POLITECNICO DI MILANO
Facoltà di Ingegneria dell'Informazione

POLO REGIONALE DI COMO
Master of Science in Computer Engineering

Measuring and Allocating Costs of a Virtual Infrastructure;Automating the Process of Provisioning of Virtual Machines on Vmware Lifecycle Manager and Chargeback

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Como December,2010

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Corso di Laurea Specialistica in Ingegneria Informatica

Misurazione e Ripartizione dei Costi di un'infrastruttura Virtuale; Automatizzazione Del Processo di Provisioning Delle Macchine Virtuali su VMware Lifecycle Manager e Chargeback

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Como Dicembre,2010

Acknowledgements

There are many who have made this work possible. First, I would like to show my appreciation to my supervisor Prof. Danilo Ardagna and Mr Diego Perego and Fabrizio Leone from Lutech S.p.A Company, who have been my inspiration and role model for how to do good research. He has always given good advices and directions while still allowing me to go my own way.

Next, I would like to thank my family, who have offered loving support and helped me to overcome all the problems. They have always supported me in whatever the decisions I have made, and have given me the confidence to believe in myself.

I would like to thank all my professors through the years of studying at Politecnico di Milano, both formal and informal, who gave me great knowledge, and have helped me to make the way to this thesis.

I would also like to thank to all my friends who have supported me a great moral for all the years studying at Politecnico.

Executive summary

In this thesis, the measuring and costs allocation of a virtual Infrastructure is discussed. The aim is to develop an automated process of provisioning of Virtual Machines based on Vmware Vcenter Chargebacks and Vmware Vcenter Lifecycle Manager products. I carried out Lifecycle and chargeback models on Vmware during my internship at Lutech S.p.A Company which is one of the main Consultant Company in Italy in the virtualization market and I had the opportunity to testify them in the enterprise. The main problem we faced is that many companies use a manual approach to charge for virtual machines while with vCenter Chargeback I was able to configure customized billing, base cost models, fixed costs. Furthermore, additional factors and the lack of visibility and tracking for the administrator is discussed from the lifecycle point of view.

Here I present first a Lifecycle model on VMware which allowed me to implement a consistent, automated workflow for provisioning, operating and decommissioning virtual machines as well as enables administrators to track and control virtual machines through a consistent approval process throughout the entire lifecycle. From the users point of view,they can request new virtual machines and extend virtual machines from administrator easily and it is much convenient way to acquire. If we do not have the required space for the associated virtual machine, it is automatically denied so we can not create this, otherwise it can be applied.

On the other hand,the chargeback model on VMware which shows how to account, monitor, and report the costs associated with the virtual infrastructure. The idea is therefore to enable accurate cost measurement, analysis, and reporting of virtual machines. In the past, without the vCenter Chargeback tool it was entirely difficult to follow the lineof-business owners and IT teams visibile of the actual cost of the virtual infrastructure required to support business services.Therefore ,vCenter Chargeback provides the ability to map IT costs to business units, cost centers, or external customers— enabling a better understanding of how much resources make cost and what can be done to optimize resource utilization. Moreover, vCenter Chargeback also allows organizations to support policy-driven accountability for self-service environments so that business owners can "pay as they go" for IT resources.Thanks to this innovative approach with little effort reporting can be obtained at the same time easily.

The overall thesis goal was to get cost visibility and implement chargeback in a virtualized datacenter and taking control of the virtual machines with lifecycle model and trying to implement those models on VMware and monitor the results such as actual usage, cpu usage, storage usage,network,memory usage and to identify what is happening in the virtual environment in terms of costs and provisioning of the virtual machines.

Sommario

In una realtà di business sempre più dinamica e globale, per mantenersi competitivi, le aziende di tutto il mondo devono implementare strategie efficienti che siano in grado di ottimizzare il proprio ambiente digitale, ovvero il proprio reparto IT. La strategia di virtualizzazione consente di migliorare l'efficienza delle operazioni IT e riduce i tempi di risposta al mutare delle condizioni aziendali. In generale, le aziende grazie al processo di virtualizzazione del proprio ambiente informatico riescono a ridurre i loro costi. Infatti, oggi grazie alla virtualizzazione i responsabili IT hanno a disposizione uno strumento efficacie per far fronte sia alle esigenze degli utenti, che chiedono tempi di risposta più rapidi, sia a quelli del management che pretendono costi sempre decrescenti.

In questa tesi sono stati discussi strumenti di misurazione per la ripartizione di costi di un infrastruttura informatica virtuale, cosi come il processo di automatizzazione dell'approvvigionamento delle macchine virtuali. Questi aspetti sono stati valutati grazie all'utilizzo di uno strumento innovativo come Chargeback di VMware vCenter e lo strumento di gestione del ciclo di vita dei prodotti VMware vCenter Lifecycle manager. In prima persona, ho realizzato e applicato sia il modello del ciclo di vita , che quello del Chargeback relativi alla tecnologia VMware durante il periodo di tirocinio prestato alla società Lutech S.p.A . Quest'ultima è un'azienda leader nel mercato italiano nel settore della consulenza di sistemi virtualizzati.

Attraverso questo progetto è stato affrontato il problema dell'approccio di pagamento manuale utilizzato da molte aziende per le macchine virtuali, ma grazie lo strumento innovativo di Chargeback di vCenter è stato possibile configurare un processo di pagamento personalizzato basato sui modelli di costo base, costi fissi e altri fattori come la mancanza di visibilità e monitoraggio del ciclo di vita del prodotto da parte dell'amministratore aziendale.

Attraverso questo progetto ho cercato di presentare il primo modello del ciclo di vita della tecnologia VMware che mi ha permesso di implementare un processo di workflow consistente per quanto riguarda l'approvvigionamento, il funzionamento e la disattivazione delle macchine virtuali dando l'opportunità all'amministratore di monitorare e controllare le macchine virtuali attraverso un processo di approvazione automatizzato e coerente per tutto il ciclo di vita della tecnologia virtuale.

Dal punto di vista dell'utente, quest'ultimo po' richiedere facilmente una nuova macchina virtuale e l'estensione di questa macchina virtuale è molto più facile anche per la persona che la deve gestire rispetto l'approccio tradizionale ovvero l'acquisto fisico di tale macchina.

Il modello di costo VMware mi ha permesso di monitorare e avere visibilità sui costi legati all'infrastruttura virtuale. L'idea di base consiste nel attivare un analisi accurata attraverso l'implementazione di una reportistica per poter misurare i costi reali delle macchine virtuali. In passato, per mancanza dello strumento Chargaback di vCenter non è stato possibile identificare sia da parte dei responsabili di unità di lavoro sia da parte dai responsabile dell'area IT, in maniera effettiva i costi associati all'infrastruttura virtuale richiesti per il supporto dei servizi aziendali. Di conseguenza, lo strumento Chargeback vCenter offre la possibilità di mappare i costi nel suo insieme a seconda delle necessità aziendale. Infatti attraverso questo tool , è possibili mappare i costi associati all'infrastruttura IT aziendale suddiviso per costi relativi all'unità di business, vari centri di costo esistente all'interno dell'azienda, o clienti esterni, in questa maniera l'azienda ha una visione completa di come sono stati allocati i costi delle varie risorse all'interno dell'azienda e come potrebbe ottimizzare l'utilizzo di queste risorse. Inoltre, lo strumento sopra menzionato permette alle organizzazioni di promuovere più ambienti di lavoro self-service dove i dirigenti aziendali pagano unicamente per l'utilzzo che fanno delle risorse IT. Grazie a questo approccio innovativo è stato possibile ottenere un reportistica di analisi in maniera molto facile e con l'impiego di minor sforzo, rispetto gli approcci tradizionali.

Lo scopo principale della tesi è quello di avere sviluppare un ambiente che consenta di ottenere una visibilità sui costi e sui ritorni d' investimento (chargeback) di un data center virtualizzato. L'obiettivo è quello di controllare le macchine virtuali tramite il modello del ciclo di vita e applicare questo modello anche per sistemi virtualizzationi monitorando i

risultati inerenti all'utilizzo effettivo della CPU, storage, spazio disco, memoria, network, con l'obiettivo di identificare che cosa accade nell'ambiente in termini di costi e approvvigionamento delle macchine virtuali.

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Chapter 1

Introduction

This chapter acts as as an introductory entry to the whole report. First,my motivation about being involved related to my thesis is explained and its connection with my objectives are presented. Next, general information about the whole project and the problem how my participation within is expounded. Lastly, the structure of the report is given and several terms and acronyms that the reader may come across while reading the whole document are listed.

1.1 Objectives and motivations

During my academic years, in addition to computer and system engineering itself, I have always been interested in new technologies.Performance engineering and creating useful infrastructure was always my passion. Although one can optimize and develop the infrastructure on his own, in order to perfect it, market it and monetize it a group of different people with different expertises are required.

In in this manner, I interpret the phrase "human side of things" as "communication between the stakeholders of a product being engineered". I believe a good engineer has to have excellent communication skills and an entrepreneurial point of view to take himself to new higher positions. Especially with the emergence of virtualization and cloud computing ,they always attracted me and I found myself to follow those new technologies and I can dedicate myself lucky because the future is going to virtual.

During the last year of my studies, I have started to grow an interest in virtualized environments and analysis tools that give me detailed feedbacks on what people and companies are already using about virtualization, vmware tools, cloud services, online communities and forums. I also had in-depth experience in database and system development and I was in search of this kind of project that I can be a part of .

As a result, I decided to do my thesis with this project that is currently being analysed at the Lutech Company.

1.2 General Overview

Throughout my thesis work,I had the opportunity to carry out at Lutech S.p.A which is the main consultant company in Italy.It was an entirely different experience for me to test magnificent technologies there.In the area of Information Technology,there is a need for Virtualization and cloud computing concepts which are going together,mean evolving and they are considered one of the most significant milestones for cost-saving for huge enterprises.Therefore ,Lutech company was dealing with those techniques for their clients. If we look at Virtualization concept , was first developed in the 1960s to partition large, mainframe hardware for better hardware utilization.Today,computers based on x86 architecture are faced with the same problems of rigidity and underutilization that mainframes faced in the 1960s.VMware invented virtualization for the x86 platform in the 1990s to address underutilization and other issues, overcoming many challenges in the process.

I used VMware which is a provider of virtualization software component.In 1999,VMware introduced virtualization to x86 systems to address many of these challenges and transform x86 systems into a general purpose, shared hardware infrastructure that offers full isolation,mobility and operating system choice for application environments. Virtualizing your IT infrastructure lets you reduce IT costs while increasing the efficiency, utilization, and flexibility of your existing assets. Around the world, companies of every size benefit from VMware virtualization.Lower your capital and operational costs and improve operational efficiency and flexibility.You can go beyond server consolidation and deploy a standard virtualization platform to automate your entire IT infrastructure.Virtual Machine Technology users have harnessed the power of virtualization to better manage IT capacity, provide better service levels, and streamline IT processes.

A virtual infrastructure lets you share your physical resources of multiple machines across your entire infrastructure.Resources are shared across multiple virtual machines and applications.Your business needs are the driving force behind dynamically mapping the physical resources of your infrastructure to applications—even as those needs evolve and change. Aggregate x86 servers along with network and storage into a unified pool of IT resources that can be utilized by the applications when and where they're needed. This resource optimization drives greater flexibility in the organization and results in lower capital and operational costs.

Therefore, Virtualization is a proven software technology that is rapidly transforming the IT landscape and fundamentally changing the way that people compute. Today's powerful x86 computer hardware was designed to run a single operating system and a single application. This leaves most machines vastly underutilized. Virtualization lets you run multiple virtual machines on a single physical machine, sharing the resources of that single computer across multiple environments. Different virtual machines can run different operating systems and multiple applications on the same physical computer.

Cloud computing is a style of computing in which dynamically scalable and often virtualized resources are provided as a service over the Internet. A growing number of consumers and businesses are turning to cloud services, which offer on-demand, pay-as-they-go software, developer platforms, and storage capabilities — delivered over the Internet. Cloud computing generally utilizes virtualized IT resources such as networks, servers, and computing devices. Cloud Computing IaaS allows to focus on core business while letting provide with an enterprise-level infrastructure for a fixed, predictable monthly fee.In my thesis,I focused on IaaS because Infrastructure as a service (IaaS),the proposition here is the offering of compute power and storage space on demand. In practical terms, the model is based on the same principles of virtualization that we are all familiar with in the context of server partitioning or flexible storage.Rather than running a virtual image on a partition existing on a physical server in your data centre, you spin it up on a virtual machine that you have created in the cloud. Virtual disks can be created in a similar manner, to deal with the storage side of things.

From the chargebacks point of view, when properly calculated and applied for virtual environments, chargeback data can actually help lower and control expenses, rather than merely documenting and allocating them. But making the right configuration and allocation decisions requires having data on actual usage, not forecasts.Therefore, the information can help enterprises bring optimization to virtualization by helping guide decisions regarding outsourcing, upgrades, new purchases, leases and service models. Chargeback and utilization data also help simplify management and reporting by enabling some consistency in how virtual and traditional assets are measured and managed.So I did deliver chargebacks as part of the IaaS.It allowed me to understand the cost of deploying and maintaining business services,eliminate the perception that virtual machines are "free" and for complete cost visibility across physical and virtual resources.

Therefore,I wanted to make use the chargebacks on VMware at Lutech S.P.A company to monitor cost analysis of virtual environment.Main advantages are to model the realities of datacenter costs accurately, configuring base costs, fixed costs, one-time costs, multiple rate factors, and overage fees to model true costs associated with virtual machines. We can track costs for power, cooling, real estate, software licenses, and maintenance associated with virtual infrastructure deployments.We can maintain reusable cost templates that allow the process of adding cost models to VM's to be standardized.On the other hand, it provides Increasing Resource Utilization with Effective Visibility into Costs and we can schedule and distribute reports on a periodic basis to communicate usage and costs to business owners,it drives better decision making and planning for infrastructure budget requirements and optimizing the use of shared virtual infrastructure.

On the other hand,provisioning is another important issue while dealing with virtual machines ,we need to know how to follow what we created,who created,when they will expire and i need to know whether i have enough storage or space for virtual machines,so therefore VMware vCenter Lifecycle Manager automates the process of creating virtual machines and removing them from service at the appropriate time. The tasks that I can perform depends on the role that the Lifecycle manager administrator has assigned to me.

1.3.The Problem

Unfortunately, one of the problem is that many organizations don't utilize chargeback data tool to actually charge business units for the IT resources they consume. Instead, they find the data valuable for optimizing how resources are deployed and to guide forward-looking decisions about purchases, leases, licenses, warranties and other expenditures. This ability is just as valuable for virtual environments. Detailed utilization and performance data helps IT administrators decide the value of virtualizing various assets, and measure the value of virtualization efforts. The data may reveal excess capacity in some areas, or could lead to recommendations for some business units to have their own dedicated resources instead of using shared ones. Utilization data not only helps measure true IT costs, but also the relative value of different business units or initiatives relative to the IT costs they incur. To overcome these challenges, a virtual chargeback tool should have a convenient user interface that simplifies the tasks of collecting, reviewing, formatting and presenting data.Reporting capabilities should be flexible enough to support the enterprise's preferred formats and metrics.

Generally speaking, the main problem is many organizations are still not using brand new chargeback tools for calculating actual costs of usage , main problem we faced is that many companies use a manual approach to charge for virtual machines while with vCenter Chargeback I was able to configure customized billing, base cost models, fixed costs. The current generation of virtual machine management tools doesn't support that.Therefore,the problem is that virtual machines are pooled resources, so IT must figure out not only how to measure usage but also how to attribute costs for virtual machines and the shared, underlying hardware. Adding to the complexity, both the number of virtual machines and utilization levels for a given application can vary over time.We also would like to see more detailed reporting of usage allocations and the ability to tie those back to billing.

The problem for Provisioning is that Business challenges such as leveraging money already spent on resources , lack of automation in a growing virtual environment and from the Technical challenges and environment point of view,such as decommissioning unused virtual machines,provisioning physical systems sometimes took up to 8 weeks ,those are very challenging and critical things to face.

Therefore, This thesis work shows by using vmware tools,I had the opportunity to Improve IT management efficiency with automation and 80% reduction in the time needed to automatically provision a virtual machine vs. a physical machine.

1.4.Terms and Abbreviations

Before getting into deeper details about the thesis, it is important to clearly define some terms that will be used throughout this report.

ESX/ESXI: VMware ESX and VMware ESXi are "bare-metal" hypervisor architectures.

LCM: Lifecycle manager.

Vsphere: The VMware vSphere object model is a comprehensive set of robust server-side composite objects that provides the complete management capabilities. The VMware vSphere Client is a graphical user-interface tool that connects to vCenter Server and ESX/ESXi systems for administering and managing virtual infrastructure components. Developers can use the vSphere Client as a tool for exploring the object model.

