WHITE PAPER

The Roadmap to Virtual Infrastructure: Practical Implementation Strategies

version 1.0

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"Thank You" to the following people for their contribution to this document

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The Roadmap to Virtual Infrastructure: Practical Implementation Strategies

Introduction

Virtualization provides opportunities to reduce complexity, improve service levels to the business and lower capital and operating costs to provide and maintain IT infrastructure.

Over the past five years many organizations have specifically deployed VMware infrastructure software on industry standard systems to significantly reduce their hardware, data center, and operational costs--many report 70-80% cost savings, and 3-6 month ROI periods--while achieving unexpected gains in operational flexibility, efficiency, and agility. To date over one million server workloads have been virtualized on this infrastructure. 90% of our customers are now rolling out this infrastructure for production usage, and over 25% of them standardized on a VMware environment for industry standard workloads. Today, our most successful customers run thousands of production application instances using VMware infrastructure and have found it to be a catalyst for implementing a true service-oriented IT model. Figure 1 below shows the extent to which some common business workloads are run on this infrastructure based on a customer survey we performed at the end of 2005. A more detailed profile is also presented in Appendix A.

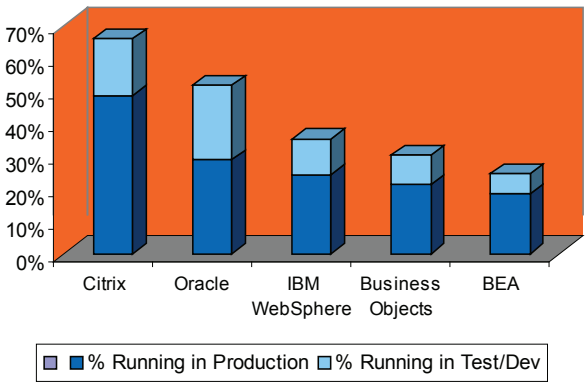

Figure 1. Common workloads running on VMware infrastructure.

Based on the experiences of our customers, implementing virtual infrastructure is completely doable and manageable. However, because virtualization is still a relatively new technology that can touch a broad set of IT stakeholders and processes, cultural resistance can stall or limit many deployments, particularly in larger enterprise organizations. Thus we recommend that IT managers proactively obtain a big picture understanding of the organizational charter, technical skills and processes that can maximize and accelerate the benefits of virtual infrastructure.

Purpose of this paper and target audience

The target audience for this paper is senior IT managers. The recommendations outlined here provide IT management with the most salient best practices and implementation strategies to get started and to accelerate a successful roll out of virtualization technology. These guidelines are based on experiences and best practices accumulated by many of our leading customers and partners.

We cover organizational charter, stakeholder buy-in strategies to ease the common non-technical resistance that can affect virtualization rollouts. We also highlight key areas of IT infrastructure and operations most impacted by virtualization. We include some actionable next steps and templates for how to build an effective virtualization support team, assess readiness of your organization to adopt virtualization, and scope initial projects to help ensure success and develop your organization's capabilities for broader virtualization deployment.

This paper is intended as a starter guide and complements a broader set of literature that provides additional information required for virtual infrastructure technical design, project planning, scoping, and implementation. In addition, your organization may benefit from the shared experiences and knowledge of other VMware users. There is a vast ecosystem of VMware partners offering various assessments, as well as design and implementation services to help you get started. For more information visit: http://www.vmware.com/partners/vac/vac_locator.html

To provide feedback and to receive updates to this paper

Given the evolving state of the technology and best practices, VMware plans to release periodic updates to this white paper, and expand a structured bibliography of supporting, follow-on documents. Please send an e-mail to virtualize@vmware.com if you wish to receive these updates. Also, if you have significant virtualization deployment experience of your own and would like to contribute your suggestions or best practices for deploying virtualization across an enterprise, VMware would like to hear from you.

Understanding Key Success Factors

To achieve the benefits of virtualization beyond a tactical and isolated project-oriented deployment, it's important to understand the key success factors and strategies that organizations should follow. Many of these address cultural and organizational challenges that may stall or slow down deployments. Other factors pertain to organizational and deployment strategies that IT managers have used to overcome the challenges to wide-scale adoption of virtualization.

Top-down sponsorship ensures success of virtualization implementation

As with any strategic IT initiative, top level management that fully endorses and champions any virtualization efforts in the enterprise ensures the appropriate levels of funding, staffing, and cooperation from all groups within the enterprise. This is particularly important for a technology such as virtualization, since it is horizontal and requires buy-in from multiple groups.

