if the servers are leased from a cloud provider. The labor is estimated at \$45,000, most of which is for integration testing and application porting tasks.

Cloud-Based On-Going Costs

The following are monthly on-going costs:

- Server Instance: Usage fees are calculated at a rate of \$1.25/hour per virtual server. The estimated scaling of the virtual server means that actual service usage is equivalent to 3.8 servers, which results in a total of \$3,420.
- Database Server and Storage: Usage fees are calculated per database size at a rate of \$1.09/GB per month = \$1,635.
- Network: Outbound WAN traffic usage is calculated at a rate of \$0.10/GB, at an estimated volume of 800 GB per month = \$80.
- Labor: Estimated at \$1,200 when cloud resource administration tasks are included.

The total on-going costs are: $\$3,420 + \$1,635 + \$80 + \$1,200 = \$6,335$

The TCO breakdown for the Client Database application is shown in [Table 15.2](#).

Table 15.2. The TCO analysis for the Client Database application.

| Up-Front Costs | Cloud Environment | On-Premise Environment |
|-----------------------------|-------------------|------------------------|
| Hardware | \$0 | \$15,000 |
| Licensing | \$0 | \$15,200 |
| Labor | \$45,000 | \$5,500 |
| Total Up-Front Costs | \$45,000 | \$35,700 |

A comparison of the respective TCOs over a three-year period reveals the following:

| Monthly On-Going Costs | Cloud Environment | On-Premise Environment |
|-----------------------------|-------------------|------------------------|
| Application Servers | \$3,420 | \$0 |
| Database Servers | \$1,635 | \$0 |
| WAN Network | \$80 | \$0 |
| Environment | \$0 | \$1,050 |
| Software Licensing | \$0 | \$300 |
| Hardware Maintenance | \$0 | \$100 |
| Administration | \$1,200 | \$4,500 |
| Total On-Going Costs | \$6,335 | \$5,950 |

- On-Premise TCO: \$35,700 up-front + (\$5,950 x 36) on-going = \$251,700
- Cloud-Based TCO: \$45,000 up-front + (\$6,335 x 36) on-going = \$273,060

The decision to migrate the application to the cloud is not supported by the TCO analysis.

You are assigned to perform a total cost-of-ownership (TCO) analysis on deploying two new enterprise application servers (each with a storage of 200GB) and one web server (no extra storage required) on the cloud. The application servers require authenticated access to database servers located in the enterprise's data center (on-premise private cloud) via WAN connection. Based on the information provided in following tables, determine TCO breakdown for a three-TCO timeframe to evaluate if the company should deploy this new service on the cloud. Show the detailed calculations for both on-premise expenses vs. cloud-based expenses.

On-premise expenses (in USD)

| CAPEX | | OPEX (monthly) | |
|--|-------|----------------------------------|-------|
| One physical server | 5,000 | Labor (IT staffs) | 3,000 |
| OS licensing (Perpetual license) | 500 | Hardware maintenance (Yearly) | 15% |
| Application licensing (Perpetual license) | 3,000 | Environmental | 1,000 |
| Web server licensing (Perpetual license) | 1,000 | | |
| Integration cost | 9,000 | | |

Cloud-based Expenses (in USD)

For application server instance, the usage fee is 2 USD/hour per VM.

For web server instance, the usage fee is 1.5 USD/hour per VM.

For storage, the usage fee is 1 USD/GB per month.

Cloud Usage Cost Metrics

- ❖ A set of usage cost metrics for calculating costs associated with cloud-based IT resource usage measurements:
- ❖ **Network Usage** – inbound and outbound network traffic, as well as intra-cloud network traffic.
- ❖ **Server Usage** – virtual server allocation (and resource reservation)
- ❖ **Cloud Storage Device** – storage capacity allocation.
- ❖ **Cloud Service** – subscription duration, number of nominated users, number of transaction.