Vcenter Server: VMware vCenter Server, formerly VMware VirtualCenter, centrally manages VMware vSphere environments allowing IT administrators dramatically improved control over the virtual environment compared to other management platforms.

Vmotion: VMware vMotion keeps your IT environment up and running, giving you unprecedented flexibility and availability to meet the increasing demands of your business and end users.

VIM API: The VMware Infrastructure API (VI API) provides language-neutral interfaces to the VMware infrastructure management framework.

Data Collector: vCenter Chargeback interacts with the vCenter Server and vCenter Server database through a data collector. The data collector synchronizes the information in the vCenter Chargeback database with that in the vCenter Server database.

VMware vCenter Chargeback Load Balancer Service: starting this service starts the load balancer. This service must be running so that the load balancer can receive user requests and route them to the application for them to be serviced.

HA: High availability.

DRS: Distributed Resource Scheduler (DRS) continuously monitors utilization across a resource pool and intelligently allocates available resources among virtual machines according to business needs.
FT: Fault Tolerance, provides zero downtime, zero data loss and continuous availability for your applications, without the cost and complexity of traditional hardware or software clustering solutions.

LCM uses specific terminology to describe lifecycle events and attributes.
Commission: The creation of a requested virtual machine. The commission time is submitted during the request process.

Decommission: The requested machine reaches the end of its life. A decommission date is submitted during the request process. The decommissioned machine can be archived or deleted.

Extension: Extending the life of a virtual machine that is to be decommissioned. If approval is required, the request for extension must be approved before the owner of the virtual machine can continue to use it.

Infrastructure: Attributes such as the network, domain, and datastore affect where the requested virtual machine is placed in VMware Infrastructure.

Criteria: Attributes attached to a requested virtual machine that are selected during the request process, such as location, organization, server environment, service level, and performance. The LCM Administrator maps this information to the infrastructure.

Template Profile: The profile that is used when a requested virtual machine is cloned.

Customization Template: The template that determines the resources that the requested virtual machine uses, such as memory reservation, memory limit, CPU shares, and disk shares.Only the LCM IT Staff, LCM Tech Requester, and LCM Administrator can modify the customization template.

Placing: The requested virtual machine is created or moved into the infrastructure,based on the selected criteria and infrastructure

LDAP User :Active Directory domain user

LDAP Group: Active Directory domain group

LDAP Server: Active Directory server

Compute-Farm :Name of ESX cluster in vCenter Server hosting VMs that are used as the source for cost reporting

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Chapter 2

Review of the State Of The Art

This chapter presents a general overview of a group of technologies and tools of general purpose that can be used to support the architecture of the Lifecycle and Chargeback Model including:

2.1. Content of the Technology

Vcenter server:

VMware vCenter Server is composed of five main components:

> ➢ A management server is the central control node for configuring, provisioning and managing virtualized IT environments. The management server runs as a service on Microsoft Windows 2000, Microsoft Windows XP Professional and Microsoft Windows Server 2003.
> ➢ A database is used to store persistent information about the physical servers, resource pools and virtual machines managed by the VMware vCenter Server. The database resides on standard versions of Oracle, Microsoft SQL Server, or Microsoft MSDE.
> ➢ VMware vCenter Agent connects VMware ESX with the VMware vCenter Server.
> ➢ Virtual Infrastructure Web Access allows virtual machine management and access to virtual machine graphical consoles without installing a client.
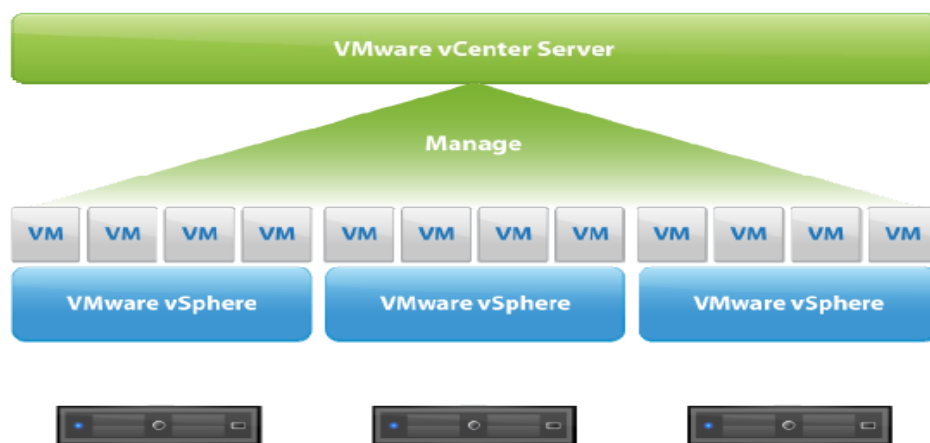
Figure 1-VMware vcenter server

vCenter Chargeback Graphical User Interface:

The vCenter Chargeback Graphical User Interface (GUI) provides an interface to centrally manage the entire system. You can configure the LDAP and SMTP servers with the application, add one or more vCenter Server instances to application, and manage the various data collectors instances. In addition, you can define the report template, set the locale and currency settings, as well as manage the product licenses. The application defines a Super User role that must be assigned to a user to allow him to perform these system administration tasks.

Virtual Machine Template:

The first and simplest reason for using virtual machine templates is efficiency. With templates, many repetitive installation and configuration tasks can be avoided. The result is a fully installed, ready to operate (virtual) server in less time than manual installation. Consider this scenario:Suppose I wish to create four virtual machines such as Lifecycle

manager and Chargeback all running Windows 2008 Server, and three of the four virtual machines are intended for production use, one for development purposes. Of the three production machines, one does not require a backup agent. Your effort, then, would involve no less than 17 steps, most of which are time consuming and repetitive

Virtual Infrastructure Client:

Virtual Infrastructure Client allows administrators and users to connect remotely to the VMware vCenter Server or individual ESX Servers from any Windows PC.

Tomcat Server instance:

vCenter Chargeback and lifecycle manager are Web-based applications that run on a Tomcat Server instance and can be accessed using one of the following supported Web browsers:

  ➢ Microsoft Internet Explorer 6.x and 7.x
  ➢ Mozilla Firefox 2.x and 3.x

Virtual Appliance:
This release of vCenter Chargeback allows you to deploy the application as a virtual appliance. The steps for deploying the application as a virtual appliance The vCenter Chargeback virtual appliance is purely for an evaluation purpose. You must use only an evaluation license for the virtual appliance. Unlike the regular installation, the virtual appliance is not configured for SSL support.

Database Management Scripts:

vCenter Chargeback provides SQL scripts that can help database administrators to manage the vCenter Chargeback database. These SQL scripts can be run by a database user with the required permissions from the SQL prompt.

MSI Installation:

a software component used for the installation, maintenance, and removal of software on modern Microsoft Windows systems which we must ensure that MSI installation is enabled on the machine. If it is not, it must be manually installed Microsoft Visual C++ 2005 Redistributable Package (x86) before running the vCenter Chargeback installer.

vCenter Chargeback database:

You must create a database for vCenter Chargeback to store the application-specific data. In addition, you must also create a database user with permissions to create and delete schema, as well as read from and write to the database.

LDAP Server:

 an application protocol for querying and modifying data of directory services implemented in Internet Protocol(IP) networks which must be configured in the LDAP Server setting to enable Windows Active Directory users to access the application using their Windows Active Directory login credentials. vCenter Chargeback supports Microsoft Windows Server 2003 Active Directory and Microsoft Windows Server 2008 Active Directory.

SMTP Server:

Electronic mail servers and other mail transfer agents use SMTP to send and receive mail messages which must be configured in the SMTP server settings in vCenter Chargeback to send the generated and archived cost reports through email.

VMware VIX API :

A high-level, easy to use API (with C, Perl, and COM bindings) for automating virtual machine and guest-OS operations. Automate test cases, help reproduce bugs, and customize virtual machine configurations.

VMware VMCI Sockets:

An interface for fast, efficient communication between a guest virtual machine and its host, or between virtual machines on the same host.

VMware vSphere Guest SDK:

A read-only API that enables software running on a guest operating system (Windows or Linux installed on a virtual machine) to collect various statistics, such as virtual machine memory usage and CPU speed.

Legacy Interfaces

- ➤ **Programming API** Available on VMware Server (VMware Server 1.0 and prior releases only). Used to create scripts and applications for automating virtual machine test and development operations
- ➤ **Scripting API** Legacy Perl and COM interfaces supported on ESX 3.0.x and GSX Server.
- ➤ **VMware vSphere PowerCLI Documentation** Windows PowerShell interfaces to VMware vSphere functionality. Two products are available: the VMware vSphere SDK for .NET, and the VMware vCenter Update Manager – PowerShell Library.
- ➤ **VMware vSphere SDK for Perl** Client-side Perl framework that provides an easy-to-use scripting interface to the vSphere Web Services API.
- ➤ **VMware vSphere Web Services SDK** Sample code, WSDLs, and documentation for creating Java and C# client applications that can leverage the Web-services based vSphere Web Services API for managing, monitoring, and controlling the life-cycle of all VMware vSphere components.
- ➤ **VMware vSphere Management Assistant** (vMA) Virtual machine with prepackaged software, a logging component, and an authentication component for non-interactive login. Perform most ESX service console tasks, and run scripts and agents to manage ESX/ESXi hosts.

IIS(Internet Information Services):

Internet Information Services (IIS) – formerly called **Internet Information Server** – is a web server application and set of feature extension modules created by Microsoft for use with Microsoft Windows. It is the second most used webserver behind Apache HTTP Server which is used for vcenter chargeback and lifecycle manager.

.NET framework 2.0:

The .NET Framework is intended to be used by most new applications created for the Windows platform which is a must for Vcenter chargeback and lifecycle manager.

Chapter 3

Implementation of Chargeback Model

In this chapter, Vcenter chargeback tool of VMware is used throughout the development process of the thesis presented. In addition,the results of the usages of mentioned tool and how they were tested and evaluated as useful are analyzed. Later on a detailed infrastructure of how I built the overall system and how each component interacts with each other are explained.

3.1 Overview

VMware vCenter Chargeback, a component of the VMware vCenter product family of management solutions, lets customers model, measure, and assign costs associated with virtual machines. Chargeback enables accurate cost measurement, analysis, and reporting. With vCenter Chargeback, you can create cost transparency and accountability so business owners and IT staff can understand the actual cost of the virtual infrastructure required to support business services. VMware vCenter Chargeback is fully integrated with VMware vCenter Server and gave me the ability to map IT costs to business units, cost centers, or external customers — enabling a better understanding of how much resources cost and what can be done to optimize resource utilization to reduce overall spend on IT infrastructure.

Chargeback lets me define a custom hierarchy that maps to different business entities, such as departments,divisions, business units, service level tier, applications, or virtual machines, Flexible cost models allow IT to measure fixed costs, allocated costs, actual utilization, or a mix of all three, tracking costs by business unit or group. With simplified billing and reporting, Chargeback provides cost transparency for IT services by automatically creating detailed billing reports that can be submitted to business units within an organization.

VMware vCenter Chargeback enables administrators to deliver IT as a service with a simple, flexible, and accurate chargeback model. Using vCenter Chargeback, administrators can create customized cost models and metrics to suit organizational needs – Flexible cost models allow IT to measure fixed costs, allocated costs, actual utilization or a mix of all three, tracking costs by business unit or group. In order to accurate visibility over virtualization costs – vCenter Chargeback captures accurate cost metrics for virtual environments, giving you insight in to the true costs of provisioned systems. vCenter Chargeback takes into account many different factors, ranging from hardware costs (CPU,memory, storage, etc.) to additional elements such as power and cooling,enabling the delivery of IT as a service – vCenter Chargeback provides a charging foundation for enabling cloud computing.Used in conjunction with a self-service catalog, business owners can now have complete transparency into and accountability for the services they are consuming.
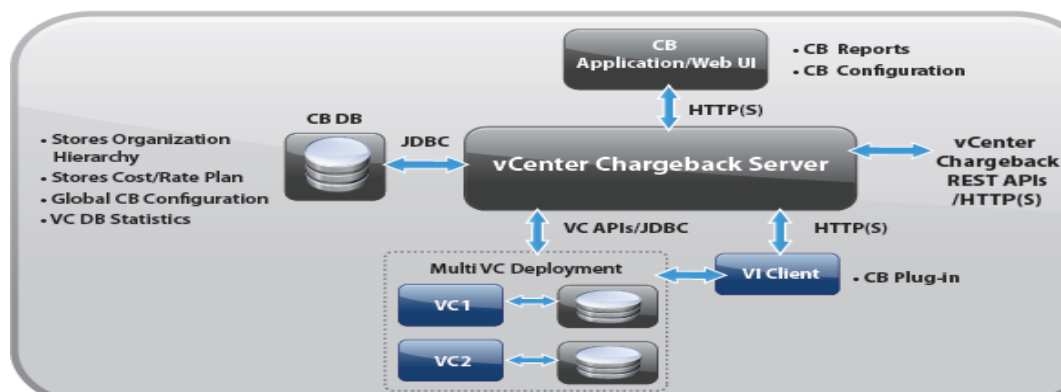

Figure 2 - VMware vCenter Chargeback Architecture Overview

In a virtual environment, a chargeback solution requires a flexible metering system that can account for the utilization of resources shared across the organization.These measurements can be based on allocation or actual usage of individual servers and resources. In the case of VMotion, DRS, or HA being enabled, the measurements could be based on the allocation or actual usage of resource pools.The virtual environment and the chargeback solution must provide ways to measure resource usage and associate the usage with a specific costing model. The chargeback solution must also support the use of different costing models so as to charge the various departments or cost centers differently.

A chargeback solution for a virtual environment defines a hierarchy with different types of entities such as departments, divisions, business units, cost centers, physical servers, virtual machines, and so on. For each entity type, a cost model is defined that determines the rate for each unit of a resource utilized. The chargeback solution determines the resource usage by using either utilization-based metering or allocation-based metering of virtual machines. The metered parameters are then associated with the designated entities, and the cost model defined for that entity along with specific chargeback formulas are used as part of the overall chargeback solution.

Determining the resource utilization and calculating the corresponding cost for a virtual environment that uses Mware vSphere typically involves VMware professional services' work or use of partner solutions. These solutions are built using custom methods for VMware vSphere resource data collection and chargeback cost calculation for organizations.vCenter Chargeback is an end-to-end cost reporting solution for virtual environments that use VMware vSphere. This Web-based application interacts with the vCenter Server Database to retrieve usage information,calculates the cost by using the defined chargeback formulas, and generates reports. Figure 3 shows how vCenter Chargeback interacts with various components of a virtual environment.
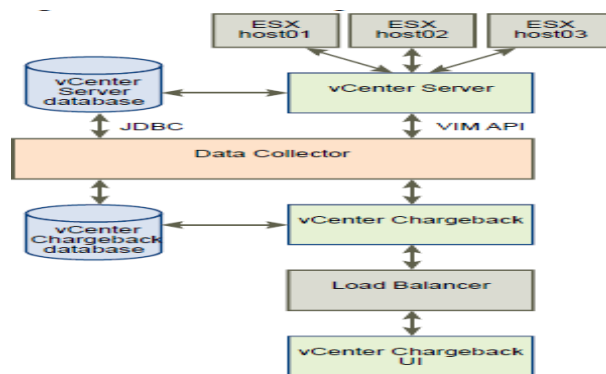

Figure 3 – vCenter Chargeback in a Virtual Environment

vCenter Chargeback runs on an Apache Tomcat server instance. The user interacts with the vCenter Chargeback application through a load balancer (Apache HTTP Server). vCenter Chargeback connects to a vCenter Chargeback database that stores application-specific information, such as the defined chargeback hierarchies, cost models, users, roles, and so on. The application also interacts with the vCenter Server and vCenter Server database through a data collector. The data collector communicates with the vCenter Server using VIM APIs and with the vCenter Database using JDBC.

When you install vCenter Chargeback, the vCenter Chargeback application, the load balancer, and the data collectors are installed and run on the same machine. Although the vCenter Chargeback database can also be installed on the same machine, in a real-world scenario you would install the application and the database on separate machines.vCenter Chargeback retrieves the virtual infrastructure inventory and the resource usage information for each virtual machine from the vCenter Server database through the data collector. The data collector replicates this information in the vCenter Chargeback database. vCenter Chargeback uses this information from the vCenter Chargeback database along with the cost model and chargeback cost calculation formulas to generate the cost reports.

