

BMIS Practicum:  
IS Issue  
Current Knowledge & Resources

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Virtualization ROI/TCO

Assignment 6:

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## IS Issue Discussed in the Information Space and Resources

### *What is the issue?*

The principal question is how do CIOs and technology decision makers model and capture the true benefits and costs of implementing all or part of a virtualization solution matrix and what are some of the strategies issues that are core to adopting a virtualized infrastructure.

The Return on Investment (ROI) metric and the Total Cost of Ownership (TCO) models are traditionally the primary measurement that was developed by the Gartner Group to help organizations understand how to estimate and control ongoing IT infrastructure costs, but ROI has the added ambiguity and is rarely quantified in a standardized way, because it is difficult to contextualize both obvious and non-obvious benefits and costs into a cognitive framework that makes sense and can be quantified. There are many suggestions for calculating ROI/TCO, with opinions expressed by vendors with vested interests in product adoption, consultants or “knowledge experts” looking to leverage or present themselves as fully aware of the “leading edge” to be hired for your next project, or the majority of people working in the information space that are just trying to objectively find the best method or a combination of methods that will measure the tangible and intangible returns associated with adopting virtualization technologies in their infrastructures. The core benefit of most of these aspirations is to execute the tactical and operational strategies of their firms as cost effectively as possible, while minimizing the impact of the tradeoffs to providing the service levels necessary to do so. Of all the infrastructure technologies in the modern information space, virtualization appears to be a revolutionary option, if you believe the press bluster about its potential, however, the delivery of that promise is proving to be a most elusive outcome.<sup>i</sup>

Normally, the TCO analysis is a highly detailed attempt to gauge costs of a particular project over a given time period, while ROI analyzes the return on an investment in terms of its current monetary value or the monetized value of the benefit provided by a project. However, by that definition, ROI is subject to a high degree of subjective context. However, technology decision makers and executives not only need to be familiar with the requirements of capital budgeting, they have to allocate their organizations scarce resources for these projects and give executive managers a clear understanding of how those resources of time, budget, and human capital will bring value to the organization. More specifically, these implementers have to be able to correctly select the most beneficial use of any trend even one so flexible and slippery as virtualization can be. A daunting challenge and difficult to capture and articulate because the technology is currently part of an evolving landscape of complex solutions that are being discovered and put into practice constantly. Further complicating matters is the common issue for stakeholders in organizations with disparate goals all vying for the same finite resources.

Virtualization by itself is not the panacea for providing competitive flexibility and cost reductions, but also a facilitation technology that enables great changes and potential in organizations infrastructure, but there are opinions that its payoff is simply techno-hype. In every constituent group supporting a particular “camp”, be it Linux, Unix, or Windows based, each believes that the true value of virtualization cannot be implemented in the enterprise space without the full understanding of the nuances of the underlying technology that drive the innovation.<sup>ii</sup> Currently, the common view of virtualization is as a facilitator for articulating

business strategy to leverage resources and reduce costs. Since the technology is more of a framework that has multiple complex pieces, each at various stages of development, it is difficult for managers to accurately project the ROI/TCO for these projects or qualify and quantify the “value” the various potential uses of virtualization can bring to any size organization. Most questions in the industry are currently centered around choosing either a full implementation of the virtualized infrastructure, (a radical clean slate), or to use the traditional method of incremental adoption, to gain advantages for both previous investment in production software and hardware architectures, while gaining the marginal competitive advantage of the emerging capabilities of the virtualization development landscape.

The most daunting challenge evident in the various trade journals and informal discussion blogs indicates that mostly it is the cost in training, new supported hardware, retooling business processes and the unanswered support questions about the emergent technology makes the decision to adopt even the modest forms of virtualization in the enterprise a difficult sell internally. The fact that the over/under estimation of resources is traditionally the fundamental flaw that every new project estimator falls to.<sup>iii</sup> However, do to the fact that virtualization is a fundamental technology, it has become obvious that many in the information space that many decision makers do not fully understand the technology first before attempting to use older implementation estimates and methods, and have adopted a “wait and see” approach. As new developments in the virtual technology stacks are released or after several years until a critical mass of adoption is achieved, these managers are watching the primary major vendors begin to offer virtual machine (VM) enabled solutions to their core product lines such as SAP, ERP, etc, which is a very smart common-sense approach, but exposes the company to a slight disadvantage to time the eventual switch from waiting to adoption, and in the current competitive environment, that can be a very dangerous if not disastrous proposition.<sup>iv</sup>

Technically, virtualization has unfortunately been a bit too “hype” driven over the last 4 yrs. It was originally slated to be the basis for the SOA and SaaS underpinnings, but technological and patent issues prevented the widespread adoption. It turned out that most of the fervor in the industry was based on the broad assumption of its capability to deliver on the core promise (value proposition) of massive cost reductions and easy extensibility and thus flexibility to mold to any firm or enterprise solution.<sup>v</sup> Through the use of an abstraction layer which separates the physical hardware layer from a logical layer through a foundation technology called a HyperVisor, allows organizations a degree of independence from services development hold up do to a limitation in the OS, since virtualization software can support almost any operating system or any hardware platform provider via an interface module called the Virtual Machine Monitor (VMM). However, this independence doesn’t come without a price. Lack of technical support is the traditional bulwark-leverage tool service software firms use to enforce their market power against firms adopting virtualization technologies. Should an old application prove incompatible with the virtualized solution that a firm installs, service software venders are freed from the bounds of SLA contracts and thus the investment in the technology become null. However, the dynamic in the market has created a new and highly competitive landscape to the existing software providers who have extensive development expertise in the monolithic architecture, and either do not or have not augmented new and existing software to support the