Network Usage

- ❖ The amount of data that is transferred over a network connection, network usage is typically calculated using separately measured inbound network usage traffic and outbound network usage traffic metrics in relation to cloud services or other IT resources.
- ❖ Inbound/Outbound Network Usage Metric
 - ❖ Description – inbound/outbound network traffic
 - ❖ Measurement – Σ , inbound network traffic in bytes
 - ❖ Frequency – continuous and cumulative over a predefined period
 - ❖ Cloud Delivery Model – IaaS, PaaS, SaaS
 - ❖ Example – up to 1 GB free, \$0.001/GB up to 10 TB a month

Network Usage (2)

- ❖ Network usage metrics can be applied to WAN traffic between IT resources of one cloud that are located in different geographical regions in order to calculate costs for synchronization, data replication, and related forms of processing. Conversely, LAN usage and other network traffic among IT resources that reside at the same data center are typically not tracked.
- ❖ Intra-Cloud WAN Usage Metric
 - ❖ Description – network traffic between geographically diverse IT resources of the same cloud.
 - ❖ Measurement – Σ , intra-cloud WAN traffic in bytes.
 - ❖ Frequency – continuous and cumulative over a predefined period.
 - ❖ Cloud Delivery Model – IaaS, PaaS, SaaS.
 - ❖ Example – up to 500 MB free daily and \$0.01/GB thereafter, \$0.005/GB after 1 TB per month.

Server Usage

- ❖ The allocation of virtual servers is measured using common pay-per-use metrics in IaaS and PaaS environments that are quantified by the number of virtual servers and ready-made environments.
- ❖ This form of server usage measurement is divided into **on-demand** virtual machine instance allocation and **reserved** virtual machine instance allocation metrics.
- ❖ The **former metric measures pay-per-usage fees on a short-term basis**, while the **latter metric calculates up-front reservation fees for using virtual servers over extended periods**. The up-front reservation fee is usually used in conjunction with the **discounted pay-per-usage fees**.

Server Usage (2)

- ❖ On-Demand Virtual Machine Instance Allocation Metric
 - ❖ Description – uptime of a virtual server instance
 - ❖ Measurement – Σ , virtual server start date to stop date
 - ❖ Frequency – continuous and cumulative over a predefined period
 - ❖ Cloud Delivery Model – IaaS, PaaS
 - ❖ Example – \$0.10/hour small instance, \$0.20/hour medium instance, \$0.90/hour large instance
- ❖ Reserved Virtual Machine Instance Allocation Metric
 - ❖ Description – up-front cost for reserving a virtual server instance.
 - ❖ Measurement – Σ , virtual server reservation start date to expiry date
 - ❖ Frequency – daily, monthly, yearly
 - ❖ Cloud Delivery Model – IaaS, PaaS
 - ❖ Example – \$55.10/small instance, \$99.90/medium instance, \$249.90/large instance.

Cloud Storage Device Usage

- ❖ Cloud storage is generally charged by the amount of space allocated within a predefined period, as measured by the on-demand storage allocation metric.
- ❖ Similar to IaaS-based cost metrics, **on-demand storage allocation fees** are usually based on short time increments (such as on an hourly basis).
- ❖ Another common cost metric for cloud storage is **I/O data transferred**, which measures the amount of transferred input and output data.

Cloud Storage Device Usage (2)

- ❖ On-Demand Storage Space Allocation Metric
 - ◊ Description – duration and size of on-demand storage space allocation in bytes.
 - ◊ Measurement – Σ , date of storage release / reallocation to date of storage allocation (resets upon change in storage size).
 - ◊ Frequency – continuous
 - ◊ Cloud Delivery Model – IaaS, PaaS, SaaS
 - ◊ Example – \$0.01/GB per hour (typically expressed as GB/month)
- ❖ I/O Data Transferred Metric
 - ◊ Description – amount of transferred I/O data
 - ◊ Measurement – Σ , I/O data in bytes
 - ◊ Frequency – continuous
 - ◊ Cloud Delivery Model – IaaS, PaaS
 - ◊ Example – \$0.10/TB

Cloud Service Usage

- ❖ Cloud service usage in SaaS environments is typically measured using the following three metrics:
- ❖ Application Subscription Duration Metric
 - ❖ Description – duration of cloud service usage subscription
 - ❖ Measurement – Σ , subscription start date to expiry date
 - ❖ Frequency – daily, monthly, yearly
 - ❖ Cloud Delivery Model – SaaS
 - ❖ Example – \$69.90 per month