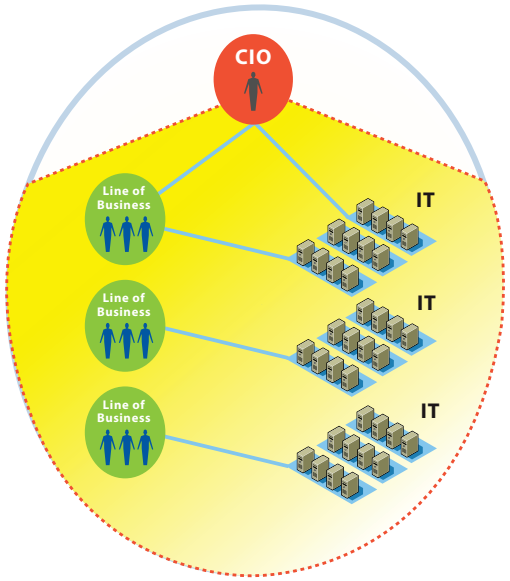

Figure 2. Senior executive sponsorship is needed to overcome organizational inertia for dedicated infrastructure

Treat virtualization as an architectural decision throughout the organization

Optimizing your systems infrastructure by implementing virtualization requires a vision of the long term architecture, even though in practice deployment may occur incrementally. Your teams should treat the deployment of virtualization as not only a project but also an architectural decision that leads to a corporate IT standard and a new model for delivering infrastructure resources.

Virtualization is an architectural decision because it is a new optimization layer in the traditional hardware/software stack that can be applied strategically to enable, accelerate and save costs for multiple projects and business initiatives. This standardization achieves the maximum ROI for your organization. Treating it as another application project or as an operating system upgrade can lead to misapplication of existing tools and skills and insufficient staff training and IT process evolution to fully realize the benefits.

This architectural mindset will also help prioritize virtualization implementation holistically. For instance, VMware has found customers prioritizing the virtualization "project" below a dozen other application implementations which are stalled for lack of datacenter space—a problem that a well scoped virtualization "project" would have solved if virtualization were "piggy backed" with these other projects.

Design for the big picture, but deploy incrementally – target initial ROI within six months

Realizing the transformative potential of a virtual infrastructure, some organizations attempt to establish virtual infrastructure designs and standards across multiple business units or lines of business, or overanalyze financial and ROI models before gaining hands-on learning or organizational buy-in through a meaningful deployment experience. .

Rather, organizations can benefit more by deploying projects in smaller steps and apply the learning and confidence generated from a first phase deployment. A bounded server consolidation or migration initiative is a great catalyst to adopt virtualization and deliver immediate returns on investment (ROI). Many VMware customers have started with the consolidation of a tier of less critical applications at the start, and used this success to evolve into a standardized implementation with more mature management processes.

Achieve stakeholder buy-in early & maintain through all phases

Virtualization requires a cultural shift so application owner buy-in is important

The cultural changes that are required to roll out new technology will be one of your biggest challenges but you can easily overcome this resistance by selling stakeholders on added benefits, higher levels of service, and a new service delivery model that improves the time to provision computing power from months to minutes. Getting support from stakeholders often requires a pilot project or test deployment to demonstrate these new benefits.

Form a virtualization core team to be the agents of change, ensuring early success

Consistent with treating virtualization as a new architecture, it's important to create a high caliber team of technically credible and socially influential people from key parts of the organization as your reconnaissance team. This internal team is chartered early on to design, operate, and drive internal change to make your virtual infrastructure deployments successful. Initiating a virtual infrastructure core team or "SWAT" team formed from the IT infrastructure ranks has been the hallmark of all successful, broad scale deployments that VMware has observed. It is not uncommon for a three or four person core team to design and manage the operation of hundreds of physical host servers and thousands of virtual machine environments.

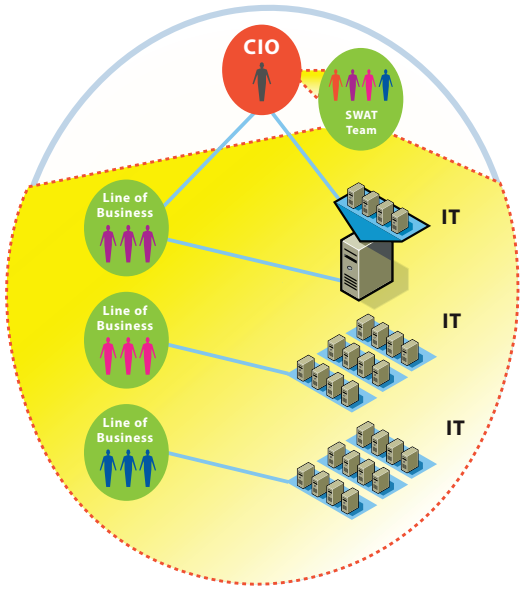

Figure 3. An empowered "SWAT" team is key to drive step-wise buy-in and deployment

Make sure the team is trained on virtualization technology and have them educate and sell the benefits of virtualization internally. Ask your core team to document their learning, share this knowledge within the company as a CIO-sponsored strategic initiative. Remember to have the team align the benefits of virtualization to business needs. Don't sell technology for technology's sake. Continue the internal education and document success with each subsequent virtualization implementation beyond the initial project, and remember to tie back to the ROI realized as an internal way to reference sell.

Ensure high quality design and remediation to avoid early shutdown

Line of business owners and business application owners may express concern regarding the impact that virtualization will have on their applications. For example, some common concerns voiced by application owners anchor around degraded service levels, competition among business units and divisions for IT resources and the uncertainty and doubt related to loss of autonomy and control of dedicated hardware resources.

Your solution to fear, uncertainty and doubt is to choose your core team carefully, establish robust best practices in technical design to minimize issues, and establish proficient ways to track and remediate issues that may arise.