“pool” of computational resources that an organization can use to carry out its business operations.<sup>vi</sup>

For some firms, the “cloud” that virtualization software and hardware provide is a reduced scale version of the large search engine and data center proprietor ISVs offer from such providers as Google, Yahoo!, MSN, etc., but without the distinction of having the information and business activities externalized to control boundaries, and thus mitigating the exposure of firm data to what has been yet unproven technologies. When companies engage with these ISV’s, client firms technically “outsource” its entire datacenter to web-enabled and hosted applications in the spare computational resource capacity of the huge network server clusters and dedicated hosting companies that are already paid for by the search companies. Salesforce.com is a notable example of a company attempting to use this business model exclusively. Many features have been developed that allow firms to recognize the advantages of “cloud” functionality and speaks specifically to the various business and tactical functions such as, automated application management, but principally on the impact of the ground breaking software VMware Infrastructure 3 as one solution. [7-Resource that talks about the advantages and disadvantages of the capability to replicate cloud functionality. Specific example by leader VMware Infrastructure 3 to meet the same requirements in direct competition]<sup>vii</sup>

Thus, virtualization creates a localized version of the resource “cloud”, and vendors in the virtualization space provide the ability to run multiple virtual machines with heterogeneous operating systems, either side-by-side in isolation or sharing interconnections within a logical layer, to truly provide the functionality promised by the SaaS framework. Firms stand to gain significant business agility from the promised “on-demand service architecture”, while supporting the existing infrastructure investment in hardware, and the compatibility problems related to production software that was designed for monolithic operation in specific NOS, OS, and hardware.<sup>viii</sup> [8-reference the talk about SOA/SaaS/Virtualization’s promises]

Though many firm managers are experts and very versed in a variety of fields due to significant technical training, advanced degrees, and/or significant experience, those experiences only allow them the ability to understand the operational parameters required to execute user-level applications on servers and workstations. In general, as a matter of specialization of labor, most of them are not equipped with the greater depth to understand the more detailed and dogmatic issues related to Kernel-level application development, which virtualization really operates in. More importantly, these managers and engineers don’t necessarily know how to handle the completely flexible offerings that virtualization can create nor do they have an understanding of the variety of normal and unknown costs grappling with the question of how to implement a virtual solution in their enterprise that will provide the ROI/TCO to justify the adoption expense and meet strategic needs.<sup>ix</sup> [9 – Paper talking about the existing training that managers have]

However, that ideal virtual solution that is turn-key, has proven elusive. The knowledge gap about virtualization in many first line managers and executive level decision makers is pandemic due to time constraints, lack of relevant objective expert commentary, and the time demands of maintaining day-to-day operations, not to mention the lack of objective and certified sources of objective information. The decision space is further complicated by the sporadic interplay of ERP vendors willing to forgo the extra profit margins for monolithic installations packages, and

embrace the democratizing nature of virtualization, that the technology gives to their customers, but traditionally are very heavy handed in their support for organizations that can pick services a'la carte.

Ordinarily, a decision maker can hire-in the necessary knowledge experts to execute a challenging technology or process. However, virtualization initiatives suffer from the same fault as wide spread Linux adoption in the enterprise in the past; principally, that its proposition has the requirement of being an all or nothing endeavor, and that the “abstraction” applications at the enterprise level have been scarce to support the granular knowledge required to successfully execute the “free” software distributions, let alone speak to the legal ramifications and liability issues surrounding support and security failures, patent trolling, and market forces. However, the virtual marketplace has experienced significant development and recent entrants of some significant players over the last 5 yrs. <sup>x</sup>[10 – Current Market Conflicts and entrants]

Several opinions about the role of virtualization are causing the rather rapid convergence and final licensing of the technology available via VMware and the final expiration of the fundamental patents that have bound the “virtualization” methods when they entered the Open Source domain are pushing the product development trend. Tool development companies are seeing opportunities to develop small, relatively low foot print applications, with a high likelihood of a company committing to enterprise wide adoption for the successful firm. This demand is viewed as potentially short lived. Current experts, even luminaries are also skeptical of the role and benefits that virtualization will provide:

“Virtualization has been around for probably 50 years. I forget when IBM started offering virtualization on their big hardware. Maybe not 50 years, but it’s been all around for decades and it’s very interesting in niche markets - I think the people who expected to change things radically are just fooling themselves...But also, I’d actually expect that the new form factor is in new input and output devices. If we actually end up getting projection displays on cell phones, that might actually change how people start thinking of hardware and that, in turn, might change how we interact and how we use operating systems. But virtualization will not be it.”<sup>x<sup>i</sup></sup> [11-Linus Torvols Interview]

Existing enterprise vendors in hardware and software industry are fueled by both the raw demand of the current market, a desire to protect existing infrastructure products from this new potential threat, as well as to have the opportunity to dominate the next new paradigm market should it materialize. However, they don’t want to commit to development as a huge initiative, but yet don’t want to marginalize their current cash cows for a disruptive technology model that SaaS/SOA and virtualization uses. Prior, the virtualization field was traditionally marginal and dominated by the high-entry cost products offered by the professional hypervisor-based solutions, such as VMware ESX Server, Microsoft Hyper-V, Virtual Iron, Citrix XenServer, Red Hat Enterprise Linux, SUSE Linux Enterprise Server, Oracle VM and Sun xVM Server. However, virtualization may prove to be a motivating vector for Linux to finally gain enterprise class capability distinction for its flexibility, awareness, and low resource footprint in both the enterprise and SMB category markets, but it is not clear where which solution is better and the field is only getting more complicated. <sup>x<sup>ii</sup></sup> [12 – Articles that talk about the current vendors]