A single data collector instance can communicate with multiple vCenter Server instances and vCenter Server databases and replicate the relevant information in a vCenter Chargeback database.vCenter Chargeback also lets you create a cluster of vCenter Chargeback instances that share a single load balancer.Each user request is routed through the load balancer.The load balancer forwards the request to a vCenter Chargeback instance in the cluster based on the number request currently being serviced by each instance in the cluster. All the vCenter Chargeback instances in a cluster are connected to the same vCenter Chargeback database.

Therefore,if we summarize why we do need to implement chargeback for our organizations in order to do those

- ➢ Increase visibility of IT operations and costs
- ➢ Modify user behavior
- ➢ Recover costs
- ➢ Give users choice
- ➢ Budgetary control for line of business owners
- ➢ Makes users accountable as well as IT
- ➢ Doesn't directly impact SLA or capacity planning
- ➢ Simplify business cases for new initiatives
- ➢ Aid in regulatory compliance and corporate governance

3.2. The Problem

A closer look at Figure 1 indicates that the majority of companies fall into one of three categories in 2007:

- Those that do not charge back IT costs to business units .
- The nearly one-quarter of the companies that aggressively allocate all of their expenses, in one way or another, to business units .
- The nearly one-third that selectively charge back only certain expenses, amounting to less--and in most cases, far less--than half of their IT budgets.

The complexity, practicality, and politics of allocating IT costs to business units often dictate against chargebacks. According to this survey of 94 managers of central IT organizations, about 42% of all companies do not charge back any portion of their IT budgets to business units.This is the problem for enterprises what they are consuming how much they are consuming.

Portion of IT Budget Charged to Business Units by Percentage of Companies

No Chargebacks 42%

All of Budget 23%

More Than Half 6%

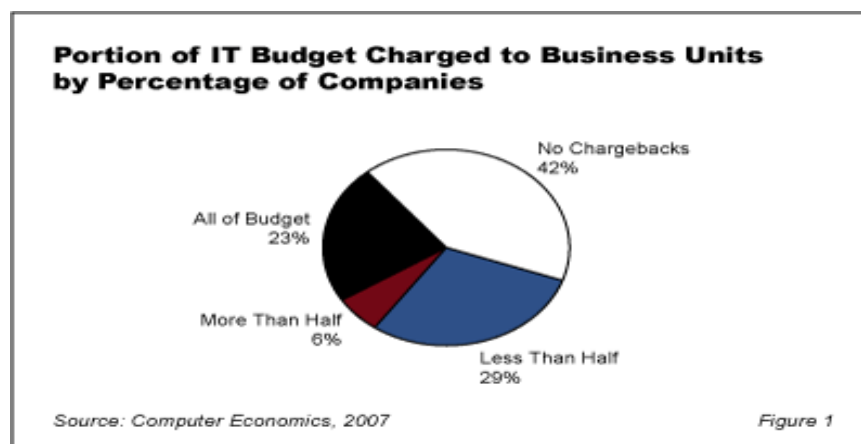Less Than Half 29%

Source: Computer Economics, 2007

Figure 1

Figure 4-Portion of IT Budget Charged to Business Units by Percentage of Companies

Chargeback is a mechanism to account for the operational costs involved in providing and maintaining an IT infrastructure, including the costs for IT services and applications. Measuring resource utilization and calculating the

corresponding IT operational cost enables you to account for the IT resources utilized and bill for the services provided.In a non-virtual environment, a physical server and the associated resources like the applications running on it can be easily mapped to the department using them, making the billing for such resource utilizations relatively easy. Also, costs incurred due to maintenance and licensing can be directly associated to a department, thereby enabling you to calculate the complete IT operational costs.In a virtual environment, however, the task of calculating the IT operational cost for each department becomes very difficult. Multiple virtual machines run on a physical server, which might be shared across different departments or cost centers in an organization. As a result, resource utilization for this server and, therefore,the cost incurred cannot be directly associated to any single department or cost center. The difficulty in accounting gets further compounded when applications and services get shifted over time to different servers,based on the load and available infrastructure resources.

A closer look at Figure 2 indicates that the majority of companies use chargebacks in 2008,2009: This is a good comparison between the years where companies use.As you see,it was %5 percentage of usage but after 2007 it is increased by %51 percentage of use.The source is used from Gartner Research Center.
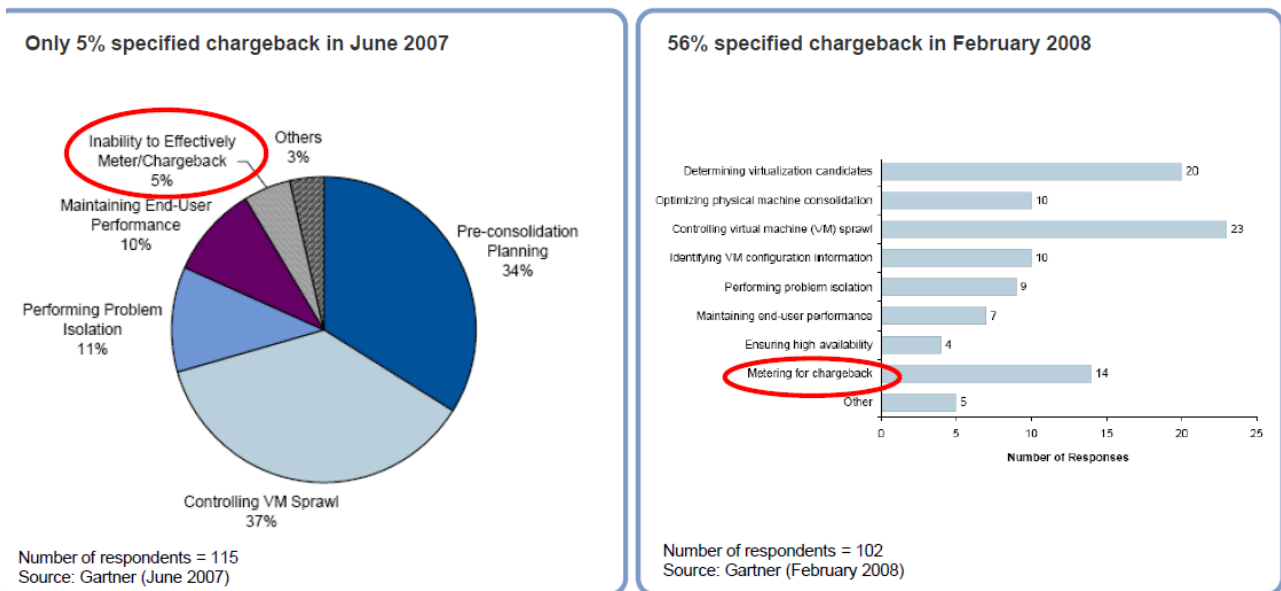

Figure 5 – The need for Chargeback

Therefore,if we want to get rid of the problems ,by using chargebacks means;

> Lack of cost allocation can turn VI benefits into challenges
> Ease of VM Deployment
> Potential increases for unchecked VM sprawl
> Rapid adoption among lines of business (flexibility, DR, etc.)
> Inability to control demand means little control over costs
> Ease of rapid or even self-provisioning
> No incentives to turn off unused VMs
> VI is a resource multiplier (CPU, Memory, Disk, Network)
> Lack of understanding of true costs, inefficiencies
> Layer of abstraction between service and infrastructure
> Service based planning becomes difficult to budget

3.3. How Vcenter Chargeback works

A Chargeback Hierarchy on VMware makes it easy to manage Chargeback Models Administrators and create a chargeback hierarchy that provides the basis for determining cost structures and delivery of reports.The hierarchy can span multiple vCenter Server instances for organization-wide chargeback. Cost templates simplify and standardize the process of adding costs for virtual machines to the chargeback hierarchy. Any number of cost templates can be created to support different cost structures across the organization.
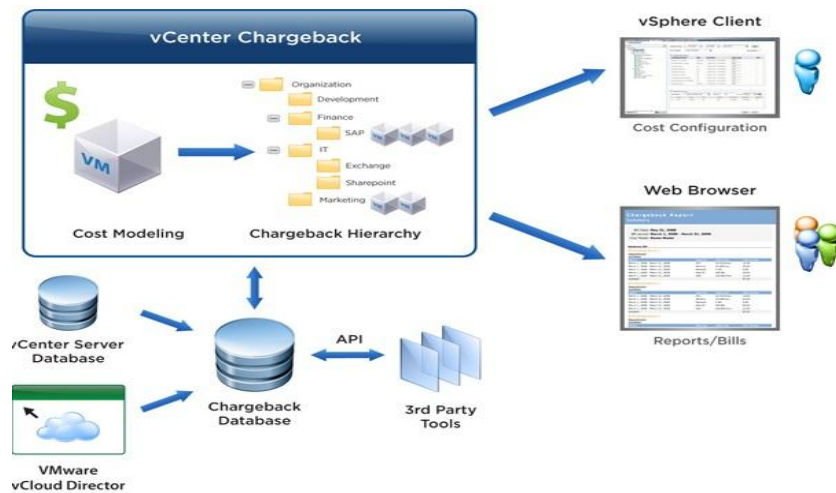

Figure 6 – VMware vCenter Chargeback accurately identifies costs associated with virtual resources
and automatically ties those costs back to the business. Chargeback maintains a database
of cost and usage metrics gathered from vCenter Server, and integrates with VMware
vSphere™ Client to simplify cost configuration.

3.4. Cost Models and Elements

A cost model is based on the cost elements you want to include and sum of the costs for each unit or element that matches your cost model. For example, a fixed model would include fixed costs such as head count, whereas utilisation based models would calculate the actual CPU and memory usage multiplied by the unit cost of CPU and memory.So what are all the components and what we should include or exclude. These are called cost elements. Each organisation will include different elements based on factors such as their motivation for chargeback or their accounting policies.

vCenter Chargeback supports three different cost models which are shown in figure 7;

➢ Fixed cost – specific per virtual machine instance costs such as floor space, power/cooling, software or administrative overhead .
➢ Allocation-based costing – Variable costs per virtual machine based on allocated resources, such as the amount of memory, CPU or storage allocated or reserved for the virtual machine in vCenter Server.
➢ Utilization-based costing – Variable costs per virtual machine based on actual resources used, including average memory, disk and CPU usage, network I/O and disk I/O Cost models can be combined in a cost template, making it easy to start with a simple chargeback model and align with organizational requirements.
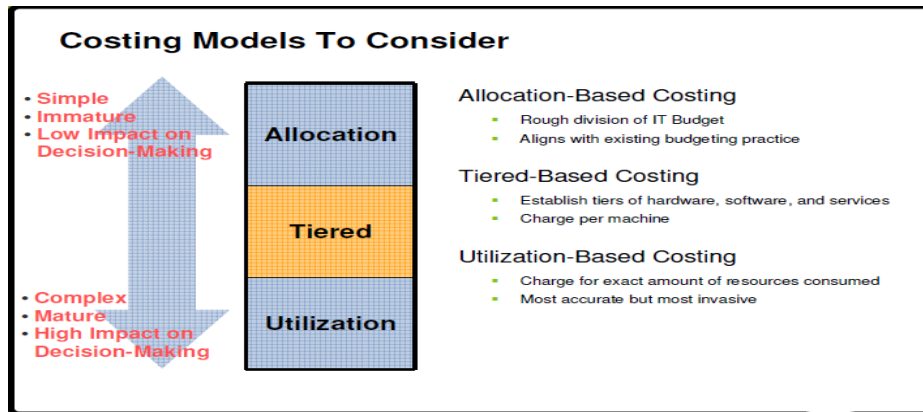
Figure 7-Cost Models

Next you need a tool to assist with calculating the unit costs of each element for each cost model you plan to use.There are basically two types of costs as shown in figure : CAPEX and OPEX. In the physical world, it is more common to find organisations only counting the CAPEX, or not counting all OPEX elements.There are also costs that are shared costs such as network or storage fabric ports, or costs managed by another cost center such as facilities. These are called indirect costs.,the motivation for chargeback may influence the decision over which cost elements are included or excluded.

Figure 8 –Cost Elements

First, I created the sample cost model on behalf of Lutech company without using Vmware Vcenter Chargeback according to figure 6 and 7 ,as you see this is very old-fashioned way and you can not calculate actual costs of virtual centers but it gives us just average costs that we can encounter. I had calculated for one virtual machine at Lutech environment,from the fixed costs point of view,i need to pay for vmware license,microsoft license,network connectivity,vcenter license and database costs.Moreover, i needed to calculate compute cost,storage cost and recovery cost for lutech environment such as RAM and processor speed which may be annual, monthly or hourly.

Recovery Cost	3 Years		Total Hours per Month	
Compute Cost	$ 17.392.00		720	
Storage Cost	$ 70.000.00			
Fixed Cost	$ 48.500.00			
Recovery Total	$ 135.892.00			

Compute Cost Calculation	Hardware Cost Recovered %	Capacity	3 Year Cost	Annual Cost	Monthly Cost	Hourly Cost
RAM (GB)	70	0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Processor Speed (GHz)	30	0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

Storage Cost Calculation	Storage Cost Recovered %	Capacity	3 Year Cost	Annual Cost	Monthly Cost	Hourly Cost
Tier 2 Storage (GB)	100	2048	$ 34.18	$ 11.39	$ 0.95	$ 0.001319

Total VMs
1

Fixed Cost Calculation	3 Year Cost	Annual Cost	Monthly Cost	Monthly Cost (Per VM)
VMware License	$ 11.500.00	$ 3.833.33	$ 319.44	$ 319.44
Microsoft License	$ 6.000.00	$ 2.000.00	$ 166.67	$ 166.67
Network Connectivity	$ 2.400.00	$ 800.00	$ 66.67	$ 66.67
Storage Connectivty	$ 3.600.00	$ 1.200.00	$ 100.00	$ 100.00
vCenter License	$ 10.000.00	$ 3.333.33	$ 277.78	$ 277.78
Database Cost	$ 15.000.00	$ 5.000.00	$ 416.67	$ 416.67
Total Fixed Cost	$ 48.500.00	$ 16.166.67	$ 1.347.22	$ 1.347.22

System Sample	RAM (GB)	Processor Speed (GHz)	Storage (GB)	Monthly Compute Cost	Monthly Storage Cost	Monthly Fixed Cost	Monthly Total	Hourly Total	Instantiation
Small	1	2	20	#DIV/0!	$ 18.99	$ 1.347.22	#DIV/0!	#DIV/0!	$ 1.000.00
Medium	2	4	80	#DIV/0!	$ 75.95	$ 1.347.22	#DIV/0!	#DIV/0!	$ 1.000.00
Large	4	8	120	#DIV/0!	$ 113.93	$ 1.347.22	#DIV/0!	#DIV/0!	$ 1.000.00

Figure 9-Cost Models with an old-fashioned way

Recovery Term (years)	1

Cluster Characteristics	
Number of Servers	1

Server Cost	Initial (per server)	Recurring (per server per year)	Term Total (per server)	Term Total (Cluster)
Physical Server	$ 17.392.00	$ -	$ 17.392.00	$ 17.392.00
VMware License	$ 11.500.00	$ -	$ 11.500.00	$ 11.500.00
Microsoft License	$ 6.000.00	$ -	$ 6.000.00	$ 6.000.00
Network Connectivity	$ -	$ 800.00	$ 800.00	$ 800.00
Storage Connectivty	$ -	$ 1.200.00	$ 1.200.00	$ 1.200.00
Total			$ 36.892.00	$ 36.892.00

Management Platform				
vCenter License	$ 10.000.00	$ -	$ 10.000.00	
Database Cost	$ -	$ 5.000.00	$ 5.000.00	
Management Total			$ 15.000.00	

Storage				
Tier 2 Storage Cost	$ 70.000.00	$ -	$ 70.000.00	
Storage Total			$ 70.000.00	

Grand Total			$ 121.892.00	

Figure 10-Cost Models with an old-fashioned way

vCenter Chargeback provides various cost-related elements. These elements enable you to define the cost to be charged for each computing resource, fixed costs, and the cost calculation formula.

vCenter Chargeback Cost-Related Elements

You must know about the vCenter Chargeback cost-related elements to effectively create and configure a cost model.vCenter Chargeback includes the following cost related elements.
- ➢ Chargeable computing resource
- ➢ Base rate

- ➢ Rate factor
- ➢ Fixed cost
- ➢ Billing policy
- ➢ Cost model
- ➢ Cost template

Chargeable Computing Resource

A chargeable computing resource is any computing resource that must be accounted for when calculating the IT operational costs. The usage of the computing resources is measured and the corresponding charge is calculated.vCenter Chargeback accounts for the following computing resources:

- ➢ **CPU:** The CPU usage is measured in GHz.
- ➢ **Memory:** The memory usage is measured in GB.
- ➢ **Network bandwidth :**The network usage (both upload and download) is measured in GB/hour.
- ➢ **Storage :**The usage is measured in GB.
- ➢ **Disk Read and Write :**The usage is measured in GB/hour.
- ➢ **vCPU :**The number of virtual CPUs in the virtual machine.