Educate the IT infrastructure groups that will need to interact with this virtual infrastructure—the network and storage operations teams for example. Later in this document there is a discussion of the key changes to IT infrastructure.

Refine virtualization processes

Transition core team to an operational center of excellence

Once internal education on the benefits of optimizing system infrastructure through virtualization ramps up, multiple parts of your enterprise will start to request virtualization for their projects. To prepare for this demand, refine the processes established in the initial project and transition your core team skills to more standardized and measurable processes. Many companies call this phase of virtual infrastructure learning a "center of excellence" (CoE) which has its own business and service delivery interface, technical design, and operational competence. You can form this team by transitioning and expanding your core team to include representatives from other functions such as engineering, support, procurement, storage, finance, capacity management, data management, server maintenance, support, security, patch management, change management, network operations, network design, and data center and operations staff throughout the organization. Review the CoE to make certain all parts of your company are represented in all major geographies where there is IT, procurement and operations staff.

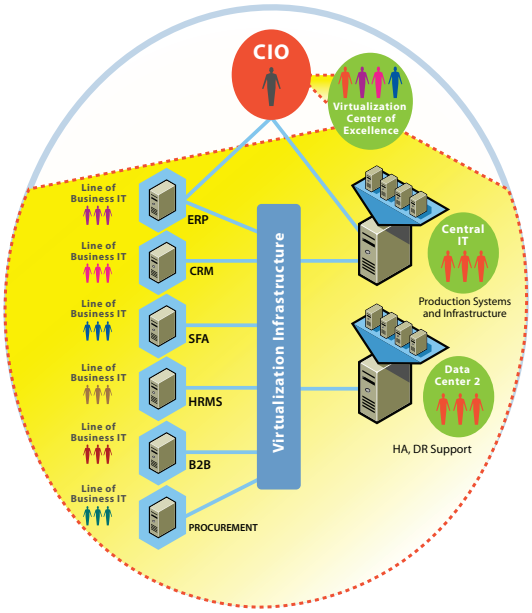

Figure 4. The center of excellence evolves the virtual infrastructure and drives changes to inter-related functions

VMware has a created a model for a typical virtual CoE team that describes the roles, skill sets, and background desired for such a team. Most organizations customize or map these prototype recommendations into skills and roles that are appropriate to their own organization.

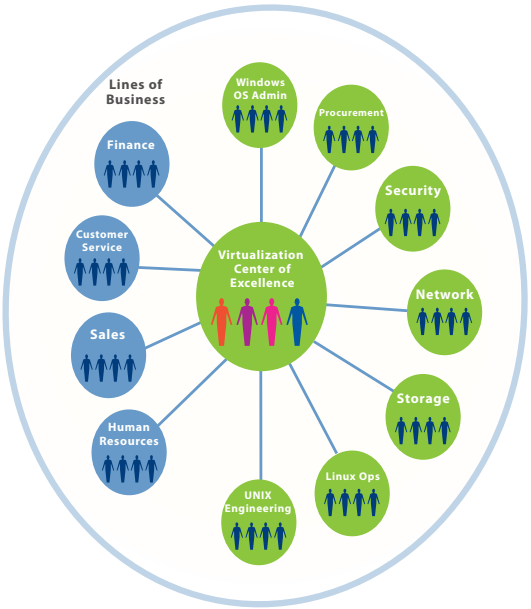

Figure 5. Upfront planning accelerates a mature implementation that delivers shared IT services across multiple business stakeholders

Start with a proper infrastructure assessment and design

Before beginning a deployment, it is important to assess the "as is" organizational and technical readiness through a current state assessment. Some of the work for this assessment may have been done as part of the due diligence for the business case for virtualization. This assessment period typically takes a few weeks to a month, and can happen in parallel with other planning activities. The key questions to address during the assessment include: What is the detailed inventory of the existing infrastructure? What are current utilization rates? And what is the blueprint for moving to a virtual infrastructure where workloads are distributed efficiently to maximize capacity utilization?

Create a detailed inventory of the existing infrastructure and its utilization rates and then derive a blueprint to move to a virtual infrastructure with your pilot and subsequent projects where workloads are distributed efficiently to maximize capacity utilization. To accomplish this systematically:

- Assess: understand your current workload capacity and utilization. Discover and inventory existing infrastructure assets per project including applications, services, CPUs, drives, NICs, RAM, etc., and then measure performance, utilization statistics and trends.
- Plan: analyze workload capacity and available options to virtualize. Understand what resources are being used most by each system, e.g. some systems may be I/O, CPU or memory intensive. The objective is to understand which virtual workloads can be combined on physical systems without causing resource constraints.
- Act: Once your workloads have been profiled and your success criteria defined, create an acceptance test for your users so they have comfort that service levels of physical infrastructure will be met or exceeded. Model various implementation scenarios against your current assets. For example, model utilization and performance of your virtualized workloads on a specific target set of hardware and system configurations in order to derive the optimal virtualized infrastructure for the target workload.

The end result is a virtualization assessment and implementation plan that is specific to your organization's infrastructure environment and needs. This upfront capacity planning allows organizations to migrate to a virtualized environment in a controlled and predictable way.