Further, line managers and technical experts versed in a variety of other fields, have found it difficult to apply existing models for capturing ROI or the vaunted TCO, and applying it directly to the current flexibility inherent to the technology of virtualization is equally difficult as evident from the great number of expert opinions and various whitepapers stipulating the various solutions. No longer are the inputs so linear nor so sequential and incremental. The better question is asking how to quantify the value of the virtualization technology, beyond the first level advantages of immediate cost savings related to server consolidation and management in the long run. However, with any estimation, the long time you expect to estimate the less accurate your prediction will be. The sheer magnitude of information that must be taken in to quantify virtualization ROI, such as how do you quantify a return that is truly capable of both vertical and horizontal technology stack support, is a daunting task, but one that can be made if a simple framework is adopted starting with the benefits, the costs, and the results from the interplay of the two.

### **Benefits: The Minuend**

Many operational functions can be incorporated into the ROI/TCO calculations used by enterprises large and small. However, the question of the best way to capture these individual promises of service is still highly debatable.

“Our conclusion was that without realism and objectivity in the cost estimating process, bias and over optimism creep into estimates prepared by advocates of weapon systems, and the estimates tend to be too low. Therefore, staff who are not influenced by the military organization’s determination to field a weapon system, or by the contractor’s intention to develop and produce the system, should review every weapon system at major decision points in the acquisition.”

[13](Comptroller General of the United States, *Theory and Practice of Cost Estimating for Major Acquisitions*, p. 32.)<sup>xiii</sup>

The above paragraph speaks to not only the military organizations role in estimation that gets muddled by fuzzy thinking, it is the more general application of this principal of structured cost estimation that will help make a project a success. Successful project planning requires good cost estimating practices that capture factors that are beyond the prediction of the cost, effort and schedule for hardware, software or systems and make rational estimations of foreseeable use.

Most cost estimation processes appear to be tool-enabled processes and decision makers adopt a mindset that has to leverage the unbiased trade-offs between scope, schedule, and budget in order to provide all the information necessary to plan and manage the development deployment of complex systems. The following will consider how virtualization contributes to ROI/TCO because it is:

**Useful for Server Consolidation:** For example, do you add for a continued cost reduction, every ten server applications that are run on a single machine that are spawned? It is a fair assumption when you consider that that application would have required its own server. However, the practical metric for measure would be to NOT include it, and just consider the activity in the utilization rate as an aggregate measure. Thus, the aggregated server utilization function can become the default measure of how effective a virtualized infrastructure compares to the

traditional operations in the long run, and its flexibility is normalized across the functions that it supports, thus yielding a good estimate of the “service” value it provides.

Value methods for use in this area has traditionally been:

-Traditional Gartner TCO methodology.

-Financial Models based on:

- **Payback Period (PP):** PP is defined as the number of periods required to recoup the original investment.
- **Internal Rate of Return (IRR):** IRR determines whether an investment will produce an acceptable return according to a rate of interest required to produce a specified sum of money on a given investment over a given time period.
- **Net Present Value (NPV):** NPV is the current value of future cash flows associated with the operation entire lifecycle of a capital expense.

-**Hurdle Rate:** defined as the minimum acceptable rate of return on a capital investment project.

$$\text{Hurdle Rate} = \text{Cost of Capital} + \text{Risk Premium}$$

- **MACRS Depreciation:** the accelerated depreciation method that is used primarily for tax purposes since its use minimizes the tax bill. Corporations typically use straight line depreciation on their financial statements in order to maximize its reported income.

<sup>xiv</sup>[14 Reference the Capital Budgeting Website or Sources]

**Useful for Capturing the Product Lifecycle:** (server and services sprawl)

Developers of new software can rapidly deploy and test multiple versions of software and there for enables rapid deployment by wrapping the application in a custom configured and tested controlled virtual environment. In today’s information space, new business services and features need to be incorporated and are requested of IT on a monthly, if not even a weekly basis. Server hardware have several known factors such as mixed libraries, hardware level drivers, and other peripheral applications and driver installations that are a large time expenses, resource drains, and many times can lead to a significant amount of organizational inertia (beyond the standard bureaucratic inertia that exists for many companies regardless). Existing technicians working in the data center are normally left in a reactive or maintenance status, and rarely can provide the needed feedback to the rest of the organization. As a result, an entire industry has arisen to support the army of people needed to maintain the physical layer. That leads to the observation that the computational capacity of a server, server farm, or grid cluster, is dynamic. However, another cost is the managing and tracking of how much the utilization rate is being used as another input to the ROI/TCO calculation, as this value fluctuates.

Value methods for use in this area has traditionally been:

-**Sunk Costs** - Costs that have been incurred in the past and cannot be recovered are not relevant to the analysis. These costs are called sunk costs. The only cash flows that matter are those that will change if we decide to accept the project. These cash flows are called incremental cash flows (or relevant cash flows).

**-Scale Effect** - If we are considering mutually exclusive proposals and the assets (e.g., machines) cost different amounts, there is a potential bias in favor of accepting the more expensive asset, simply because of the larger size of the price tag. For example, we may consider investing in either:

**-Profitability Index:** the ratio of the present value of the benefits (PVB) to the present value of the cost (PVC) and thus normalize the scale effect's bias and preference given to the asset that yields the higher value in the index.