  If the VMware Cloud Director Data Collector and vShield Manager Data Collector is installed, vCenter Chargeback also accounts for the following resources:

- ➢ **Count of Networks:** The number of networks that belong to an organization or a vApp in VMware Cloud Director.
- ➢ **NAT Service** Whether the NAT service for VMware Cloud Director network is enabled or not.
- ➢ **DHCP Service** Whether the DHCP service for VMware Cloud Director network is enabled or not.
- ➢ **Firewall Service** Whether the firewall service for VMware Cloud Director network is enabled or not.
- ➢ **External network bandwidth**

Therefore,In cloud based services ,this is much more used to calculate computing costs.

Base Rate
Base rate is a global rate that you want to charge for a unit of chargeable computing resource used, reserved,or allocated for a specific duration.

Chargeable Resource	Unit	Duration	Base Rate ($)
CPU	GHz	Hourly	0.0399
Memory	GB	Hourly	0.0048
Network Received and Transmitted	GB/hour	Hourly	0.0008
Storage	GB	Hourly	0.0013
Disk Read and Write	GB/hour	Hourly	0.0008
vCPU	Count	Hourly	0.04

Figure 11- lists a set of sample base rates for each chargeable computing resource.

During my work at Lutech Company, I configured the base rates costs according to the per hour which is shown in figure below.
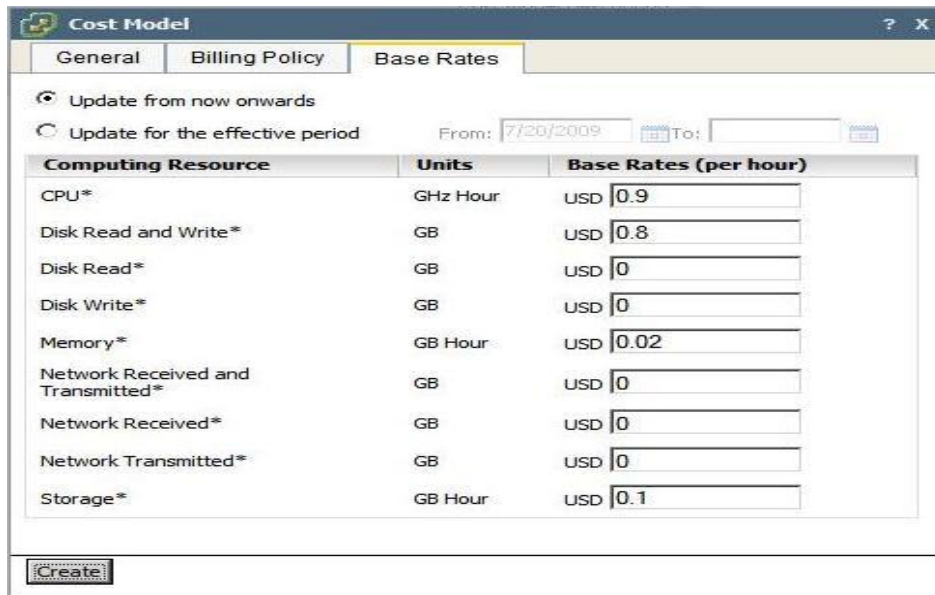
Figure 12–Configuration of Base Rates Calculations on Vmware Chargeback

Rate Factor

Rate factor is the multiplication factor to be used along with the base rate to calculate the charge for a unit of chargeable computing resource used or allocated for a specified duration. Rate factors are useful when you want to charge the entities in a hierarchy differently.The rate factors enable you to apply a cost that is a multiple or a fraction of the base rate. The rate factor value can be between 0 and 999.99. The precision is up to two decimal places.

Chargeable Resource	Base Rate ($)	Rate Factor	Total Charge ($)
CPU	0.0399	1.1	0.0439
Memory	0.0048	1.1	0.0053
Network Received and Transmitted	0.0008	1	0.0008
Storage	0.0013	1	0.0013
Disk Read and Write	0.0008	0.75	0.0006
vCPU	0.04	1	0.04

Figure 13 - lists sample base rates and rate factors.

Fixed Cost

A fixed cost is a definite cost that can be charged on an entity. Fixed costs can be recurring costs or non-recurring or one-time costs.Recurring costs that are charged periodically for specific resources or services can be defined as fixed costs in the application. For example, the annual maintenance cost for the network or for each server. Costs that are applicable to almost all the entities and hierarchies can be defined as fixed costs. This lets you update such costs periodically and manage them centrally. It also ensures that all the entities and hierarchies are uniformly charged for common services and resources. In addition, you can also define fixed costs that are specific to an entity, a group of entities, or an entire hierarchy.For example, the real estate cost for physical storage of the servers. This cost differs based on the actual geographic location.
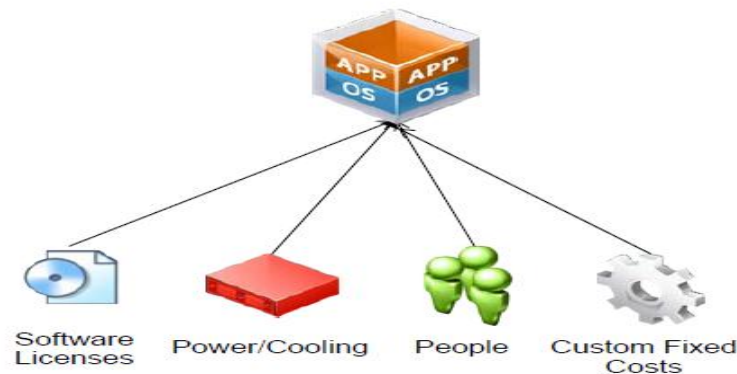
Applying Fixed Costs

Figure 14-Applying fixed costs

Billing Policy
A billing policy determines the cost types and the amount of chargeable computing resources units to be considered for calculating the chargeback cost.vCenter Chargeback provides the following billing policies:
Fixed Cost Only the fixed costs associated with each entity in the chargeback hierarchy is considered for billing. The actual usage of the chargeable computing resources is ignored.

Actual Usage In this policy, the actual utilization of the chargeable computing resources of the virtual machines is determined. The total cost is then calculated by using the base rates set in the cost model and the actual used units of the chargeable computing resources.

Reservation This policy takes into account the capacity of a chargeable resource reserved for a virtual machine. vCenter Server allows only CPU and memory reservation. This reserved capacity of CPU and memory along with the actual utilization of other chargeable computing resources is used for calculating the total cost.

Allocation This policy takes into account the user-defined allocation units of chargeable computing resources for the chargeback entities. The allocated units along with the base rates defined in the cost model is used for calculating the total cost.

CPU Reservation This policy takes into account the CPU capacity reserved for a virtual machine.This reserved CPU capacity along with the actual utilization of other chargeable computing resources is used for calculating the total cost.

Memory Reservation This policy takes into account the memory capacity reserved for a virtual machine. This reserved memory capacity along with the actual utilization of other chargeable computing resources is used for calculating the total cost.

Maximum of Usage and Reservation
In this policy, the maximum of the used and reserved units of CPU, the maximum of the used and reserved units of memory, and the actual utilization of other chargeable computing resources is used for calculating the total cost.

Maximum of CPU Usage and CPU Reservation
In this policy, the maximum of used and reserved units of CPU along with the actual utilization of other chargeable computing resources is considered for calculating the total cost.

Maximum of Memory Usage and Memory Reservation
In this policy, the maximum of used and reserved units of memory along with the actual utilization of other chargeable computing resources is considered for calculating the total cost.
Fixed Cost and Actual Usage
This policy takes into account the fixed costs associated with the entity and the actual utilization of the chargeable computing resources for calculating the total cost.

Fixed Cost and Allocation

This policy takes into account the fixed costs associated with the entity and the user-defined allocations units of the chargeable computing resources for calculating the total cost.

Fixed Cost and Reservation

This policy takes into account the fixed costs associated with the entity, the reserved capacity of CPU and memory, and the actual utilization of other chargeable computing resources for calculating the total cost.

Fixed Cost and CPU Reservation

This policy takes into account the fixed costs associated with the entity, the reserved capacity of CPU, and the actual utilization of other chargeable computing resources for calculating the total cost.

Fixed Cost and Memory Reservation

This policy takes into account the fixed costs associated with the entity, the reserved capacity of memory, and the actual utilization of other chargeable computing resources for calculating the total cost.

Fixed Cost and Maximum of Usage and Reservation

This policy takes into account the fixed costs associated with the entity, the maximum of used and reserved units of CPU, the maximum of used and reserved units of memory, and the actual utilization of other chargeable computing resources for calculating the total cost.

Fixed Cost and Maximum of CPU Usage and CPU Reservation

This policy takes into account the fixed costs associated with the entity, the maximum of used and reserved units of CPU, and the actual utilization of other chargeable computing resources for calculating the total cost.

Fixed Cost and Maximum of Memory Usage and Memory Reservation

This policy takes into account the fixed costs associated with the entity, the maximum of used and reserved units of memory, and the actual utilization of other chargeable computing resources for calculating the total cost.

vCPU Count and Memory Size

This policy takes into account the number of virtual CPUs, the total amount of memory allocated to the virtual machines, and the actual utilization of other chargeable computing resources for calculating the total cost.

Fixed Cost and vCPU Count and Memory Size

This policy takes into account the fixed costs associated with the entity, the number of virtual CPUs and the total amount of memory allocated to the virtual machines, and the actual utilization of other chargeable computing resources for calculating the total cost.

VMware Cloud Director Billing Policy -Allocation Pool

This billing policy is available only if the VMware Cloud Director Data Collector is installed. This policy takes in to account the actual usage for external network transfer and external network receive computing resources.For all other resources, the user-defined allocation units are considered for cost calculation. This billing policy is set in the VMware Cloud Director Allocation Pool Cost Model.

VMware Cloud Director Billing Policy -Reservation Pool

This billing policy is available only if the VMware Cloud Director Data Collector is installed. This policy takes in to account the actual usage for external network transfer and external network receive computing resources.For all other resources, the user-defined allocation units are considered for cost calculation. This billing policy is set in the VMware Cloud Director Reservation Pool Cost Model.

VMware Cloud Director Billing Policy - Pay As You Go Fixed Charging

This billing policy is available only if the VMware Cloud Director Data Collector is installed. This policy takes in to account the actual usage for external network transfer and external network receive computing resources.For all other resources, the user-defined allocation units are considered for cost calculation. The policy also takes in to account the fixed costs set on the entities. This billing policy is set in the VMware Cloud Director Pay As You Go – Fixed Charging Cost Model.

VMware Cloud Director Billing Policy - Pay As You Go Resource Based Charging

This billing policy is available only if the VMware Cloud Director Data Collector is installed. This policy takes in to account the user-defined allocation units for virtual CPUs and memory only if the virtual machine is powered on.It also takes in to account the actual usage for external network transfer and external network receive computing resources. For all other resources, the userdefined allocation units is considered for cost calculation. This billing policy is set in the VMware Cloud Director Pay As You Go - Resource Based Charging Cost Model.

VMware Cloud Director Billing Policy - Networks
This billing policy is available only if the VMware Cloud Director Data Collector is installed. This policy takes in to account the actual usage for external network transfer and external network receive computing resources.For all other resources, the user-defined allocation units are considered for cost calculation. This billing policy is set in the VMware Cloud Director Networks Cost Model.

3.5. Hardware Requirements

The system on which vCenter Chargeback is installed must meet the minimum hardware requirements for installing and running the application.vCenter Chargeback can be run on a computer or a virtual machine that matches or exceeds the following hardware specifications:
- 2.0GHz or faster Intel or AMD x86 processor
- 4GB or more of RAM
- A minimum of 2GB disk storage (3GB recommended)
- 10/100 Ethernet adapter (Gigabit recommended)

If you want to install the vCenter Chargeback database on the computer on which vCenter Chargeback along with the load balancer and data collector is already installed, then additional storage, memory, and processor capacity are required.

3.6. Software Requirements

Other than an operating system, you must have a database management system and a Web browser installed to run and access vCenter Chargeback.

Operating Systems
The vCenter Chargeback application can be installed and run on the following operating systems (32-bit and 64-bit):
- Microsoft Windows 2003 Server with SP2
- Microsoft Windows 2003 Server R2
- Microsoft Windows 2008 Server R2 with SP2

Database Management Systems
vCenter Chargeback supports the following database management systems (both 32 bit and 64 bit):
- Microsoft SQL Server 2005 (Standard and Enterprise)
- Microsoft SQL Server 2008 (Standard and Enterprise)
- Microsoft SQL Server 2005 Express
- Oracle Database 10g (Standard and Enterprise)
- Oracle Database 11g (Standard and Enterprise)

Web Browsers and Flash Player Plug-In
vCenter Chargeback is a browser-based application that is tested and supported on the following:
- Microsoft Internet Explorer 7.x and 8.x
- Mozilla Firefox 3.5 and later releases
- Adobe Flash Player for Windows Plug-in version 10.1 or later
- Adobe Flash Player for Linux Plug-in version 10.1 or later

VMware vCenter Server
vCenter Chargeback supports VirtualCenter Server 2.5 Update 3 and later releases and vCenter Server 4.0 and later releases.

You must ensure that the following pre-install tasks are performed:
- Ensure that system time of all the servers and databases are in sync.You must ensure that the system time of the machines on which you install vCenter Chargeback and vCenter Chargeback database are in sync. If you plan to install a separate data collector on a different machine, then the system time of this machine must be in sync with that of the other machines.

- ➢ Ensure that MSI Installation is enabled.Before you start the installation, you must ensure that MSI nstallation is enabled on the machine. If not,you must manually install Microsoft Visual C++ 2005 Redistributable Package (x86) before running the vCenter Chargeback installer.
- ➢ Ensure that port exceptions are configured on the Windows firewall.If the Windows Firewall is enabled, you must set the port exceptions for the HTTP, load balancer, and HTTPS ports on the Windows Firewall. If these exceptions are not set, the application will be not be usable.
- ➢ Ensure that the Windows user has the Log on as a service permission.If you want to use the Windows authentication option for the vCenter Chargeback database, you must ensure that the Windows user has the Log on as a service permission. If this permission is not set on the user, the installation will fail. Also, the installer must be run in the context of this Windows user.

3.7. Prerequisites for vCenter Chargeback

Before installing and running vCenter Chargeback few pre-install tasks have to be preformed.
Networking Prerequisites
You must perform the following pre-installation tasks for the successful installation and running of vCenter chargeback:
- ➢ Check whether the ports are free.Ensure that the ports that you specify during the installation are free. While installing you must specify the port numbers for the following:

HTTP port: This port is used by vCenter Chargeback for communication using the HTTP protocol. The default port number is 8080.
Load-balancer port: This port is used by vCenter Chargeback to communicate with the load balancer. The default port is 8009.
HTTPS port: This port is used by the load balancer to listen for user requests. The default port is 443.If any of the specified port is also configured for another service and the service is not running, then the installer will use the specified port. However, this might result in a port conflict and either of the configured services might fail.
- ➢ Set a static IP address on the machine.

Before you install the vCenter Chargeback application on a machine, you must obtain a static IP address from your network administrator. Set this IP address on the machine on which you are going to install vCenter Chargeback. Preferably, obtain and set static IP addresses on all the servers and databases that the application communicates with.

Database-Related Prerequisites

Before you begin the vCenter Chargeback installation you must create a vCenter Chargeback database and a corresponding database user. vCenter Chargeback stores the application-specific data, such as cost models,chargeback hierarchies, and users and roles, in the vCenter Chargeback database. You must, therefore, first create a database for storing this data. You can either create the database yourself by referring to the corresponding product documentation or ask your database administrator to create one for you.If you using an Oracle database as the vCenter Chargeback database, you must configure the database to use the Unicode character set to support the following scenarios:

- ➢ You want to deploy the vCenter Chargeback database in a non-English environment.
- ➢ You want to synchronize the vCenter Chargeback database with a vCenter Server database that has non-english data.

After you create the vCenter Chargeback database, you must also create a database user to access this database.Ensure that the database user has the privileges to create and delete schema, as well as read from and write to the database.

3.8. Configuration

Initial Configuration of vCenter Chargeback
This documents the specific Chargeback setup tasks performed .
Chargeback Database
The Chargeback lab uses the SQL instance on vCenter 4.0 but a standalone installation of SQL 2005 Express is also possible. Oracle is also supported. The Oracle JDBC driver is included with the vCenter Chargeback installation package.
- ➢ Install database software for Chargeback
- ➢ Download and start the installation Microsoft SQL Server Management Studio Express
- ➢ Use the SQL Server Surface Area Configuration utility to enable remote network connections.