VMware can help customers to undertake this effort by providing a combination of professional services and the VMware Capacity Planner tool. The resulting infrastructure assessment then becomes the basis for the implementation plan to move from physical to virtual infrastructure.

Considerations for Getting Started

Align with a Key Business Driver to Choose a Starting Point

Historically, companies have followed different paths and entry points based on the most appropriate business drivers for virtualization capabilities they wished to exploit. The following major business or IT cost-optimization initiatives can be mapped to the benefits of a broad-scale virtual infrastructure:

- Major data center infrastructure consolidation, migration or change events
- Branch office consolidation
- Cost-avoidance of data center facilities (space, power, cooling, etc)
- Improved business continuity and application protection, in-sourcing of disaster recovery
- Meeting end-user environment security, compliance goals, particularly as part of major desktop refresh
- Accelerating end-user enablement for outsourcing and off-shoring initiatives
- Accelerating large-scale application development, upgrades and implementation projects

Historically the three most common drivers and first project uses of VMware are as follows:

- Accelerated development and test environment due to ease of implementation and minimal risk to the enterprise environment
- Server consolidation targets the migration and re-hosting of existing, underutilized infrastructure in the data center, driven by the need to reduce cost, space and other environment and capacity constraints
- Server containment is a more rapid implementation strategy used to virtualize most or all new applications in a properly sized virtual infrastructure, independent of whether existing underutilized assets have been virtualized or consolidated.

Recently, however, companies are finding additional new drivers for first phase deployments.

- Business continuity/disaster recovery expansion. The cost-reduced and simplified disaster recovery methods available in a virtual environment can enable expansion of disaster recovery to new applications, or in sourcing of a DR plan. As a data point, 63% of VMware customers have used VMware to enhance disaster recovery capabilities.
- Virtual desktop infrastructure allows centralized consolidation, backup and business continuity options for end-user environments hosted in a secure data center, maps particularly well to the need to centrally secure, manage and rapidly provision remote or 3rd party knowledge workers.

Typical Deployment Phasing

While the goal of virtualization is to improve operations and reduce cost, the best practice in deploying virtualization is to take a phased implementation approach where you focus on the following areas:

- Early ROI: Choose first phase candidate workloads that are low risk, high visibility and generate early ROI.
- Low Risk: Scope initial projects appropriately to mitigate any inherent risks in deployment.
- Critical Learning: Build confidence in organizational capabilities by communicating learning and success.

By using a phased approach initial benefits can be realized much more quickly by working initially with a business partner most suited to recognize the value of virtualization. Use the first phase to demonstrate the validity and benefits of virtualization to more skeptical business partners.

The diagram below shows a possible phased deployment focused on server containment and consolidation. It uses an upfront design and assessment and a quick Phase 1 deployment that is designed to rapidly scale, but defers more sophisticated and optimized capabilities to a second phase deployment.

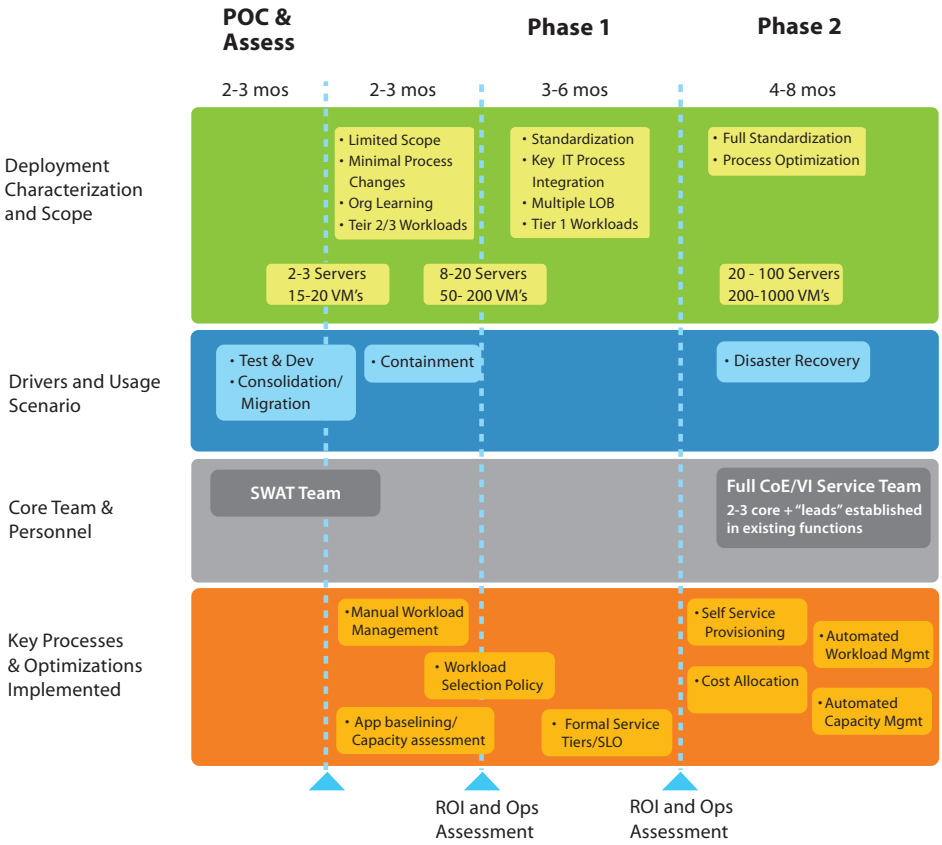

Figure 6. Typical deployment phasing

Establish a Phased Workload Selection Plan

A judicious workload selection and phasing can help your organization achieve a more successful long-term rollout, and avoid many pitfalls or end-user resistance early in the process. For instance, virtualizing high visibility or high-resource utilization applications at the beginning of a deployment, without user acceptance testing, without adequate IT training on the new infrastructure and without validated remediation options is the easiest way to alienate business partners.