**-Unequal Lives:** Comparing mutually exclusive proposals and the assets have different lives, which introduces a bias in favor of accepting the longer-lived asset, however, this can be offset by the use of replacement chains methods.

**-Replacement Chains Method:** used to eliminate the bias introduced into the NPV calculation to re-structure the analysis such that the reinvestment period is the same for any two projects when they wear out and we will continue replacing these projects until the year in which both machines will wear out at the same time. There is a practical real difficulty with this method, but it does also correlate well to the existing IT practice of replacing the hardware as OS functionality increases, but only cycling the OS replacement when absolutely necessary via obsolescence or lack of corporate support.

<sup>xv</sup>[15 – Source that Talks about how Costs are Augmented in the TCO model and Capital Budgeting]

### **Useful to capture the cost savings that Dynamic Load Balancing will bring:**

As server workloads vary, virtualization provides the ability for virtual machines to dynamically shift computational resources of a server to be moved to underutilized servers. The dynamic load balancing creates efficient utilization of server resources, and smoothes out the operating cycle for the users, therefore providing a superior use of resource, but also provides users with a seamless instance of their application. Many times entire environments are rebuilt in real time, while users are connected to the session. Severe crashes that used to require painstaking expertise and costly downtime for reinstallation of the environments, are now simply re-copied to another virtual image that is spawned, and begins executing the application from the hosted operating system in mid-process. The model for ROI/TCO should capture this benefit.

Value methods for use in this area has traditionally been: Difficult to find any direct evidence of a value placed or a quantifiable number given for the savings or costs that are incorporated.

### **Useful to capture the cost savings for Disaster Recovery:**

Organization historical records are critical for firm operations and all firms need to create a plan that restores operations quickly in the event of a disaster or failure which is normally quite a significant amount of capital to be expensed. However, costs can be cut dramatically if the enterprise is willing to withstand longer periods of operations downtime. System crashes can create huge economic losses, preventing not only the transaction from being accounted for, and executed, but also by the fact that compliance regulations, government accounting rules now require better transparency for business processes. In a virtualized environment, disaster

recovery and backup processes can be executed, independent of any site/technology specific implementation that exists, such as the use of staging areas for tape libraries or real time drivers which copy files by providing hooks into the kernel of the host server OS that are proprietary to the backup solution provider.

One rapid adoption use of incremental use of virtualization has been to provide services to the enterprise such as fast access to data contained on tapes, and also a secondary effect of providing standardization of tape management tools and processes that lead to excellent reduction of costs. Thus, the efficient utilization and management of new tape technologies and capacities can deliver tangible and intangible benefits to the organization such as better managing and automating of key tape-related processes, the creation of broad strategies to mitigate risk, reduce TCO, address compliance requirements and optimize security and support, and thus should be included in the enterprise ROI/TCO.

Value methods for use in this area has traditionally been: Fairly easy to capture

At the storage level, deployment of network-attached storage and mirroring software from a specialized vendor. The software creates a virtual storage for our database and application servers. Thus all changes to the database are captured and sent in near real-time to the backup facility without impacting the performance of the applications. Those that use this shared-storage approach can also manage storage centrally, so that storage is bought on-demand. At the database level, the leveraging virtualizations logical partitioning technology, allowed to partition each server to look like multiple servers running multiple database servers thus sharing the capacity of the individual servers. One company, Transplace Inc. , used the cost savings in the disaster recovery facility and the database server virtualization to run four to six copies of their Oracle database. A few were used for testing and development most of the time, but if a disaster event occurred to the main database, the development virtual servers would be shutdown, and a disaster recovery instance of Oracle on that same server would be instantaneously spawned. Thus the per cpu licensing costs were reduced as well as the response time in recovering the data in crashed databases.<sup>xvi</sup>[16-CIO Magazine reference for DR techniques]

**Useful to provide cost savings at the end-user node using Virtual Desktops:** As corporations become multinational, more enterprises are requiring the standardizations and procedural business controls to maintain business continuity. Multinational flexibility provides seamless transitions between different operating systems on a single machine reducing desktop footprint and hardware expenditure, and thus a company only has to invest in developing a single platform, that can be localized across the enterprise regardless of the location.

Value methods for use in this area has traditionally been: Difficult to quantify:

“Although the main benefits of VDI are with the employee as far as the flexibility to work from home, businesses experience some common soft benefits, such as employee retention and simplification of user desktop support. This is in addition to maintenance and operations cost savings, a result of not having to purchase and maintain employee's company-owned laptops or desktops.”

<sup>xvii</sup>[17-Virtual Desktop VDI and VMM development and adoption]

**Useful to capture and provide Business Agility:** Enterprises that utilize a virtual framework will find it easier to manage the ever increasing complexity of the business needs and process environment that the market, new emergent competitors or technology shocks when they occur to the demands of the IT function. The IT function needs to rapidly adapt to these shocks and desired changes in organization support by increasing profitability with a better ROI, and reducing the time for procurement, setup and delivery, and leading to the rapid deployment to full production capability of any system or process in a very short period of time.

Value methods for use in this area has traditionally been: Difficult to capture.

Currently, applications and processes are easier for organizations to conceptualize and manage when they are run using dedicated servers. This monolithic perspective results in low server utilization rates across the data center and enterprise environment, and thus virtualization will help maximize the capacity on each physical server and by extension increase the return on the investment for current and future server budgets, but it is difficult to determine how or if the time benefit should be included in the ROI/TCO calculation.