- Use the SQL Server Management Studio Express to verify that the "sa" user account is enabled.
- Use the SQL Server Management Studio Express to verify that SQL Authentication using the "sa" user ccount.
- Enable SQL Server Browser
- 1. Click Start | Run | services.msc
- 2. Set the "SQL Server Browser" to automatic and click Start
- Create a Database for vCenter Chargeback
- 1. Click Start | All Programs | Microsoft SQL Server 2005 | SQL Server Management Studio Express
- 2. Click Connect
- 3. Right-click Databases and click "New Database"
- 4. Enter "Chargeback" for Database name and click OK

Chargeback Installation

1. Download and start the installation of vCenter Chargeback

2. Click Next (Introduction)

3. Accept the license and click Next (License Agreement)

4. Click Next (Choose Install Folder)

5. Enter: Database Type: SQL SERVER Database URL: xx.xxx.xxx.xxx\sqlexpress Database Name: chargeback Database Username: sa (or other SQL account) Database Password: *sapassword*

6. Click Test Connection

7. Click OK (Connection Successful)

8. Click Next

9. Enter a Server Instance Name (any name will work) and click Next (Server Configuration)

10. Click Next (Load Balancer)

11. Select a username and password for the administrative account for vCenter Chargeback and click Next (Authentication Details)

12. Select "Install Data Collector" and click Next (Install Data Collector)

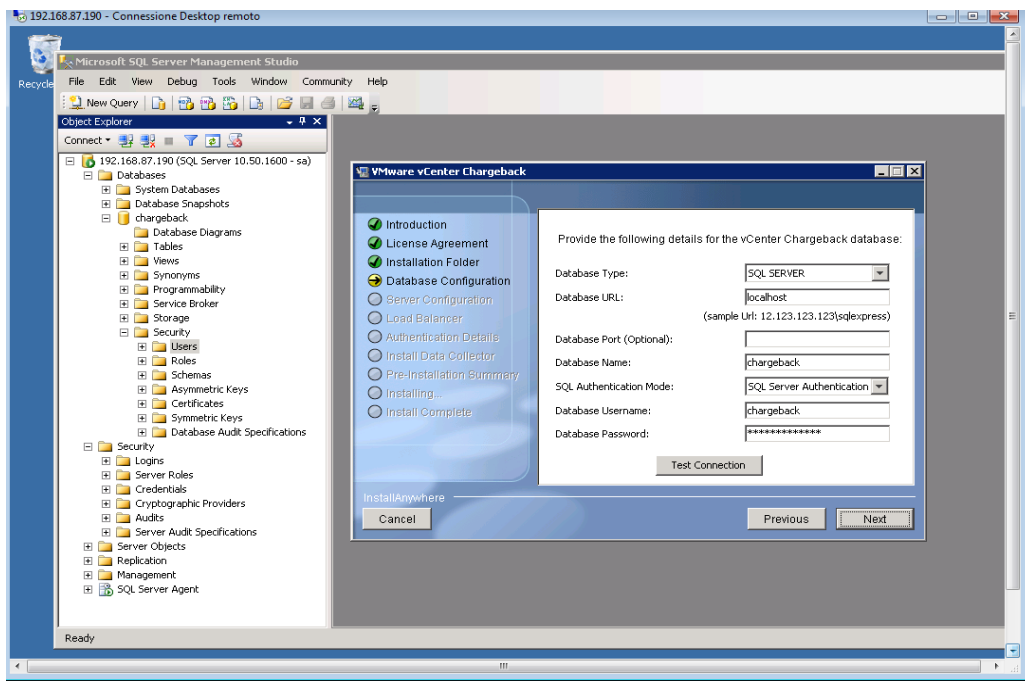13. Click Install (Pre-Installation Summary)

14. Click Done (Install Complete)

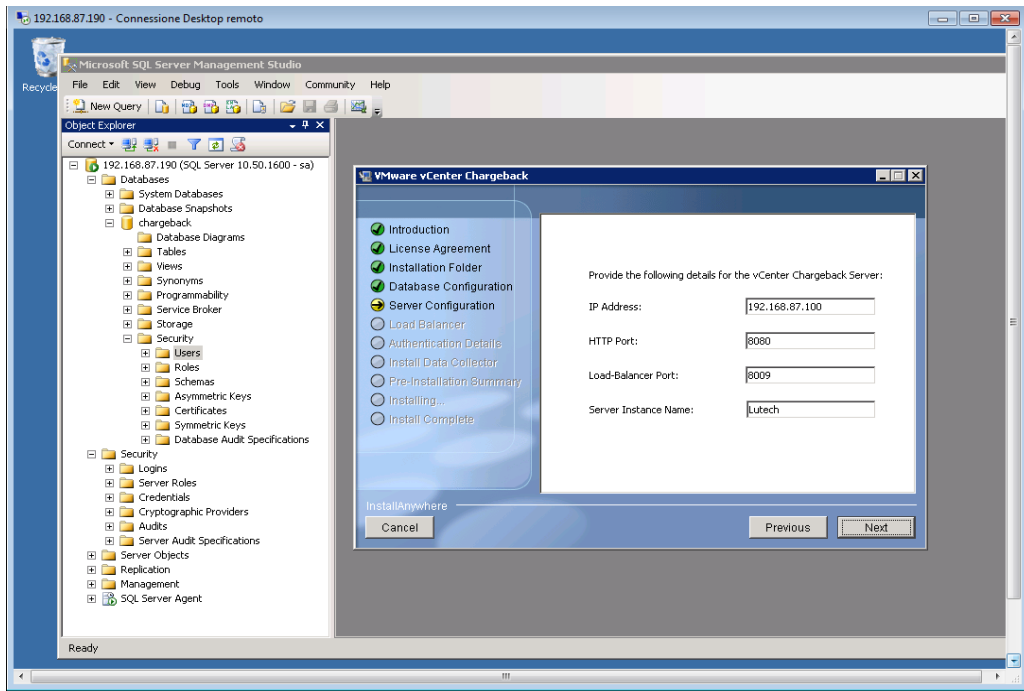

Figure 15 –Vcenter Chargeback database installation

Figure 16–Vcenter chargeback server installation

Chargeback Vcenter Configuration

1. Open Chargeback UI (https://chargebackipaddress/cbmui/)
2. Enter a license key and click Ok
3. Click Settings and vCenter Servers
4. Click Add
5. Enter the vCenter Server Information as per screenshot below and click Add
6. After installation, connect to the Chargeback web UI and login as admin with the password specified during installation.
7. On the Settings tab, select "vCenter Server Accounts" and click the "Add" button. Complete the connection dialog box for both the vCenter web service API connection and vCenter database connection as illustrated below:
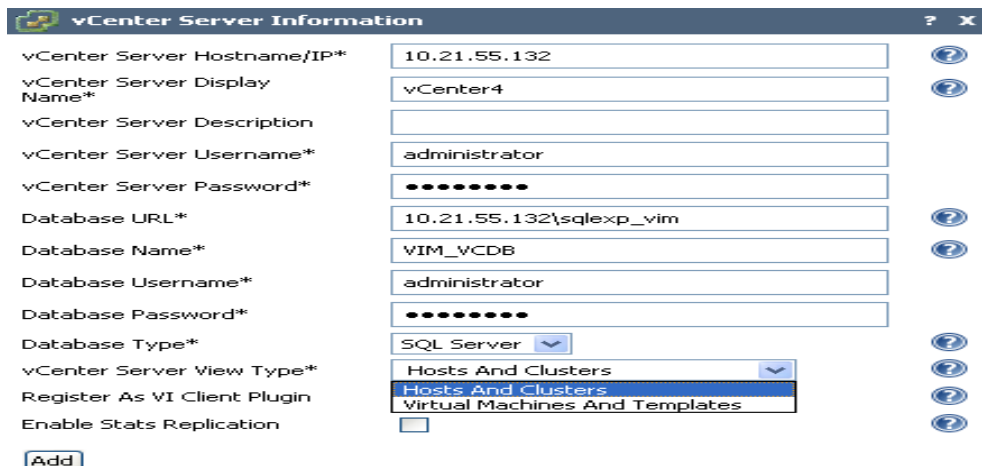
Figure 17 –Chargeback Vcenter server Configuration

8. The vCenter Server View Type allows you to select either Hosts and Clusters view or the Virtual Machines and Templates view from vCenter Server.
9. The "Register As Plugin" option enables the Chargeback tab in the VI Client. This VI Client plugin leverages the connection specified in this dialog to give VI Client users access to the Chargeback server.

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10. The "Sync Enabled" option enables vCenter performance data replication into the Chargeback database for Chargeback report generation. By default this option is not enabled. Report generation imposes a modest load on the vCenter database compared to the effort involved in replicating vCenter performance records to Chargeback. For a small environment, either setting is fine.

11. On the Settings tab, select "General" and then "Add" in the LDAP section to establish a connection to an Active Directory LDAP server as illustrated below
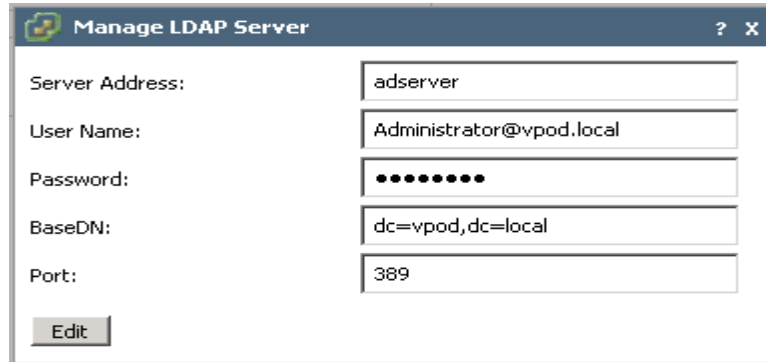
Figure 18 –Configuration of LDAP Server

3.9.Test and Evaluation

My scenario was to

> ➤ Create a custom hierarchy for Lutech S.p.A and import cluster
> ➤ Create a fixed-cost model to map to Lutech
> ➤ Create a report based on the fixed model
> ➤ Create two variable costs with a slight difference between development and production
> ➤ Create a comparison report

As you see in the figure,Vcenter chargeback is based on web interface.First I needed to create my hierarchy according to the company.

1. Create chargeback hierarchy

Chargeback interacts with the vCenter Server to determine the utilization of the computing resources by various virtual machines that are created in the vCenter Server hierarchy. Chargeback enables to create different chargeback hierarchies, which can be different from the vCenter Server hierarchies.A chargeback hierarchy defines how the various virtual machines and ESX Server hosts are assigned to and shared by different departments, cost centers, or business units in an organization.

To start login to Chargeback by a Web browser, create a custom hierarchy to setup the connection between vCenter Server and Chargeback entities.

Step 1: Login to Chargeback

1. Open up a browser and enter the address of the server where I installed Chargeback using http (default port is 8080) or https (default port is 443) followed by /cbmui (e.g. https://cbm-app-01.tml.local/cbmui) and login as user 'admin' with the password provided during the install.
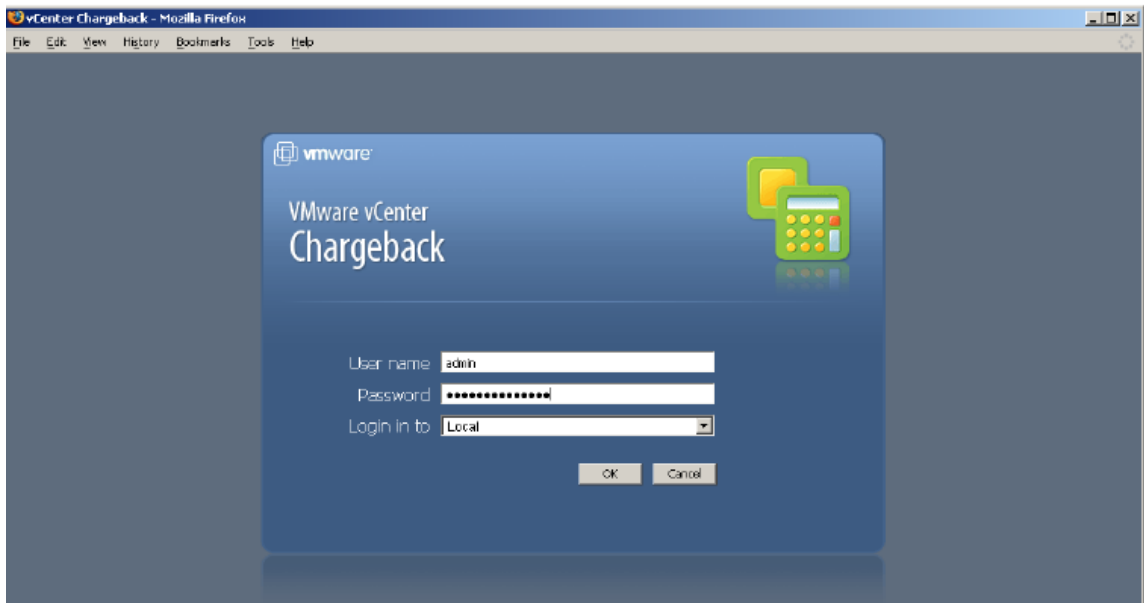
Figure 19-Chargeback login

Step 2: Create custom chargeback hierarchy

A chargeback hierarchy allowed me to easily define how virtual machines and ESX server hosts are assigned to and shared by different departments, cost centers, or business units in an organization.I could create a new custom hierarchy as per your requirements, or create a hierarchy that is the same as the vCenter Server hierarchy through synchronization. In this example, a custom hierarchy was created.

1. Select the Manage Hierarchy tab and click on Create Chargeback Hierarchy. Enter "my-datacenterhierarchy" for Name and Description and click on Create.
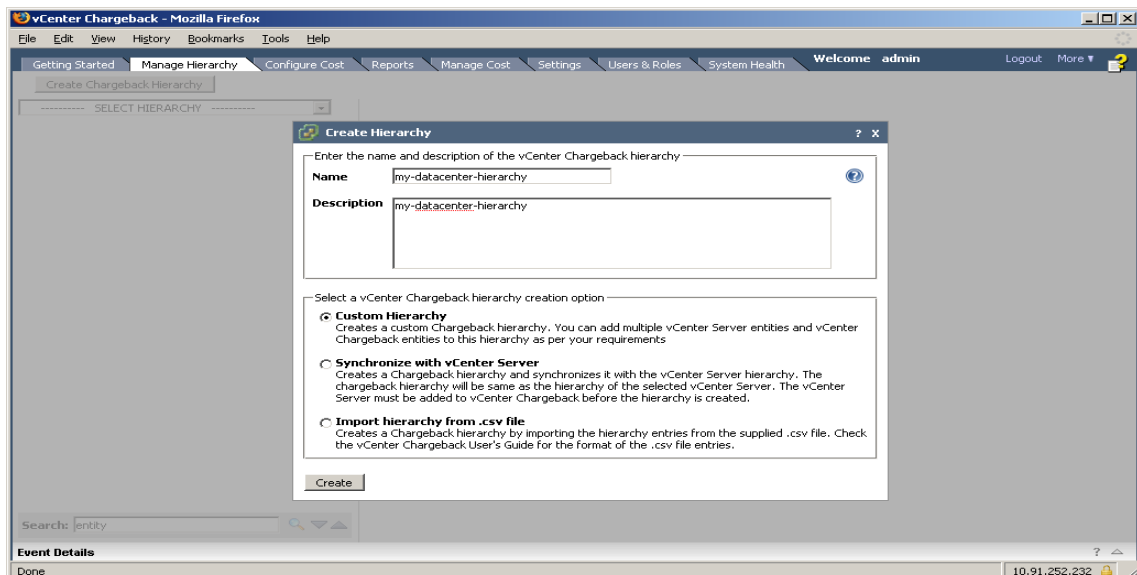