Technically speaking, the great majority of your applications targeted for industry-standard platforms will be virtualizable with adequate performance and scalability, particularly in light of the most recent advances in virtualization technology from VMware. Over the years many of our customers have developed "rules of thumb" for selecting and sizing workloads for virtualization. Today automated assessments and technical collateral is available from VMware or partners to achieve "technically correct" recommendations for which workloads should be virtualized given a particular infrastructure design. Furthermore, instituting an application baselining and staging process can provide the final acceptance testing needed before an application is deployed into a production virtual infrastructure.

However, the business goals of a virtualization project as well overall organization maturity and comfort with the implementation may be the larger influencer for what you virtualize initially. For example in a Phase 1 deployment, an organization may not wish to consider virtualizing an application instance that is moderately resource intensive, and does not have a clear software vendor support policy for running on VMware infrastructure (Appendix C of this document addresses the vendor support obstacles in more detail). As both IT and business owner confidence builds in the robustness and transparency of the new infrastructure and after a virtual to physical remediation and risk process has been validated, the same application may now be a candidate for virtualization three or six months down the line.

In practice, most organizations that have standardized on VMware infrastructure select virtualization for more than 80% of their industry standard based applications while using moderate or conservative policies for candidate selection. You should plan on getting to this state through potentially two phases of implementation, business goals and risk management policies.

Prepare to Socialize Benefits to Business Owners

To help sell virtualization and create champions, your core team should plan on repeated education of the benefits of a virtual infrastructure in a language that is relevant to the application owner. We recommend focusing on the following typical areas of significant benefits from implementing virtualization:

Faster Provisioning of Applications and Project Budget Control:

- Significantly reduce business unit costs on hardware acquisition (since you may already have extra unused capacity residing on your existing servers that will benefit from consolidation).
- During peak times of the month or year, provision additional servers within minutes to help handle peak loads.
- Provide application isolation.
- Keep projects under budget by reducing costs using shared hardware, memory, HBAs, backup agents, etc.

Higher Availability and Dynamic Resource Management:

- In case of hardware failure, IT will be able to bring up virtual machines in a matter of minutes versus hours or days.
- If an application needs additional resources for an abnormally high usage peak, VMware Infrastructure can dynamically allocate more resources.
- Guarantee virtual machine SLAs to end users for CPU, memory, bandwidth and HBA bandwidth.
- Treat mission critical applications with more importance by giving them resources unused by other systems.

Accelerate Application Projects with Increased Development Lifecycle Productivity

- Save application "snapshots" from production environments to use in test and development.
- Test production servers with new patches in a Test and Development environment and then move the patched servers seamlessly into a production environment.
- Eliminate planned downtime for applications due to hardware upgrades or refresh.
- Eliminate the need to certify new hardware with your application; virtual machines make application hardware agnostic.
- Migrate legacy NT applications that cannot be altered onto newer faster hardware without changing the OS or the applications.
- Ease handoffs between developers, testers, and operational staff.

Key Changes within the IT Infrastructure

Rolling out virtualization can introduce change within the IT infrastructure and the organization. IT management (e.g. VP of Infrastructure or Operations) should properly guide and sponsor the necessary education and changes in the following areas:

- Provisioning - IT processes around application, capacity and hardware provisioning is the most fundamental area that requires re-engineering to achieve a virtual infrastructure implementation that scales across multiple application teams.
- Virtualization specific IT Skills - Virtual infrastructure-specific knowledge and skill sets need to be developed during the design, planning and first phase deployment.
- Other IT Infrastructure and Processes – A range of IT processes and infrastructure designs are commonly affected by virtualization. In many cases, virtual infrastructure can introduce tremendous cost savings and service level improvements to existing IT practices. In most cases, a straightforward evolution of current technical standards and operational processes will achieve a smooth integration of virtual infrastructure into existing practices. These changes should be addressed through upfront education, cooperative planning between the SWAT/COE team and existing IT infrastructure stakeholders.

Application and Hardware Specification and Provisioning

In a purely physical environment, deployment of IT infrastructure is typically a "build to order" model, with new hardware ordered and dedicated specifically for an application request. Application groups drive much of the hardware selection with minimal or no sizing or capacity planning since "industry standard hardware is inexpensive." The application teams can wait up to wait two to three months for hardware to be procured.

In an environment where VMware has become the standard, new application deployment requests can be fulfilled almost instantaneously from a virtualized resource pool. Even with prior versions of VMware technology, many customers typically fulfill at least 80% of new application provisioning requests from this virtualized infrastructure.