<sup>xviii</sup>[18 – Source that Talks about Business Agility of Virtualization and how it’s hard to capture]

**Useful to help measure the impact of Compliance and Business Continuity:** One of the recent advances that virtualization software suppliers have responded to the industry demand is to create a new way for processes to have a permanence but leverage exceedingly lower cost storage media by the use of encapsulation. When a virtual machine (VM desktop/server/process) terminates, it leaves a footprint per se, or the entire system runs as a single file, which can then be archived, transferred or accesses by a new VM which can be completely different from the original VM system environment due to the standardized API for a particular hyper-visor. This additional complexity is abstracted from the users, and adds a significant level of business continuity through high availability and disaster recovery for critical production systems that can be deployed, transferred and redeployed!

Value methods for use in this area has traditionally been: Binary benefit, fines vs compliance, operation or not. Too simplistic and non-quantifiable to measure or consider.

<sup>xix</sup>[19 – Source that talk about Virtualization and Compliance]

**Useful to capture cost savings role in Security:** Security compliance frameworks and regulations many times have been influenced by the prevailing infrastructures that are the “best practices” of organizations being measured and held accountable, such as COBIT, SOX, etc. Many of these compliance frameworks were considered a balance between the generalized functionality of limited access and preventing fraud, and the need for necessary protection and transparency of critical business information for the competitive advantage of a company in its chosen industry. The fact that systems were both physically and logically separated from each other through complex networking, software trust relationships or firewalls, now must learn to adapt to having all functions reside on the same logical layer environment, yet isolated logically from each other using very simple and provided virtualization parameters. Questions of access,

security, and a reduced exposure to risk from corruption, is a hidden benefit that's normally not included in the ROI/TCO.

Value methods and strategies used to capture ROI and business value:

**Still unproven and untested very vendor specific.**

- Use of security pods in logical groupings of virtual machines (VM) that require a similar level of regulatory compliance controls
- Consolidate all related VM files into one directory and use roles and privileges to control access using virtual arbitrators to partition access to only those that need it.
- Aggregate storage volumes into security zones
- Implement access level controls through Virtual Center, Virtual Machine, and Resource Groups.
- Group specific admin groups to enforce processes that reflect actual operational and regulatory compliance implementations
- Enforce established security relationships within and across security pods
- Security is Topology Sensitive
- Data breaches and hacker exploits – new malware development opens the door to creating thousands of virtual zombies, as security researchers found bugs in every piece of virtualization software, including products.
- Increased number of Security Blind Spots
- Lack of Configuration Control over offline VM's
- There no single point of failure.

<sup>xx</sup>[20 -“Putting Security First in the Newly Virtual World”, July 07, 2008, [www.lumension.com](http://www.lumension.com), Copyright 2008, Lumension Security Associates page 2]

### **Costs: The Subtrahend**

What “value” exactly means as it is translated into financial and business decisions and calculations varies the definition according to context. All of the following concepts are universally spoken of as having a “value” to most business functions in an organization and how technologies meet that need represents the “cost” that must be incorporated into the ROI/TCO calculation, but none of them are simple to determine however, there are attempts. Virtualization vendors have added the functionality to create a virtual environment on existing hardware, so the capital expense of hardware and software is relatively the same between methods, thus only the unique aspects of creating a virtual environment have been included below.

**Costly due to Incompatibility (Risk):** An example of incompatibility is when organizations based on Windows are used to handling the hyped and mixed promises of installing the leading vendor's solution from Microsoft. However, by subjugating the NOS to a supporting role, a product like VMware ESX Server, (primarily using a Linux subsystem and interface), would appear to provide little validation for external applications that are not partnered with it. Thus, enterprise server operability experts are dependent on a single solution provider once an organization converts to a standardized VDI from one of the vendors. The fact that organizations would not be completely sure of how their applications would operate in the virtual environment

would mean that they would have to recertify every application in their arsenal. SAP and other ERP software providers are currently in partnerships with the leading virtualization vendors.

Cost estimation methods for use in this area have traditionally been: Risk identification matrix(s)

“Risk identification, analysis and response planning. The primary manifestation of this is the risk register containing the identified risks, their probability and impact factors based on analysis, what trigger(s) indicate that the risk event could occur, who owns the risk, and what the response to the risk should be. It’s also important to plan for periodic reviews of the documented risks to identify any new risks or changes to previously identified risks.”

<sup>xxi</sup>[21-Article that describes the risk and impact associated with mismanaged risk process and incompatibility checks.]

**Costly due to Severe Lack of Training and Expertise:** Enterprises who have a long standing and large I.T. organization have taken years to get business leaders to support various protocols, frameworks and methods, with a significant investment in I.T. talent. However, early adopter of virtualization was used to dealing with users who had both the time and patience to teach themselves the software and products. The training industry offered little if any training courses or books on the subject. Thus, organizations were remiss to be able to hire, or recruit talent that can successfully install and manage a virtual environment, and thus were slow to adopt and implement a technology they couldn’t support.

Cost estimation methods for use in this area have traditionally been: Variable and related to the consulting fees, overtime, and HR related issues.

**Costly to get Technical Support:** The idea of trying to solve a problem with an application running inside a hypervisor layer is daunting both conceptually and practically. Current trends to develop the tools to operate in the logical layer are now quite significant. For many existing enterprise IT managers, a new class of errors that can be sourced from not only the hardware and software layers, but now can be a combination of four layers, the OS and Software inside the virtualization software running on the physical layer. Thus, support specialists will attempt to recreate a particular problem in a real server environment to ensure that virtualization isn’t the root cause, however, as organizations begin to scale operations to take advantage of the new flexibility, it will be practically impossible to replicate the density of a virtual solution.