Figure 20-Creating new hierarchy details

2. To add a vCenter Server entity to the newly created Chargeback hierarchy, select the newly created hierarchy name on the left pane and on the right pane select the name of the vCenter Server that was added during the install.
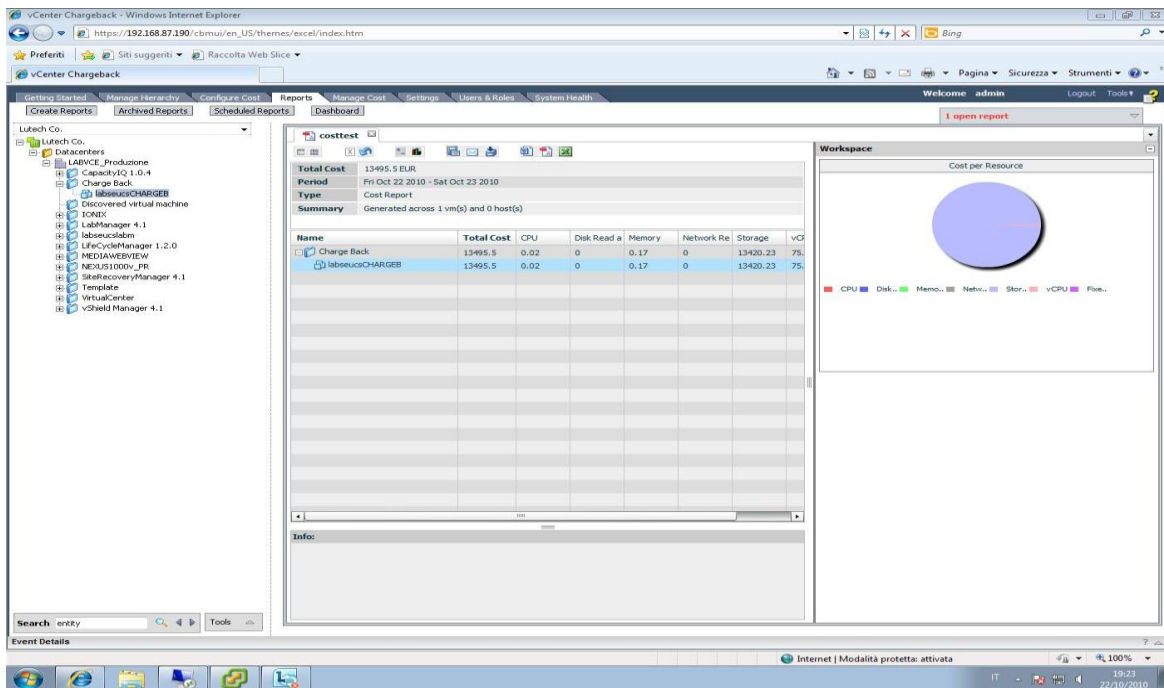
Figure 21 – Adding vCenter Server cluster to chargeback hierarchy

2. Utilize fixed cost model

Many environments today do not have a current billing or cost tracking policy for virtual infrastructure, so this scenario shows how to start with a simple fixed cost model based on the fixed cost of a virtual machine. With the help of the VMware Chargeback calculator, I could translate physical costs to virtual and determine fixed costs per VM, the value of $25 per VM per day is used.The fixed cost model relies on defining fixed costs that are setup in the current environment, and then attaching them to one or more folders in the hierarchy through a cost template. In this scenario, resource pools are used, then a report is run, and the results are verified.

Step 1: Define fixed cost template
Chargeback enabled me to create cost templates. A cost template consists of rate factors for each of the chargeable resources, global, and local fixed costs.Rate factor is the multiplication factor to be used along with the base rate to calculate the charge per unit of a resource for an entity. Rate factors are useful when you want to charge the entities in a hierarchy differently.The rate factors enable you to apply a cost that is a multiple or a fraction of the base rate.

Local fixed cost is a cost that is specific to an entity, a group of entities, or to an entire hierarchy. For example,real estate cost for physical storage of the entities. This cost differs based on the actual geographic location.The rate factors and local fixed costs are entity-specific. You can set these values in a cost template and use the template to configure the costs at the entity level.

In this scenario, a global fixed cost of $25 per VM per day. This value includes the hypothetical cost of the OS license, cost of disk space, etc. per day will be set up. After defining the global fixed cost, a cost template that utilizes this global fixed cost will be defined and all the resource rate factors will be set to zero, to indicate that this template will be used for fixed cost modeling instead of resource usage based.
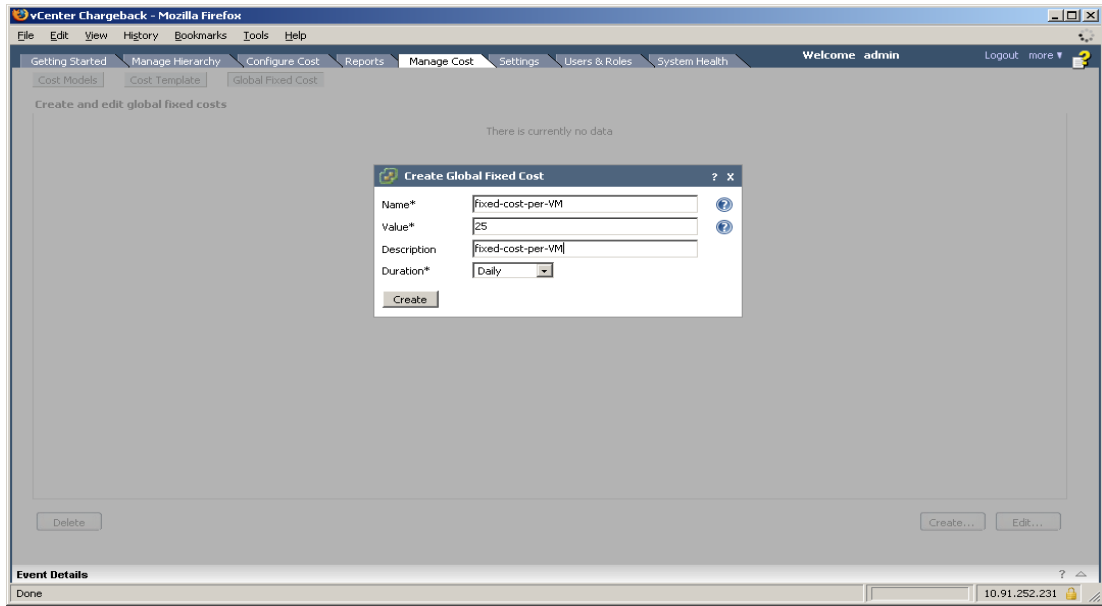
Figure 22 - Creating Global Fixed Cost

Step 2: Define fixed cost model

Chargeback cost model defines the base rate and billing policy. Base rate is the global rate that you want to charge for a unit of the chargeable computing resource, e.g. CPU, memory, etc. A billing policy determines the cost types and chargeable units to be considered for calculating the chargeback cost. Chargeback provides several types of billing policies, e.g. Fixed Cost, and Actual Usage, etc. In this scenario a fixed cost model that only defines the billing policy and have the base rates set to zeros defined indicates that resource usage based costs are not to be calculated.

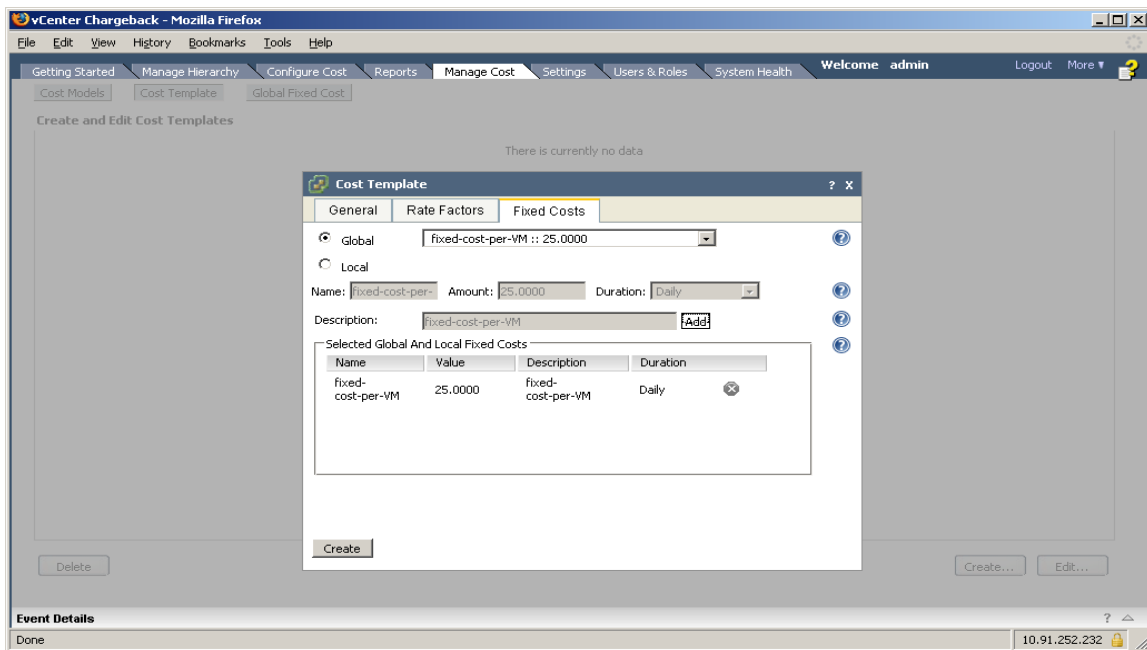1. Click on Cost Models and then Create. Complete "fixed-cost-model" for Name and Description.

Figure 23 - Fixed Cost Model – General

2. Select Billing Policy . A billing policy determines the cost types and chargeable units to be considered for calculating the chargeback cost. Leave "Update from now onwards" radio button select and select Fixed Cost for the "Billing Policy" from the drop down list. By selecting a fixed cost billing policy, Chargeback will consider only the fixed cost associated with each entity, and will ignore the actual resource usage and base rates defined for each resource.
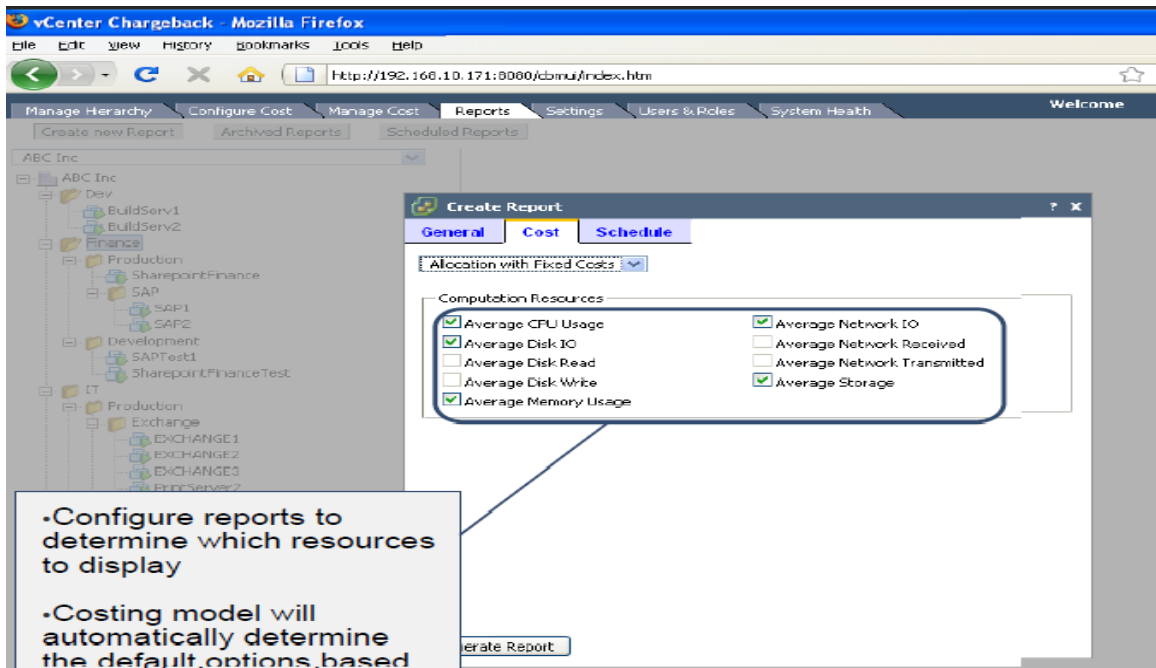
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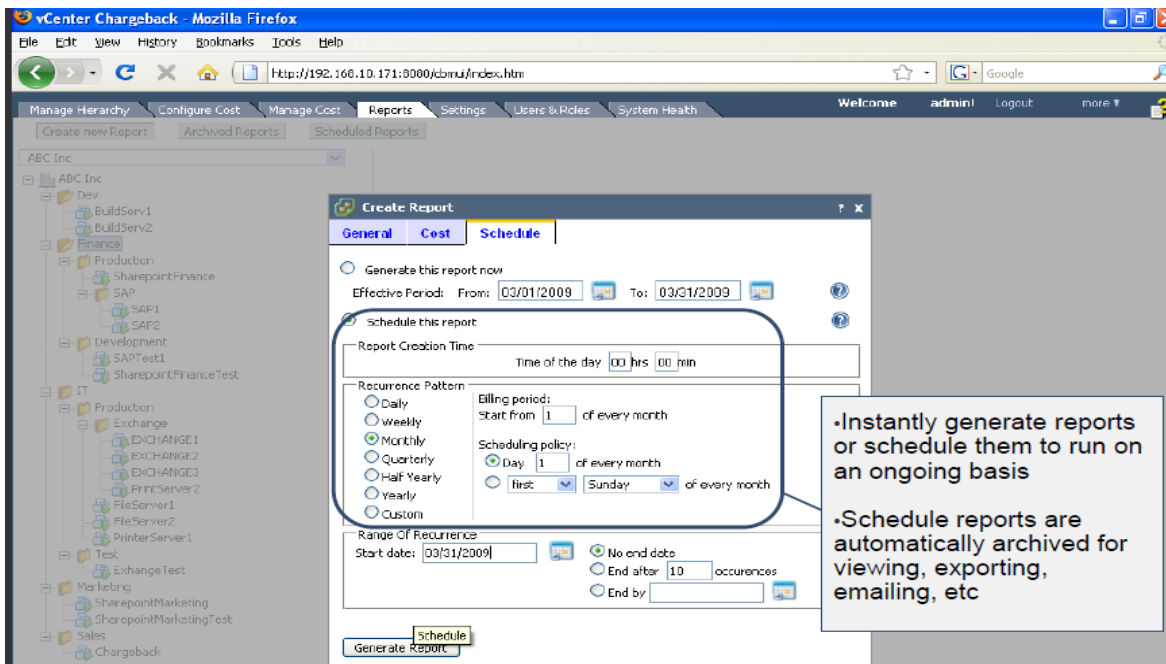Figure 24 –Configuring reports to determine which resources to display

Figure 25-Generating reports on an ongoing basis

Figure 26-Usage report

Figure 27 –cost report

Therefore With Chargeback, I can easily reap the following benefits:
- o Create a simple, flexible, and accurate model for measuring costs in a shared IT services environment
- o Make better resource utilization and allocation decisions by ensuring accurate measurement of the true costs of virtualized workloads
- o Help end users make informed decisions about service levels requested with better visibility of their associated costs

Chapter 4

Implementation of Lifecycle Model

In this chapter, Vcenter Lifecycle manager tool of VMware used throughout the development process of the thesis is presented. In addition,the results of the usages of mentioned tool and how they were tested and evaluated as useful are analyzed. Later on a detailed infrastructure of how I built the overall system and how each component interacts with each other are explained.

4.1. Overview

VMware vCenter Lifecycle Manager allowed me to implement a consistent, automated workflow for provisioning, operating and decommissioning virtual machines. Lifecycle Manager automates the steps within the workflow to improve efficiency and productivity, and to ensure strict corporate compliance with company policies.There are many benefits such as employing standardization and best practices for tracking and managing virtual machine deployment and using,eliminating manual and repetitive administrative tasks through automation,preventing virtual machine sprawl and ensure corporate IT compliance.

VMware vCenter Lifecycle Manager (LCM) automates the process of creating virtual machines and removing them from service at the appropriate time.Using this, I performed the following tasks:
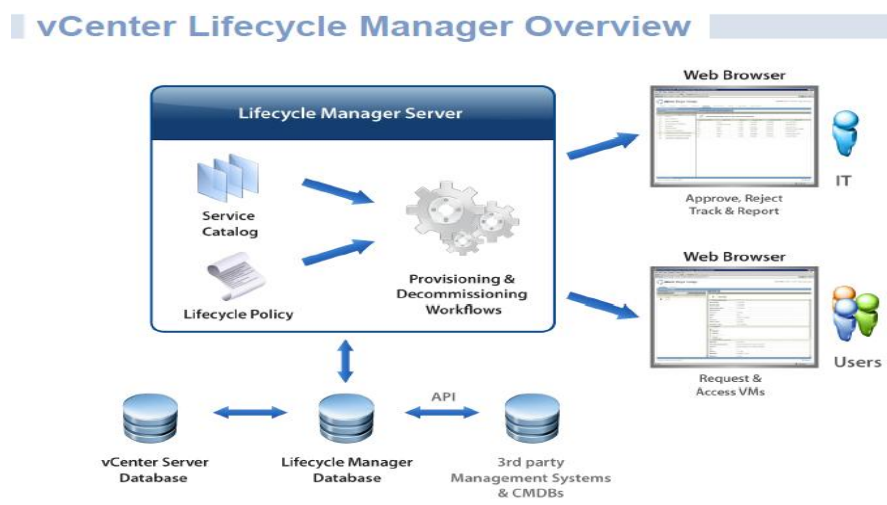
Figure 28 –Vcenter Lifecycle Manager overview

➢ Handling and processing virtual machine requests in a Web user interface
➢ Automatically placing servers based on their location, organization, environment, service level, or performance levels. When a solution is found for a set of criteria, the machine is automatically deployed.
➢ Enforcing automatic deployment and configuration to reduce errors and speeding up provisioning processes. I tracked lifecycle information for requested machines. Tracking helped me maintain on-time archiving and deletion of end-of-life servers and avoids server sprawl.