To achieve this efficiency the virtual infrastructure team must take responsibility for building, managing and servicing virtual capacity by inserting itself into the application request and hardware deployment process. They must take on two distinct responsibilities:

First, the virtual infrastructure team must closely co-ordinate with the application developer/owner to identify the needs of a new application and to provision virtual machines that meet the configuration, compatibility and performance requirements. Typically this means that the team:

- Defines a request process for application teams to specify new capacity requests by application type and associated requirements
- Publishes current "fact-based" rules for placing a workload in to a virtual environment
- As required, implement an application staging and monitoring process to achieve user acceptance that the application will run well in a virtual environment. In mature implementations, this step is often by-passed for well characterized applications, and the team may set up a self-provisioning portal for application managers and system administrators, particularly for high change environments such as test and development labs.

Second, it is now the responsibility of the team to continuously manage the aggregate infrastructure capacity, independently of any single application request. This involves managing and forecasting demand, monitoring the IT hardware infrastructure utilization that backs the virtual resources, and procuring additional hardware capacity as needed.

Unifying Server Administration Teams Around Application Baselining and Service Level Objectives

The above introduction of new functional roles and interfaces can foster the integration and streamlining of various silos in the IT organization. Several organizational alignment opportunities can arise from implementing this virtual infrastructure model. First, the discipline of consistent application base-lining and qualification gives IT a new tool to engage with the business in terms of service tiers, service level objectives and chargebacks if such interfaces have not already been implemented. Second, because different OS and application teams must co-ordinate with and depend on common infrastructure processes, this model can also catalyze increased teamwork and unify what were once silo organizations (for instance the Windows and Linux engineering and operations teams).

Technical and Operational Skills

Rolling out virtual infrastructure provides an opportunity for you to develop new technical skills and design expertise specific to this infrastructure. The table below highlights areas where core teams focused on VMware infrastructure will need to develop deployment, training and operational plans.

Technology Area	Design and Operational Considerations
Distributed topology and high level design	• Configuration of physical clusters/farms and logical resource pools • Deployment topology, security of VC management servers • Standardized HW recommendations/designs for server infrastructure
SAN and Networking Integration	• Key design standards and constraints for key interfaces with other corporate resource teams
Workload and Guest Design and Management • Workload Selection Process • Application and Guest Access	• Standard OS-specific Guest configurations, agents, templates • Target VM density for different workloads/workload classes • Virtual Workload Selection/Admission Process • Administration/Access Roles and Rights to rest of IT and LOB users • Guest-specific backup, recovery, protection
VMware Infrastructure Configuration and Operations • Backup and Recovery • Resource Mgmt • Standardized Configurations	• Standardized builds and configurations for VMware ESX Server • Deployment, maintenance and recovery of the VMware infrastructure itself

Table 1. Technical IT and operations skill-sets

Detailed technical guidelines for achieving organization-specific designs and best practices for the above areas are available from VMware and many of our partners, as part of integrated assessment and design services. Standard product documentation, training and education classes, as well as an emerging library of technical best practices provide a baseline for this information.

Your organization will also find it useful to network with the vast array of customers that have or are implementing virtual infrastructure. To this end, VMware sponsors regional user group meetings, provides a range of community discussion forums at www.vmtn.net, and constantly explores ways to provide deeper and more effective deployment knowledge around this infrastructure.

Understanding Changes to the Rest of the IT Infrastructure

A virtualized infrastructure can introduce changes (many of them highly beneficial) to the IT infrastructure that can be readily addressed through proper education and co-operative planning within the various IT infrastructure practices. This table provides a bird's eye view of the nature of the changes, and some considerations for how and where to address the impact of changes

Area	Key Changes and Considerations	Recommendations
Datacenter Facilities	• Dramatic reduction and avoidance in aggregate power, cooling consumption, and space requirements - 70-80% reduction in many cases • Slight power and thermal density increases possible due to more highly utilized, dense memory systems - Density increases should be well within headroom associated with current datacenter designs, (unlike prior blade systems)	• Build hard operational savings into ROI, if needed. Most VMware and our partner ROI tools take this into account. • Utilize the output of the VI hardware design and system vendor calculators and specifications to ensure compliance with your datacenter specs
Industry Standard Server Hardware Design	• Full, larger memory, higher availability I/O configurations over prior x86 designs • 1-2 standardized design configurations for VI vs. application-specific dedicated hardware	• Operations/facilities teams should be educated and to verify the feasibility of these designs • Ensure procurement process/teams understand "standardized" VI design vs. application specific physical HW requests
Shared Storage	• Enterprise deployments will generally dictate a shared storage architecture - FC or IP SAN, NAS based on cost & environment • "Port consolidation" makes SAN attach of new workloads on VI a lot more cost-effective • Dedicated, standalone SAN or leverage of corporate SAN for VI • Requires SAN team to treat VI "cluster" as new type of host	• Implement refinements to existing standards & procedures specific to VI with storage eng/ops teams: - Mapping of VI storage requirements to SAN storage tiers - Batch pre-provisioning of LUN's to VI team vs. app- or server-specific requests - New SAN zoning & LUN configuration guidelines