Cost estimation methods for use in this area have traditionally been: Commercial software offers technical support, installation assistance or consultation, or per project fees related to any unforeseen issues that occur. Direct expense and normally related on a statistical estimation proportional to the degree of criticality of the application or service to the day-to-day function of the enterprise.

<sup>xxii</sup>[22 – Source that talks about how technical support is leveraged against companies and many times support costs can escalate once lock in happens with a vendor, and supplier power is multiplied once contracts need to be renegotiated. Represents true risk, similar to debate and issue with open Source and how the market responds]

### **The Difference: It's the real question...**

When looking at what will be required to answer the questions that have been previously raised, it becomes apparent that a background in the following areas would be considerable in the development of an articulated expression and understanding of the fundamentals of this paper.

The following courses could be useful:

Technology Diffusion and Adoption

Corporate Financial Management

Financial Accounting

Business Systems Platforms

Information Systems Planning

Information Technology Certifications (MSCE, Unix/Linux Certs for any specific distribution, CISSP, Subscription or Certification from one of the major vendors such as VMware)

Project Management Institute Certification (PMI, PMP)

### **Engineering and Software Engineering course work:**

Software Engineering:

Software Project Management

Systems Development

System Optimization

Operating Systems

### **Industrial Engineering:**

Stochastic Optimization Techniques for Estimation

Operations Management

Systems Engineering

Production Engineering

Manufacturing Systems Engineering

Unfortunately, the primary sources of information available are specifically tied to vendor related companies and services. Therefore, they are de facto standard for explaining and framing the uses and innovations for the technology. However, now that virtualization has started to reach critical mass, and there are competing open-source versions of the hyper-visor in direct competition, more information from objective sources are occurring on a daily basis.

## Annotated References:

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<sup>i</sup> Elliot, Stephen, *Virtualization: The BIG Picture*, IDC's Enterprise Systems Management Software Service and Industry Insights' IT Management Service, November (?) 2008  
[http://www.bmc.com/USA/Promotions/attachments/01-Elliot\\_v2.6.pdf](http://www.bmc.com/USA/Promotions/attachments/01-Elliot_v2.6.pdf)

The best summary for the Virtualization landscape, discussing the various challenges that organizations, 4 of the core features of virtualization currently being considered the entry point into the mainstream, and is probably going to be one of the most revolutionary technologies to impact the enterprise infrastructure since networking and relational database. Much like the relational database, it's true power doesn't happen until adoption, capacity, and widespread supporting tools realized the conception promise, only then did it move from academic concept to business mainstay. Virtualization is experiencing that now. However there are costs and limitations that are still falling short. The first draft of my paper started out surprisingly the same way as this white paper, (released in November)

<sup>ii</sup> *Ovum Summit: Virtualization delivers IT and business benefits for SMB*. John Madden, 07 July 2008, Commissioned by VMware, 11 May 2008.  
[http://www.vmware.com/files/pdf/virtualization\\_delivers\\_IT\\_business\\_benefits\\_SMBs.pdf](http://www.vmware.com/files/pdf/virtualization_delivers_IT_business_benefits_SMBs.pdf)

Discusses several of the causes of why virtualization has finally been able to go mainstream, and as the democratizing of the technology continues, the costs for implementing have gone down, but so has the profit margins available to corporate development firms who depend on support dollars to keep developing software and new business. However interesting to note that the demand and long tail aspects of the SMB market with respect to hidden long term profit potential, and also highlighted the critical dependency of the virtual infrastructure is to the management tools market available. The core dynamic for software companies has just changed oceans.

<sup>iii</sup> United States Government Accountability Office, Applied Research and Methods. *COST ASSESSMENT GUIDE: Best Practices for Estimating and Managing Program Costs*. GAO-07-1134SP Cost Assessment Guide, August 13, 2007 - July 14, 2008,  
<http://www.gao.gov/new.items/d071134sp.pdf>

A fundamental, groundbreaking, and exhaustive study and guideline for any contractor doing work for the U.S. Government in providing cost estimation standards for TCO that is used for RFP's for any government body. Clearly the impact of this guide cannot be overemphasized, since many companies that still consider government sponsored projects a core part of their business, it get's relatively little press given the quality and scope of its contents.

“Cost estimation is the summation of individual cost elements, using established methods and valid data to estimate the future costs of a program, based on what is known today. The management of a cost estimate involves continually updating the estimate with actual data as they become available, revising the estimate to reflect changes, and analyzing differences

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between estimated and actual costs—for example, using data from a reliable earned value management (EVM) system.”

Highlighted content included: risk of cost overruns, missed deadlines, performance shortfalls, cost increases, intended or deliver objectives, methodology outline as a compilation of best practices throughout the life of a government program.

Key idea: “the guide will also serve as a guiding principle for our auditors to evaluate the economy, efficiency, and effectiveness of government programs” Read: This is the standard.