VMware Lifecycle Manager – (LCM) helped me to manage the creation of virtual machines and prevent machine sprawl by allowing me to do the following:
➢ Handling and process virtual machine requests in a simple Web user interface.
➢ Disabling the approval process to provide a self-service portal.

- ➢ Automatically determine the provisioning infrastructure, based on organizational and logical criteria, not technical ones.Servers are automatically placed based on their location,organization,environment, service level, or performance levels. When a solution is found for set of criteria, the machine is automatically deployed.
- ➢ Enforcing the best-practice provisioning processes, such as automatic deployment and configuration, that reduces error and speeds up the process.
- ➢ Tracking lifecycle information for requested machines. This helps maintain an audit trail, which allows on-time archiving and deletion of an end-of-life server and avoids server sprawl. These requests can be modified to extend a virtual machine's life span.

4.2. The Problem

As you see the figure 12 ,the main problem for administrator is to follow the creation and deploying of the requests of the virtual machines.Many years ago, the clients were sending an email to request for virtual machine and it is very old-fashioned way to do that because it is time-consuming but by using Vmware Lifecycle Manager tool ,i had the opportunity to automatize the requests easily.So The pain points for the administrator were asking themselves:

Lack of Visibility and Tracking
- ➢ Who owns what?
- ➢ What VM's have been created?
- ➢ What VM's have changed; who changed them?
- ➢ How long will they be in use?

Hard to Maintain Control
- ➢ Who can deploy what into the environment?
- ➢ Are random VM's being deployed without approval?
- ➢ Are VM's being placed in the appropriate places?
- ➢ Are we removing VM's that are no longer needed?
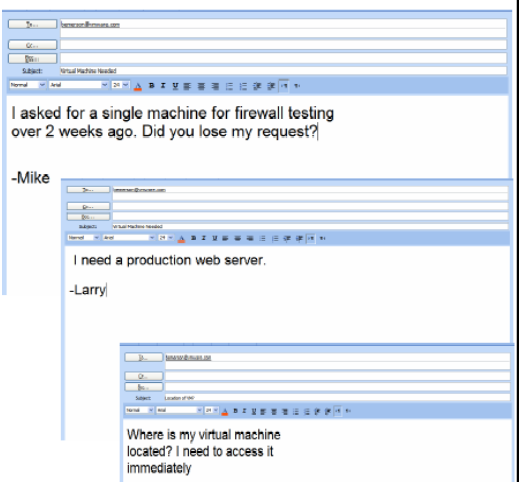
Wasting Time on Manual and Repetitive Tasks
- ➢ Is time spent adding business value?
- ➢ Are lots of manual steps leading to errors?
- ➢ What is your defined process if you have one-off deployments?

Figure 29-After Lifecycle manager,before Lifecycle manager

4.3. Role-Based User Interface

LCM has a role-based interface and presents information that is relevant to a role. This maintains the proper role separation that is required by most regulatory procedures. The following roles exist in the LCM:

- **LCM Administrator** – Establishes the criteria used for machine placement and determines how these criteria convert to sizing or placement values. This role configures LCM and establishes the placement of virtual machines.
- **LCM Requester** – Requests a new virtual machine and an extension of the life of a new virtual machine. Requesters can also access elementary functions of machines assigned to them, such as opening consoles and shutting down or restarting machines. Requesters can also delegate this control to other users.
- **LCM Tech Requester** – In addition to doing everything the LCM Requester can do,this role can also modify customization templates.
- **LCM Approver** – Approves current requests for deployment or extensions.Approvers have the authority to approve or reject deploying a machine. If no unique solution is available to place a machine based on the provided criteria, an IT staff member must manually choose the sizing and placement of the new machine.
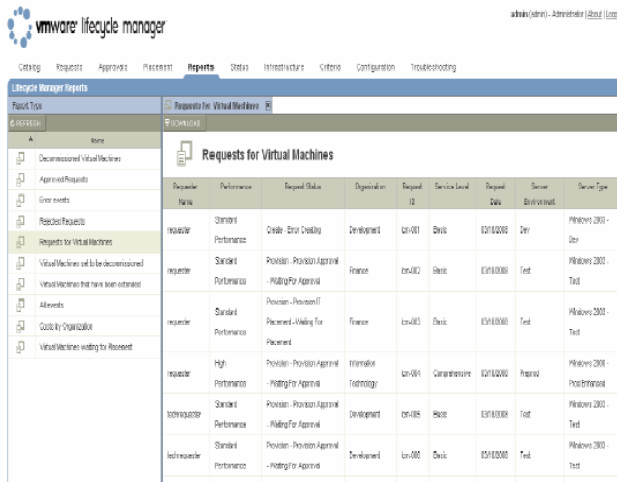- **LCM IT staff** – Completes manual placement of approved virtual machines.

All of these roles can request a virtual machine.

Role	Privileges
User	- Request virtual machines and specify decommissioning time - Use virtual machines - Request extensions - Technical Users have option to customize virtual machine CPU, memory, and disk resources
Approver	- Approve or reject requests - Change VM or Guest OS name
IT Staff	- Manually place approved virtual machines (if automatic placement cannot take place) - Approves or rejects extension requests
IT Administrator	- Configure Infrastructure mapping - Configure deployment policies - Configure Lifecycle Manager

Figure 30- User roles and Privileges

LCM Administrator-- The LCM Administrator is responsible for the following tasks:
- Initially configuring LCM
- Mapping the infrastructure, which includes:
- Configuring the criteria, such as location, organization, server environment, and so on
- Reconfiguring LCM to set up email notifications, the look and feel of the user interface, and style sheets

Mapping determines who can access a newly created element, such as a resource pool or datastore. If you have a requested virtual machine that is set up with all the criteria, it is mapped to the existing infrastructure.This role can complete all the tasks for all the other roles and has the most power in LCM.

With Lifecycle Manager,administrators can:

- Create a catalog of standard IT services: Users can select from a group of pre-defined virtual machines. This allows the virtual infrastructure administrator to maintain control over what types of resources are deployed into the IT environment.
- Associate Chargeback Metrics: Lifecycle Manager enables IT staff to associate chargeback metrics to specific virtual machine deployments and resource pools. These chargeback metrics can be assigned to specific business groups, or tie in to existing financial systems.
- Streamline the request and approval process.:Lifecycle Manager establishes a consistent and scalable mechanism to route and approve all requests for virtual machines, ensuring compliance with internal policies.
- Track and control virtual machines: Tracking who owns virtual machines in a virtual environment or keeping record of when a virtual machine is created, deployed or decommissioned can be challenging. Lifecycle Manager tracks virtual machine deployments with a web-based request log, so IT staff knows exactly when the

request is made, approved or denied. IT staff also knows when the machine is deployed and how long it has been in operation.

➢ Eliminate manual, repetitive, and error-prone tasks: As deployments grow, automation becomes a critical factor in helping IT staff do more with less. Lifecycle Manager automates each step in the virtual machine lifecycle based on predefined policies.

➢ Integrate with existing management tools. Many organizations have existing tools to handle various aspects of IT,such as change management, asset management, networking or storage. Lifecycle Manager can be used in conjunction with existing IT operational or management tools.

User Roles and Permitted Tasks

Lifecycle Manager provides an easy-to-use web interface for managing the interactions among everyone involved in the lifecycle of a virtual machine. There are four main roles and functions in the product:

1. User: Requests virtual machines and can track the status of any pending requests.
2. Approver: Approves or denies requests for virtual machines. The Approver can be from any department.
3. IT Staff: Decides where virtual machines are placed.
4. IT Administrator: Configures Lifecycle Manager,including parameters such as interactions between user roles.

Every LCM user role can perform a certain set of tasks. The LCM Administrator can perform all tasks. Table 1 describes how roles are mapped to tasks. Tasks marked with an O can be performed only by the owner of the request.

	LCM Admin	LCM IT Staff	LCM Approver	LCM Tech Requester	LCM Requester
Create infrastructure elements	X				
Map infrastructure elements with criteria	X				
Configure email notifications	X				
Generate reports	X	X	X		
Request virtual machines	X	X	X	X	X
Cancel virtual machine requests	O	O	O	O	O
Change state of virtual machine requests	X				
Change rights for virtual machine requests	X				
Approve virtual machine requests	X		X		
Set up virtual machines	X	X			
Retry placing failed virtual machine requests	X	X			
Validate virtual machine requests manually	X	X			
Check infrastructure for virtual machine requests	X	X			
Request extensions	X	O	O	O	O
Approve extensions	X		X		
Choose customization templates	X	O		O	
Approve customization templates	X	X			
Approve customization change requests	X	X	X		

Table 1- Roles and Permitted Tasks
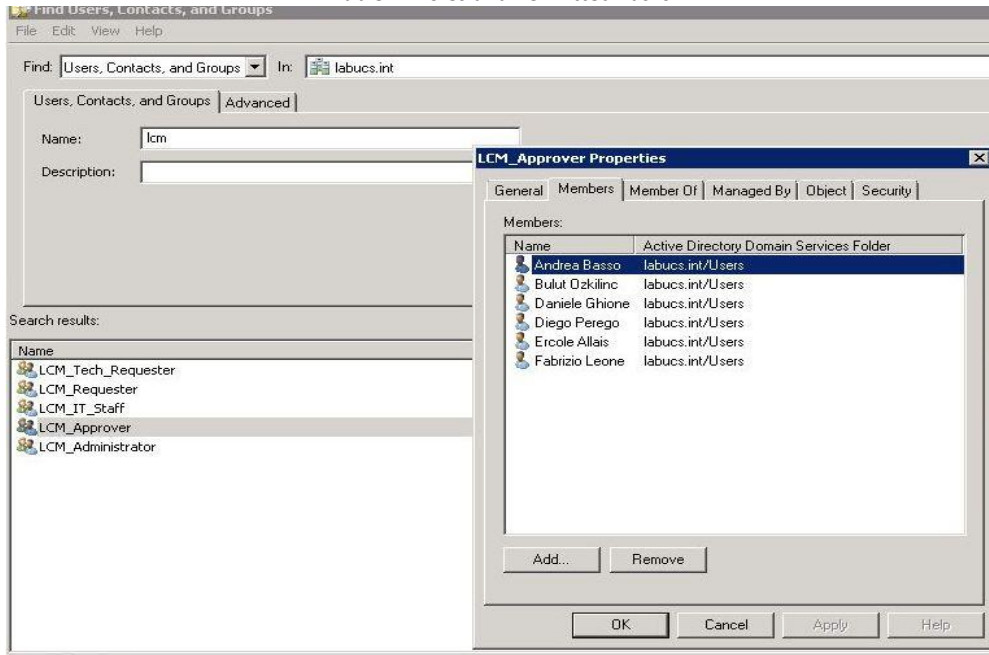
Figure 31-Active directory configuration for User policy in Lutech S.p.A

During my internship at Lutech company, I configured active directory configurations for group policy shown in figure because first of all,we have to configure those prior to beginning.I described our users /members such as administrator, staff ,approver and for requestor because everybody will have different grants such as requsting machines or cancelling the vm requesting according to the table 1 described.

4.4. The Process

LCM automates the process of creating virtual machines and removing them from service at the appropriate time. Figure 10 provides an overview of the process and the tasks completed by each role. These tasks depend on the role the LCM Administrator has assigned me.

The way that LCM handles requests to create virtual machines depends on how the LCM Administrator has configured the approval process. If approval is required, an email notification is sent to the LCM Approver user. If approval is not required, and there is no conflict with the request, the virtual machine is created. If there is a conflict, an LCM IT Staff user receives an email notification that a virtual machine is waiting to be created.After a virtual machine is created, it can be used until the decommissioning date. It is shown in the following figure .

Figure 32 –The process

Figure 33 - Stages in the Lifecycle of a Virtual Machine under LCM

As shown in Figure 10, the process starts when a virtual machine is requested. The next step depends on how the LCM Administrator configured the approval process.If an approval is required, the LCM Approver receives an email notification that a virtual machine is waiting for approval. If approval is turned off, and there is no conflict with the placement information, the virtual machine is placed automatically. If there is a conflict, such as incorrect or missing information, an LCM IT Staff user receives an email notification that a virtual machine is waiting to be placed. The LCM IT Staff user must display the current setup and provide the appropriate information After the virtual machine has been placed, the virtual machine can be used until the decommissioning date. Five days before this date, an email is sent to the user who requested the virtual machine to notify the user that the virtual machine is close to being decommissioned. The user who requested the virtual machine can do one of the following:

➤ Request an extension of the life of the machine If the extension is approved, continue using the virtual machine until the new decommissioning date.If the extension is not approved, the virtual machine reaches its end of life at the previously set decommissioning date and is archived or deleted.
➤ Manually decommission the virtual machine
➤ Delete the virtual machine

An LCM Requester can only decommission, not delete, a virtual machine. An LCM Administrator has access to a **Delete** button and can remove information about a virtual machine. A deletion means that there is no information about the deleted virtual machine in reports, but the associated virtual machine is not destroyed. If the virtual machine is accidentally deleted, the LCM Administrator can recover it.

➤ Archive the virtual machine before it is deleted.An LCM Administrator specifies whether decommissioned virtual machines are archived. This setting is specified during the initial configuration of LCM.The solid blue line in Figure 10 shows the process if an LCM Requester manually decommissions a virtual machine, it is deleted or archived.The broken blue line shows what happens if approval is turned off. A requested virtual machine is created and placed automatically, or if there is a conflict, an LCM IT Staff user is notified. Also, if approval is turned off, a request to extend the life of a virtual machine is completed automatically.

4.5. Installation Prerequisites

Component	Description
VMware vCenter Orchestrator 4.1	
VMware vSphere™	Requirements: ■ vCenter Server 4.1 or vCenter Server 4.0 Update 2 ■ The Sysprep utility for the guest OS must be available in the proper directory on the vCenter Server.
VMware ESX™	Support for ESX depends on the version of vCenter Server that you are using. See the documentation for the relevant version of vCenter Server.
ActiveDirectory domain	
Sample ActiveDirectory groups that correspond to LCM roles	The roles are: ■ LCM Administrator ■ LCM IT Staff ■ LCM Approver ■ LCM Tech Requester ■ LCM Requester
Appropriate permissions for the LCM groups	Include the following permissions: ■ Allow the Orchestrator Administrator to deploy from vCenter Server templates. ■ RDP access in the guest operating system. Use xrdp for Linux virtual machines.

Component	Description
LCM database	Choose one of the following approaches: ■ Use the same database as Orchestrator. ■ Use a separate database for LCM (recommended). NOTE Because of CPU and memory usage, you should consider hosting the LCM database and the Orchestrator server on different machines on a local network with low latency.
Static account for each vCenter Server that LCM and Orchestrator can use	
DHCP server and fixed range of IP addresses for new virtual machines	

Table 2- Installation Prerequisites

4.6. System Requirements

Your system must meet the technical requirements that are necessary to install and configure VMware vCenter Orchestrator and VMware vCenter Lifecycle Manager. Because LCM runs as an Orchestrator plug-in, the hardware requirements and the supported operating systems are the same for both products.

Hardware Requirements for Orchestrator
Make sure your system meets the minimum hardware requirements before you install Orchestrator.
➢ 2.0GHz or faster Intel or AMD x86 processor. At least two CPUs are recommended. Processor requirements might differ if your database runs on the same hardware.
➢ 4GB RAM. You might need more RAM if your database runs on the same hardware.
➢ 2GB disk space. You might need more storage if your database runs on the same hardware.
➢ A free static IP address
Operating Systems Supported by Orchestrator
Orchestrator offers support for several operating systems.