cont'd

Area	Key Changes and Considerations	Recommendations
Network Infrastructure	• Simplification and cost savings from network port & cable consolidation • Larger # of higher speed ports to each server (vs. prior x86 designs) • Specialized needs for VMotion and management network segments	• Educate and establish appropriate refinements to standards & operating procedures with network engineering/operations teams: - New standard designs for VI configurations - Batch provisioning of IP's to VI team - Address need for DHCP assignment to servers for certain use models
System and Application Availability	• Overall increased availability from shared storage and higher availability HW design • Operational flexibility & greatly minimized downtime for planned maintenance (VMotion) • Larger risk domain in case of unplanned single system hardware failure	• Implement built-in (VMware HA) or 3rd party VI availability capabilities • Re-visit which applications are clustered during application candidate selection • Document "virtual system" availability service agreements as appropriate
Backup and System Recovery	• Standard backup and recovery tools and processes can be translated to virtual infrastructure with minimal disruption - Scheduling rules and capacity headroom for standard network backup agents need to be accommodated • VI enables more efficient strategies for applying a new set of "off-VM" techniques that can improve backup/recovery service levels different workloads	• Pull-in backup and recovery ops teams into design and deployment planning sessions • Follow VMware best practices for tiering and integrating new backup options • Consider org readiness to consider new data protection tooling for VI, and fold in new backup options (e.g. VMware VCB) using existing and/or VMware-specific data protection tools from 3rd parties
Disaster Recovery	• VI enables new cost structure and automation capabilities to dramatically simplify and expand DR coverage - Significantly better cost, SLO, RPO, RTO and capex compared to 1:1 physical designs, or outsourced service options • Up front design decisions (e.g. SAN capabilities, mixing production and dev/test workloads) can optimize the cost and efficiency of a subsequent DR/BC design • Certain orgs may be willing to use a "physical to virtual" DR strategy to implement expanded DR to workloads and applications that will not be initially virtualized	• Use improved or expanded BC/DR beyond the hard cost savings ROI to augment the rationale and organization buy-in for rolling out VI • Roll in high level BC/DR considerations (but not a complete design) into Phase 1 - Typically, most organizations roll out a compete design and implementation for a "V-to-V" BC/DR strategy as part of a Phase 2 deployment, as baseline operational skills around a single site VI is a pre-requisite • Evaluate "P2V DR" strategy if organizational resistance or priorities dictate such a path

cont'd

Area	Key Changes and Considerations	Recommendations
Cost Allocation/ Chargeback	• VI reduces infrastructure costing for server workloads compared to a physical server environment. Commonly in the range of: • 60% less for initial deployment • 10:1 or greater cost savings for hard on-going infrastructure costs • Offers a cost-justified way to introduce dramatically lower cost service tiers for infrastructure to business units	• If a chargeback model exists, create a new service tier that roughly represents the new cost structure (e.g. 20% of existing physical server cost). This will provide additional rationale for business owner buy-in to VI • If a chargeback model does not exist, use VI to introduce such a model as part of a Phase 2 deployment - E.g. 2-3 tiered service offerings for virtual/physical server & storage infrastructure • Focus on simple, cost-based allocations independent of usage. Defer sophisticated "metering" or usage based models well into or beyond Phase 2 deployments
Windows, Linux and Application Team Integration	• Many have found virtual infrastructure implementations to be a catalyst for increased teamwork, integration or outright unification of "OS and application stack" silos in the IT organization. • Windows and Linux teams should view their interface with the virtual infrastructure core team as the providers of their "hardware infrastructure" • Outside of initial application and OS sizing/base-lining/ provisioning, system administrator's day to day tasks and expertise should be minimally affected. • Areas of impact & training typically include: • Virtual infrastructure team should be consulted for incident resolution around application performance & service levels • Standard OS-centric monitoring and performance tools will need "re-interpretation" in a VI implementation	• Pull in Windows, Solaris and Linux and other OS engineering and ops teams as appropriate into design and deployment planning sessions • Modify only the minimum set of roles and tools to preserve the tools and skill sets of existing OS admin teams to interface with the VI team as a hardware/infrastructure team. i.e. OS admin roles and tooling should be preserved for: - Patch and OS management - OS & app-specific problem/incident management - Application deployment/changes • Access methods and security rules for virtual machine access by OS, system administrators and application teams need to be defined and implemented
Problem, Change and Incident Management	• The virtual infrastructure layer and COE team should be carefully considered to see if they need to be in the monitoring/change and remediation path for established IT operations teams and processes around: - Fault/availability events in HW or at the application level - Configuration changes to OS, network, storage infrastructure. - Application performance - Infrastructure (e.g. HW) service and changes	• Preserve as many of the problem/incident monitoring and resolution workflows, org responsibilities as possible • Ensure a responsive, technically educated SWAT team for virtual infrastructure problem remediation, particularly during the first phase of deployment to achieve business and client buy-in • Implement off-the-shelf problem and reporting modules that fit into your current monitoring, problem resolution tooling and are "VMware-aware"

Table 2. Impacts on IT infrastructure

Getting Started: Going Beyond the Initial Project

After completing an initial project to validate functionality is complete, there are some practical next steps to ensure a successful deployment. This paper focuses primarily on the "Build CoE" and "Assess" phases while touching briefly on the "Plan and Design", "Build", and "Manage" phases. (See Figure 7.)