<sup>iv</sup> Ingemi, Joseph, *Aligning IT with Business Objectives – Maintaining the Connection*, Price Systems Symposium, July 2008,

[http://www.pricystems.com/resources/white\\_papers/Aligning%20IT%20with%20Business%20Objectives%20-%20Maintaining%20the%20Connection%20-Thought%20Leadership%2004-08.pdf](http://www.pricystems.com/resources/white_papers/Aligning%20IT%20with%20Business%20Objectives%20-%20Maintaining%20the%20Connection%20-Thought%20Leadership%2004-08.pdf)

The benefits and obstacles always exist in aligning business goals with IT objectives. The primary reason is that many organizations view IT as a cost center rather than an investment or a tool for competitive advantage that can create value. Companies emphasize project management and implementation rather than project planning; the Project Management Book of Knowledge plays a role in this priority, or other more balanced frameworks like ITIL are good starts. Lastly, many business cases analyses lack any robust cost-benefit analysis, for which the whitepaper suggests four solutions:

- 1) emphasis on business case development;
- 2) establishment of a robust project budget;
- 3) use of cost analysis in change control management;
- 4) implementation of a post-project audit process to give feedback to the project that takes objective and subjective measures of the project success and failure.

<sup>v</sup> Minkiewicz, Arlene, *The Costs and Business Impact of SOA – Is it Right for You?*, Price Systems Symposium, July 2008,

[http://www.pricystems.com/resources/white\\_papers/Costs\\_Business\\_Impacts\\_SOA102007.pdf](http://www.pricystems.com/resources/white_papers/Costs_Business_Impacts_SOA102007.pdf)

Based on the observation of Metcalfe’s Law concerning the value of a telecommunications network is proportional to the square of the number of users of the system, the promise of the Service oriented Architectures (SOAs) would capitalize on the observational law. Envisioned SOA architecture’s promise is the advantage of networking capabilities that will integrate applications independent of architecture, programming language, development platform and more importantly vendor. The conceptual development of standard interfaces, services (or software based capabilities) is made available to any consumer willing to follow the rules for interface and consumption within the SOA. Gartner pundits estimate SOA will be used in more than eighty percent of mission critical operational applications and business processes by the year 2010, and service oriented implementations result in cost saving, but that without them many currently envisioned capabilities in the corporate world will be impossible to deploy, maintain, and evolve as requirements and priorities shift. Much of this work is not technical in nature, and the bigger questions come about how do business practices change to accommodate this world new flexible world.

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<sup>vi</sup> Adams, Keith and Ageson, Ole, “*A Comparison of Software and Hardware Techniques for x86 Virtualization*”, ASPLOS’06, 25 Oct 2006, ACM 1-59593-451-0/06/0010 <  
[http://www.vmware.com/pdf/asplos235\\_adams.pdf](http://www.vmware.com/pdf/asplos235_adams.pdf)>

Technical brief concerning the two principal sides of the virtual transaction/translation, and how these are resolved and executed at the kernel level. Deeply technical, yet a great read since it outlines many of the limitations from a system perspective that have been overcome to provide today explosive realization of commercially and diffusing Hyper-Visor creation. Particular interest was development of the hardware virtualization, and the emerging hardware support that is now coming into mainstream at a highly accelerated rate, and the identification of many performance trade-offs.

<sup>vii</sup> Green, Diane, “*Virtualization: Transforming the IT Landscape*” VMware Website, Jun 2008, [http://www.vmware.com/pdf/wp\\_transformingtheitlandscape.pdf](http://www.vmware.com/pdf/wp_transformingtheitlandscape.pdf)

An overview of VMwares Infrastructure 3 product specifically how the product offers many of the same functionality of that is the normal domain of “cloud” ISV’s, but in a single product that companies can run locally. More of a qualitative overview of the various impacts and functions of the software. Noticed the comparison of services between it and cloud vendors.

<sup>viii</sup> Jan Stafford, Site Editor, “*Server Virtualization: Figuring out costs, ROI and chargeback*” *SearchServerVirtualization.com on the Web* 02 May 2007.  
[http://searchservervirtualization.techtarget.com/news/article/0,289142,sid94\\_gci1253537,00.html](http://searchservervirtualization.techtarget.com/news/article/0,289142,sid94_gci1253537,00.html)

An example framework and methodology for calculating ROI and chargeback to demonstrate how the expense of virtual solutions can change cost centers into potential cost recovery centers using the chargeback mechanism.

<sup>ix</sup> VMware, for IBM, “*The Roadmap to Virtual Infrastructure: Practical Implementation Strategies*”, PC Magazine, 17 August 2008, <http://whitepapers.pcmag.com/whitepaper2097/>

A salient look (yet skewed for VMware’s role of course as a vendor whitepaper), that demonstrated some of the best practices and implementation strategies to roll out of virtualization technology. These guidelines are based on experiences and best practices accumulated by VMware’s leading customers and partners. Covers areas such as organizational charter, stakeholder buy-in strategies, and IT infrastructure and operations most impacted by virtualization. Does offer some actionable next steps and templates for how to build an effective virtualization support team to adopt virtualization, but many of those practices and templates have been criticized as being a bit too idealized, which also makes sense being a vendor sourced document.

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<sup>x</sup> Rodney Gedda, IDG News Service, " **Virtualization Battle Heats Up As MS, VMware Trade Blows.**" CIO Website 19 November 2008, <http://www.cio.com/article/print/464519>

Discussion of the relevant conflicts in the marketplace as major software vendors are offering competing products, and because the virtualized infrastructures have released users from the monolithic constraints that these companies have traditionally leveraged against firms, but are not having to compete openly, because it's truly all or nothing for large scale adoption.

<sup>xi</sup> Dana Blankenhorn & Paula Rooney, "**Torvalds criticizes patent trollers, Microsoft, Sun, virtualization craze**", Open Source Blogs, February 4, 2008, <http://blogs.zdnet.com/open-source/?p=1968> Referencing: <http://linux-foundation.org/weblogs/openvoices/linus-torvalds-part-ii/>

Interview with the Linux creator luminary, about his perspective towards the current market and what Virtualization will and will not truly be to the market.