Cloud Service Usage (2)

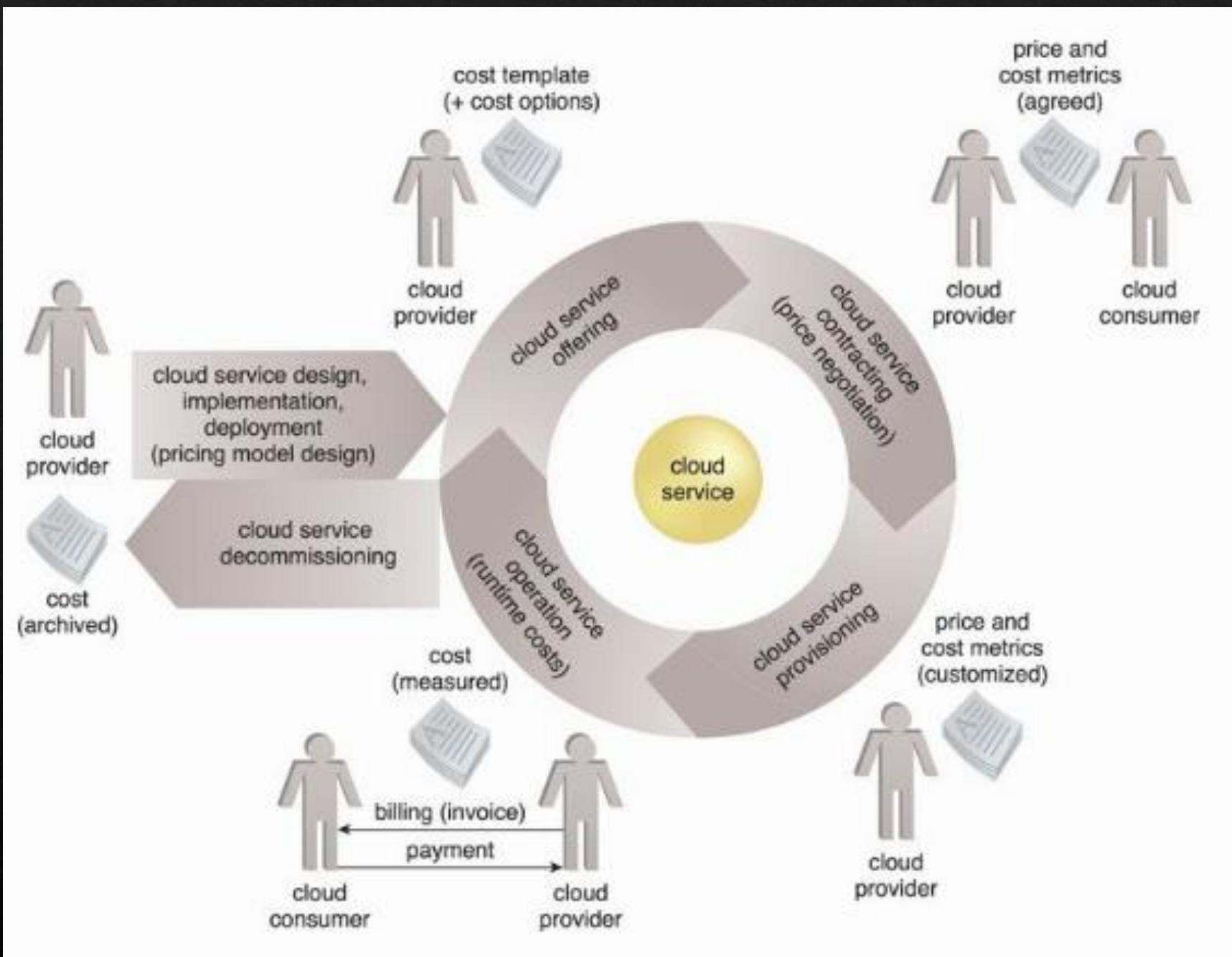
- ❖ Number of Nominated Users Metric
 - ❖ Description – number of registered users with legitimate access
 - ❖ Measurement – number of users
 - ❖ Frequency – monthly, yearly
 - ❖ Cloud Delivery Model – SaaS
 - ❖ Example – \$0.90/additional user per month
- ❖ Number of Transactions Metric
 - ❖ Description – number of transactions served by the cloud service
 - ❖ Measurement – number of transactions (request-response message exchanges)
 - ❖ Frequency – continuous
 - ❖ Cloud Delivery Model – PaaS, SaaS
 - ❖ Example – \$0.05 per 1,000 transactions