➢ Windows Server 2008 Enterprise, 64-bit
➢ Windows Server 2008 Standard, 64-bit
➢ Windows Server 2008 R2 Datacenter, 64-bit
➢ Windows Server 2008 R2 Enterprise, 64-bit
➢ Windows Server 2008 R2 Standard, 64-bit

Supported Directory Services
➢ LCM requires a working LDAP server on your infrastructure.
➢ LCM supports these directory service types.
➢ Windows Server 2003 Active Directory

- ➢ Windows Server 2008 Active Directory
- ➢ Sun Java Directory Server Enterprise Edition (DSEE) Version 6.3
  Supported Browsers
- ➢ The LCM user interface requires a Web browser.
- ➢ You must use one of the following browsers to connect to LCM.
- ➢ Microsoft Internet Explorer 6, 7, or 8
- ➢ Mozilla Firefox 3.0.19 or 3.6.x
- ➢ To connect to a virtual machine through your browser, you must use the VMware WebCenter Remote MKS
- ➢ Plug-in, which is compatible with the following browsers and operating systems:
- ➢ Microsoft Internet Explorer 6 or 7 on Windows XP or Windows Server 2003
- ➢ Mozilla Firefox 3.0.19 or 3.6.x on Windows XP, Windows Server 2003, Windows Server 2008, Windows 7,or Linux

  Database Requirements
- ➢ Orchestrator requires you to have a database that is separate from the standard vCenter database.
- ➢ LCM can use either the same database as Orchestrator or a separate database. The best practice is to use a
- ➢ separate database for LCM.
- ➢ **NOTE** Because of CPU and memory use, you should consider hosting the database and the Orchestrator server on different machines from the same datacenter. Make sure at least 1GB of free disk space is available on each machine.
- ➢ The following database types are supported by LCM.
- ➢ Microsoft SQL Server 2005 Service Pack 2 x64
- ➢ Microsoft SQL Server 2008 Enterprise Edition x64 (10.0.1600)
- ➢ Oracle 10g Standard Edition, Release 2 (10.2.0.3.0)
- ➢ Oracle 11g Standard Edition, Release 1 x64 (11.1.0.7.0)

4.7. Test and Evaluation

The IT administrator creates a catalog of virtual machine templates that users can view and select. The templates help the user determine the characteristics of available virtual machines (machine size, memory, storage,backup services, etc.). The IT administrator also defines what types of approvals are required prior to virtual machine deployment.After the IT administrator completes setup and defines the catalog of templates, the user can log into Lifecycle Manager and make a request for a virtual machine. During the request process, the user enters information to help Lifecycle Manager select the specific resources that best support the request. The user can log back into Lifecycle Manager any time to check on the request status. Requests are only visible to the user who made them.Once submitted, requests are routed to the approver. If the request is approved, the virtual machine is deployed automatically, based on the user-defined criteria and the way in which IT staff has mapped those criteria to existing computing resources. For example, a request for a production virtual machine requiring high performance will be mapped to the highest performing server, network and storage resources available in the virtualized environment.

If several choices exist to support the user request, IT staff will be notified by email and can make a determination about where to deploy the virtual machine in the environment.Users follow the same request and approval process to change resource specifics for existing virtual machines.The final step within Lifecycle Manager is to decommission the virtual machine. The decommission process, which consists of archiving and ultimately deleting a virtual machine, provides better resource utilization by ensuring resources come back into the resource pool for future use. The virtual machine will be decommissioned based on the end date the user enters when first submitting a request. This date represents that length of time the user will need the resource. The user can request more time within the web interface or let the virtual machine go into the decommission process. The archive function, prior to deletion, is useful for IT staff, because a virtual machine can be moved to lower-cost storage.

During my internship at Lutech S.p.A company, I tried to request a virtual machine as a normal user and logged in the system and afterwards I logged in as an administrator or (approver) to check whether my request has been taken into consideration.First,
Requesting a Virtual Machine
To request a virtual machine as lcmuser:
1. Launch Internet Explorer or Firefox. By default, it will go to http://localhost:8280/vmo/lifecycle/default.html.

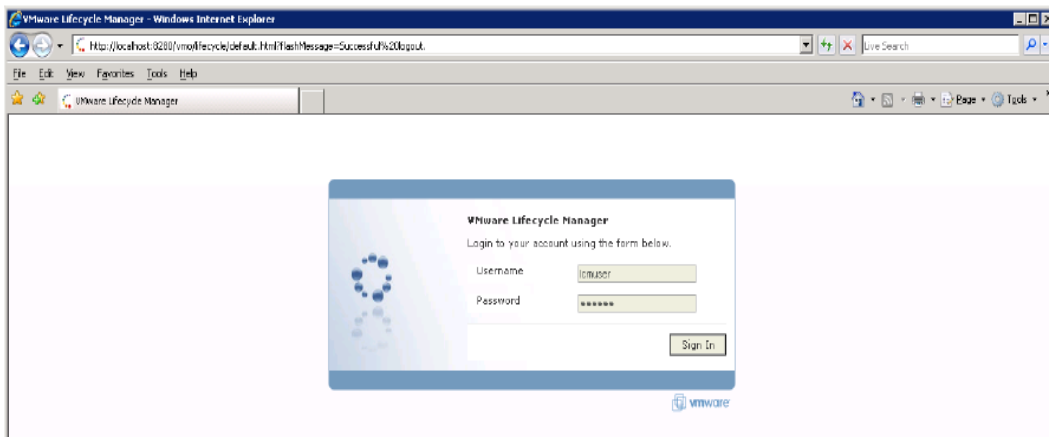2. Log in as lcmuser with the password vmware.

Figure 34 – Login to Vcenter Lifecycle manager

To obtain a virtual machine, you must submit a request. You can request a specific start date or accept the first available date.

Procedure

1. Log in to LCM and click the **Requests** view.
2. Click **Request**.
3. (Optional) To specify a commissioning date, select **Yes** for **Set commissioning date** and select a date.
If you do not specify a commissioning date, the virtual machine is created at the first available opportunity after approval.
4. (Optional) To specify a decommissioning date, select **Yes** for **Set decommissioning date** and select a date.If you do not specify a decommissioning date, the virtual machine remains in service until it is decommissioned manually.
5 .(Optional) Specify who can control the virtual machine request.If you do not specify a user or group, only you and the LCM Administrator have control.
   - From the **Virtual machine control by** drop-down menu, select **Group** or **User**.
   - Type the name of the user or group, or search from a list of available group or user names and descriptions.
   - Type the email address for the user or group if email notifications are enabled.
6 .(Optional) Specify who can connect to and view the virtual machine when it is running.
If you do not specify a user or group, only you and the LCM Administrator can view the virtual machine.
   - From the **Virtual machine view by** drop-down menu, select **Group** or **User**.
   - Type the name of the user or group, or search from a list of available group or user names and descriptions.
   - Type the email address for the user or group if email notifications are enabled.
7. Click **Next**.
8. Select settings for the Location, Organization, Server Environment, Service Level, and Performance
options. The available settings for these options are specified by the LCM Administrator.
9. Type the requester email and click Next.
10 .Select the server type.
11 .(Optional) To start the virtual machine as soon as it is provisioned, select Yes for Start virtual machine.
12. Click Next.
13. Type comments about the virtual machine, which are viewed in the approval process.
14. Click Submit.
The virtual machine is deleted on the decommissioning date. You cannot retrieve it, unless the LCM
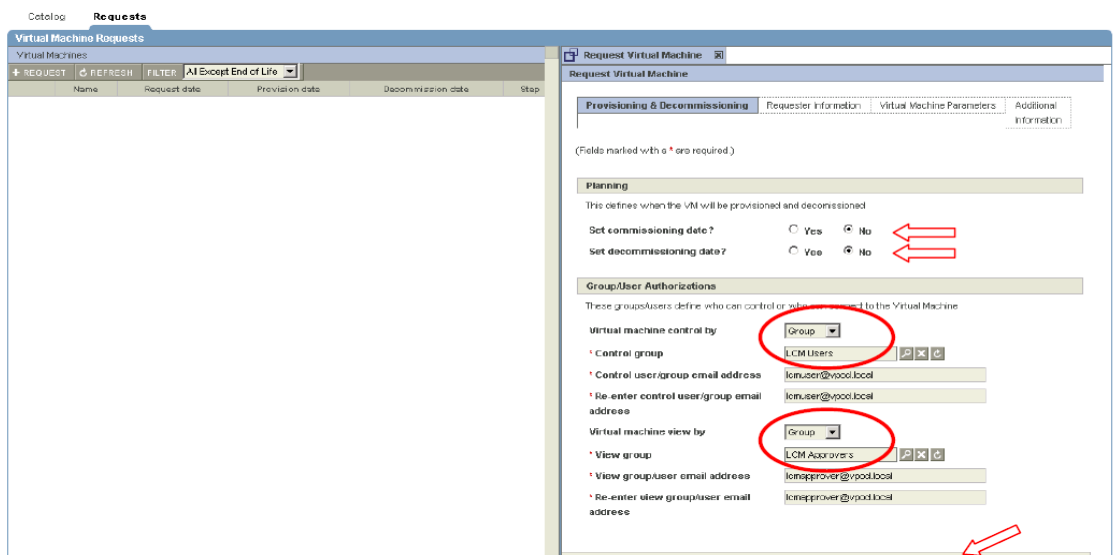Administrator has configured LCM to archive the virtual machine.

Figure 35-requesting virtual machine

Display Requested Virtual Machines

After having requested a virtual machine as a normal user, for instance, windows server 2003, I am trying to log in as an administrator role and checking the virtual machine out and controlling if it is suited as shown in figure.If the administrator approves it ,that virtual machine will be given.All the properties of that machine are displayed also and I can change the properties such as memory size or cpu size depending on the change request.
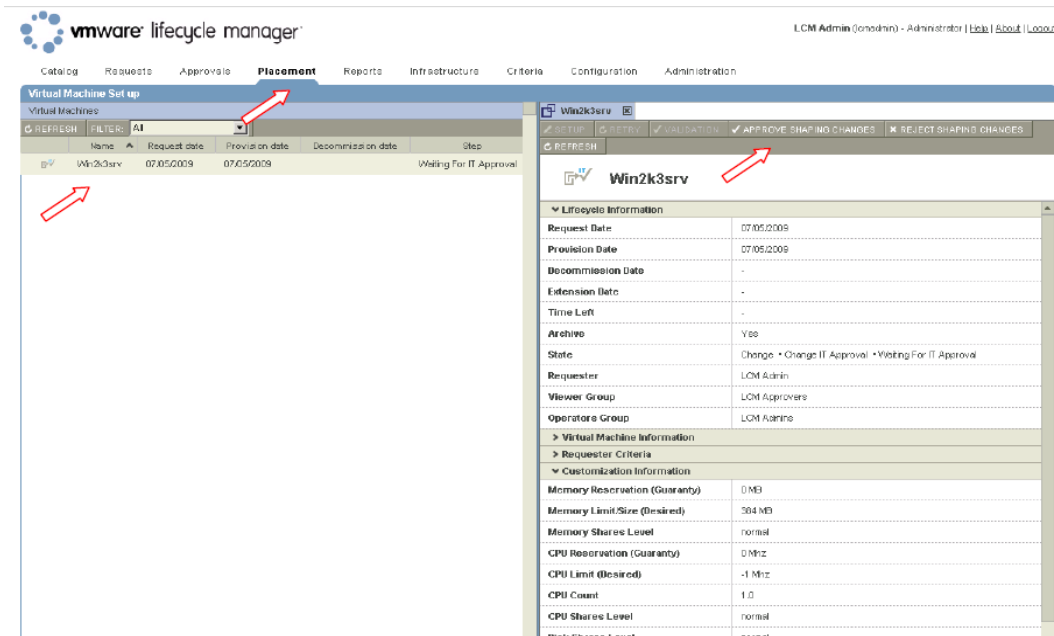

Figure 36-displaying requested virtual machine

Chapter 5

Conclusions

What characterizes the most this thesis has been constructive approach taken, and the assembly of a set of tools that power final big picture. This chapter has got two sections, first one explaining the conlusion of the current status of the work and the latter one listing my opinions on how future enhancements can be.

5.1. Conclusions

As discussed in detail in the preceding chapters ,my aim was to research and accurate cost management, analysis, and reporting to create cost transparency and accountability.This allowed me to understand the actual cost of virtual infrastructure required to support business services and bill those charges out according to the IT resource billing policy.Vcenter Chargeback tools enabled me to accurately report and give insight into the true costs of provisioning systems as well as taking into account the different factors that range from CPU, memory, storage and additional elements such as power and cooling .

In the research process, I first had to enhance brand new chargeback model and implement this with VMware tools. Due to the fact that, companies use a manual approach to charge for virtual machines while with vCenter Chargeback I was able to apply those during my thesis .Furthermore,using them I validated some techniques that tested and created some new virtual machines for the Provisioning phase.

As a result of this thesis project ,Finally I presented the results obtained and validated the approaches used. The final application presents the complete optimization of budgets and improving resource utilization.

The results obtained from the program indicate that the approaches used were quite successful in the technical aspects as I explained in the evaluation section and are a strong base for future testing and development of the tasks researched. VMware vCenter Chargeback delivers cost accounting for the entire virtual infrastructure in 3 steps:

> - Create the hierarchy that makes sense for IT and the business
> - Enter costs (variable and fixed)
> - Report and bill back to the business

On the other hand, I had the opportunity to automate, manage and control the life of VMs through a web portal with VMware Lifecycle Manager.I did have the reporting for virtual machines that I created and requested.I obtained Provisioning & decommissioning of the virtual machines also I had the chance to see of Group authorizations for VM request control and VM request view and approve the vm requests.

I configured and managed a VMware vCenter Lifecycle Manager (LCM) environment to request, approve,commission, change, and decommission virtual machines for various use cases that stress policy adherence, regulatory compliance, and chargeback. It provided me an opportunity to see how I can apply LCM to the challenges of tracking and controlling virtual infrastructure.

5.2. Future Research

This section deals with the analysis of required features and their characteristics I find needed for the new marketable version of the product. As VMware continues to focus and invest in customers' journey to cloud computing, they are focused on products that are consistent with this vision, such as VMware vCloud Director which will offer a new way to provision infrastructure as an on-demand service. As a result, sales of Lifecycle Manager have been discontinued.

1. **Deliver Infrastructure as a Service with VMware Vcloud**

From my point of view,with this new model,it is a new provisioning for IT organizations will become cloud service providers for the business, achieving the benefits of cloud computing without sacrificing security or control. Users experience unprecedented responsiveness and agility, and IT management will reduce costs through increased consolidation, task automation, and simplified administration. All this is achieved cost-effectively while leveraging existing investments in people and technology.VMware vCloud Director will integrate with existing VMware vSphere deployments and supports existing and future applications by providing elastic standard storage and networking interfaces, such as Layer-2 connectivity and broadcasting between virtual machines.VMware vCloud Director will use open standards to preserve deployment flexibility and pave the way to the hybrid cloud.Through partnerships with a broad ecosystem of service providers offering cloud services based on VMware vCloud Director, customers will extend their datacenter capacity to include secure and compatible public clouds and manage them as easily as their own private cloud.

VMware vCloud Director will enable IT organizations to deliver resources to internal users as virtual datacenters. By logically pooling compute, storage, and networking capacity into virtual datacenters, IT organizations can manage resources more efficiently with complete abstraction between consumption and delivery of IT services.

Instead of providing users or organizations with siloed physical infrastructures, IT teams will deliver isolated virtual datacenters that draw resources from a common physical infrastructure. By pooling these physical resources on the back end, hardware utilization and consolidation increases. Similarly, underlying infrastructure can be pooled into tiers and offered to users at distinct service levels and prices.

The most important benefits will be instead of using Vmware Vcenter Lifecycle manager according to those such as

> ➢ Increasing business agility by empowering users to deploy preconfigured or custom-built services with the click of a button.
> ➢ Maintaining security and control over multi-tenant environments with policy-based user controls and VMware vShield™ security technologies.
> ➢ Reducing costs by efficiently delivering resources to internal organizations as virtual datacenters to increase consolidation and simplify management.
> ➢ Leveraging existing investments and open standards to ensure interoperability and application portability between clouds.

2. **Consume Infrastructure as a Service**

From my point of view,VMware vCloud Director also will change the way that users consume IT services. Instead of filing service desk tickets and waiting in queues,application and line-of-business owners will utilize self-service portals to access their own virtual datacenters. VMware vCloud Director will enable users to consume these resources as a catalog based service through a Web portal and programmatic interfaces.

IT teams will define multiple consumption models using the same infrastructure, ranging from capacity-as-you-go to reserved pools. These can be delivered at an appropriate cost model with VMware vCenter™ Chargeback, which will help drive accountability and enables granular usage monitoring.Ultimately,IT organizations will maintain control with permissions,quotas and leases governed by role-based access controls that leverage existing LDAP directory services.