<sup>xii</sup> Sun Gives Away Virtualization, September 10, 2008, 12:00 am, **Christopher Lawton** <http://blogs.wsj.com/biztech/2008/09/10/sun-gives-away-virtualization/>

Sun's attempt to leverage its virtual friendly hardware and overcome the previous marketing mistake and lack of complete follow through with the Java development, who's concept was an extension of the current virtualization movement. Java Virtual Machines were a bridging technology that was way ahead of its time, and required significant support.

<sup>xiii</sup> Comptroller General of the United States, *Theory and Practice of Cost Estimating for Major Acquisitions*, p. 32.)  
United States Comptroller General of the United States, *Theory and Practice of Cost Estimating for Major Acquisitions* . B-163058 July 24, 1972,  
< <http://www.gao.gov/products/094047>>

The first attempt by the government to provide guidance on capital budget operations, that estimations that are used for making decisions related. Showed that the problems then are the same problems now. Interesting read to be honest from an anthropological view of the nature of project estimation here for the DOD in 1972!.

<sup>xiv</sup> Comptroller General of the United States, *Theory and Practice of Cost Estimating for Major Acquisitions*, p. 32.)  
Same as previous.

<sup>xv</sup> Daigle, Patrick, and Arrasjid, John, "Surviving Regulatory Compliance in the Virtual Infrastructure", Virtual World Conference 2006, < <http://download3.vmware.com/vmworld/2006/adc9521.pdf>>

Another vendor specific article that details how virtualization and compliance can be a strong component and easier to manage, however, it does point out some serious limitations principally: How virtual "security pods" can form logical groupings of virtual machines (VM) and since the environment can be standardized, it is only possible to truly provide regulatory compliance controls through consolidation and related VM files into one directory and use roles and privileges to control access using the VMware specific "VI3 Segregated network switch". This virtual switch configurations allows the segregate storage volumes into security zones which aid compliance. Other examples of how virtualization can meet the compliance regulations,

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however, only showing the clear dependence of virtualization implementation on having the management tools be sophisticated and certified.

<sup>xvi</sup> Hill, John and Kochishan, Stefan, *Mainframe Tape Technology: Eight Myths, Realities and Best Practices*. Technology Brief: Best Practices for Mainframe Tape Technology, CA Associates Inc. 30 Oct 2008 < [http://www.bitpipe.com/detail/RES/1225387470\\_22.html](http://www.bitpipe.com/detail/RES/1225387470_22.html)>

Strategies on how traditional and virtual DR solutions interface and replicate functionality.

<sup>xvii</sup> Alex Barrett, News Director, “*ClearCube spin-off goes for piece of Hyper-V's VDI pie*” *SearchServerVirtualization.com on the Web* 07 July 2008.  
[http://searchservirtualization.techtarget.com/news/article/0,289142,sid94\\_gci1320320,00.html](http://searchservirtualization.techtarget.com/news/article/0,289142,sid94_gci1320320,00.html)

A new entrant application framework for deploying, managing, and maintaining the Virtual Desktop Infrastructure to reduce costs and drive adoption.

<sup>xviii</sup> Business Impact from Server Consolidation using VMware Infrastructure, October 2008, VMware Marketing and Technical Sales Materials,  
([http://download3.vmware.com/elq/pdf/Preso\\_Business\\_Impact.pdf](http://download3.vmware.com/elq/pdf/Preso_Business_Impact.pdf))

Straightforward analysis of the advantages and suggested ways to capture the best possible ROI and TCO for achieving Server Consolidation, but also how the new infrastructure will enable other business functions to experience knock-on effects.

<sup>xix</sup> United States Government Accountability Office, Applied Research and Methods. *COST ASSESSMENT GUIDE: Best Practices for Estimating and Managing Program Costs*. GAO-07-1134SP Cost Assessment Guide, August 13, 2007 - July 14, 2008,  
<http://www.gao.gov/new.items/d071134sp.pdf>

Same as Above

<sup>xx</sup> -“Putting Security First in the Newly Virtual World”, July 07, 2008, [www.lumension.com](http://www.lumension.com), Copyright 2008, Lumension Security Associates page 2

A rather objective view of the role and nature of security that virtualization can provide and exposes the enterprise both large and small to. Suggests some common sense best practices and also gives several examples how recent attacks to virtual environments are even MORE dangerous, because the monolithic architecture allows a certain amount of stop-gap control should a single machine get compromised. Since functions are aggregated across the physical layer resource pool, new types of malware and viruses are being designed to take advantage of some of the demonstrated bugs in almost every piece of virtualization software in the market today.

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<sup>xxi</sup> PMP'n Virtualization – Part Two: Planning: Virtualization, Kevin Lees, Wednesday, January 23 2008 <http://www.virtual-strategy.com/features/pmp-n-virtualization-part-two-planning.html>

Another study of how Virtualization and how project managers need to be the first to understand the begin the adoption process but that they need to use better estimates.

<sup>xxii</sup> Minkiewicz, Arlene, *The REAL costs of Developing COTS Software*, Price Systems, IEEEAC paper #1159, Version 3, 10 December 2003, ISBN: 0-7803-6599-2 <  
<http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=00931307>>

Commercial Off the Shelf Software are not always the best solution. Provides several arguments for and against COTS, and some of the unexpected costs that occur due to supplier power, and also some of the advantages that have to be compared with the price of the software vendor's sometimes divergent incentives to provide maximum flexibility but only with other COTS projects. Further a brief mention of the role of COTS with respect to the open source movement and profitability