Cost Management Considerations

- ❖ Cost management is often centered around the lifecycle phases of cloud services, as follows:
- ❖ **Cloud Service Design and Development** – During this stage, the pricing models and cost templates are typically defined by the organization delivering the cloud service.
- ❖ **Cloud Service Deployment** – Prior to and during the deployment of a cloud service, the backend architecture for usage measurement and billing-related data collection is determined and implemented, including the positioning of pay-per-use monitor and billing management system mechanisms.
- ❖ **Cloud Service Contracting** – This phase consists of negotiations between the cloud consumer and cloud provider with the goal of reaching a mutual agreement on rates based on usage cost metrics.

Cost Management Considerations (2)

- ❖ **Cloud Service Offering** – This stage entails the concrete offering of a cloud service's pricing models through cost templates, and any available customization options.
- ❖ **Cloud Service Provisioning** – Cloud service usage and instance creation thresholds may be imposed by the cloud provider or set by the cloud consumer. Either way, these and other provisioning options can impact usage costs and other fees.
- ❖ **Cloud Service Operation** – This is the phase during which active usage of the cloud service produces usage cost metric data.
- ❖ **Cloud Service Decommissioning** – When a cloud service is temporarily or permanently deactivated, statistical cost data may be archived.



Pricing Models

- ❖ The pricing models used by cloud providers are defined using templates that specify unit costs for fine-grained resource usage according to usage cost metrics. Various factors can influence a pricing model, such as:
 - ❖ market competition and regulatory requirements.
 - ❖ overhead incurred during the design, development, deployment, and operation of cloud services and other IT resources.
 - ❖ opportunities to reduce expenses via IT resource sharing and data center optimization.

Pricing Models (2)

- ❖ A pricing model can contain multiple price templates, whose formulation is determined by variables like:
 - ❖ **Cost Metrics and Associated Prices** – These are costs that are dependent on the type of IT resource allocation (such as on-demand versus reserved allocation).
 - ❖ **Fixed and Variable Rates Definitions** – Fixed rates are based on resource allocation and define the usage quotas included in the fixed price, while variable rates are aligned with actual resource usage.
 - ❖ **Volume Discounts** – More IT resources are consumed as the degree of IT resource scaling progressively increases, thereby possibly qualifying a cloud consumer for higher discounts.
 - ❖ **Cost and Price Customization Options** – This variable is associated with payment options and schedules. For example, cloud consumers may be able to choose monthly, semi-annual, or annual payment installments.

Pricing Models (3)

- ❖ Price templates are important for cloud consumers that are appraising cloud providers and negotiating rates, since they can vary depending on the adopted cloud delivery model.
- ❖ For example:
 - ❖ IaaS – Pricing is usually based on IT resource allocation and usage, which includes the amount of transferred network data, number of virtual servers, and allocated storage capacity.
 - ❖ PaaS – Similar to IaaS, this model typically defines pricing for network data transferred, virtual servers, and storage. Prices are variable depending on factors such as software configurations, development tools, and licensing fees.
 - ❖ SaaS – Because this model is solely concerned with application software usage, pricing is determined by the number of application modules in the subscription, the number of nominated cloud service consumers, and the number of transactions.

Additional Considerations

- ❖ Negotiation – Cloud provider pricing is often open to negotiation, especially for customers willing to commit to higher volumes or longer terms.
- ❖ Payment Options – There are two common payment options available to cloud consumers: pre-payment and post-payment.
- ❖ Cost Archiving – By tracking historical billing information both cloud providers and cloud consumers can generate insightful reports that help identify usage and financial trends.