Future versions of this paper will be expanded to provide additional details of the other phases.The duration of each phase can vary based on the scope of the project, expertise and resource availability within the organization, and organizational readiness. Virtualization capabilities can and should be developed in parallel with these activities as they help reinforce planning and design after the pilot project, launch a small pilot project of 10 to 20 applications using a conservative workload selection in parallel with building the Virtualization Center of Excellence and conducting the Assessment.

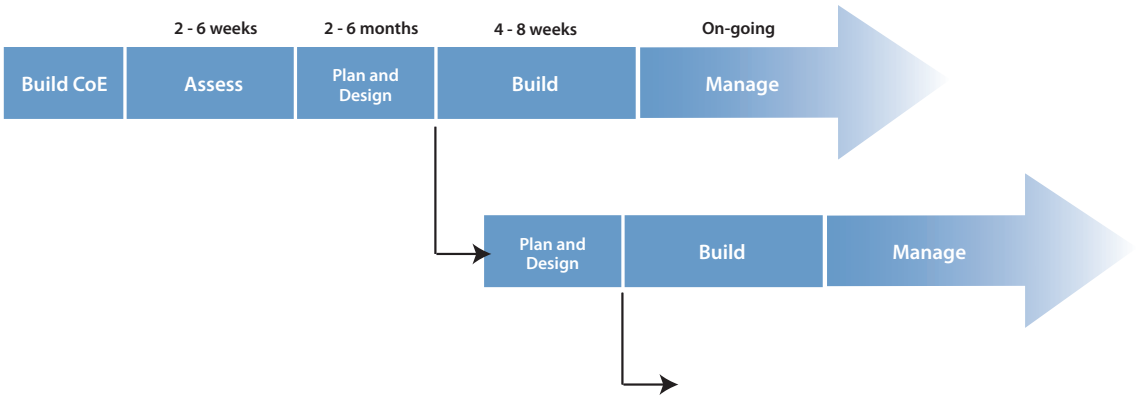

Figure 7. Phases of virtual infrastructure deployment

Build a Virtualization Center of Excellence (2 to 4 weeks)

Build a core virtualization team. The team should be comprised of individuals with the following characteristics:

- Working knowledge of a virtualized environment – this may require supplemental training such as VMware Certified Professional (VCP) training.
- Familiarity with current IT infrastructure operations.
- Credibility with business application owners as well as IT infrastructure leaders.

The key roles for the team are listed below.

- Relationship Manager – Act as primary interface between application owners and infrastructure groups.
- IT Analyst – Identify impacted operational areas and recommend changes.
- IT Infrastructure Architect – Translate requirements into architectural designs.
- IT Infrastructure Engineer – Provide specific technical design for virtualized solutions.

See Table 3 in Appendix C for more details.

The size of the team will vary depending on the scope and size of deployments, but it can be as small as three people or larger where multiple people are acting in each role. These positions should be viewed as relatively senior positions for highly regarded and skilled employees. Suitable candidates can often be found in the current organization (for example, in relationship management, IT infrastructure architecture, or server engineering groups). Once the team is in place, the team members play a central role in the deployment of projects in a virtualized environment.

Phase 1: Conduct Operational Assessment (2 to 6 weeks)

Assessing maturity is useful when determining preparedness to deploy a virtual infrastructure. The VMware Maturity Model (VMM) identifies additional capabilities required to support virtualization. Most companies that do not have much experience with virtual infrastructure will have a VMM score of at most 2 but can quickly gain maturity through the right mix of practical experience and planning.

The assessment phase includes the following steps, which can be executed in parallel:

1. Determine operational readiness.
2. Assess how well the IT infrastructure environment is understood and documented (for example, asset inventory and server utilization).
3. Review current and planned projects to assess impact and identify candidate projects to add virtualization capabilities.
4. Document current application portfolio and fit with virtualization.

Step 1. Determine operational readiness

Operational readiness is determined primarily through interviews and/or self assessments of the various IT infrastructure functions such as design, deployment, operations, and support. Operational readiness should be assessed through a combination of interviews and self assessments by key IT operational leads (for example, head of server administrators, help desk manager). For a detailed list of questions, see Table 5 in Appendix C.

Step 2. Assess how well the IT infrastructure environment is understood and documented

Understanding the current IT infrastructure environment is an important first step in defining an end state and the path to get there. There are three basic types of information to document.

- Asset information – This information includes basic asset information such as type of server, number of processors, asset location, etc. This information can often be found in a Configuration Management Database (CMDB). If the information is not available, auto-discovery tools exist to find asset information. This information is helpful when determining a migration strategy (for example, focus on servers in the same data center with common operating systems).
- Asset utilization – This information indicates how much of an asset's available resources are currently being used (for example, average server CPU utilization, peak CPU utilization, and storage utilization). This information is helpful in determining how much the infrastructure can be consolidated and the priority of the assets to migrate, focusing first on assets with lowest utilization. It is common for many Wintel servers not to have asset utilization data. In these cases, it is generally safe to assume CPU utilizations in the 5 to 15% range.
- Security policies – This information is an important consideration when designing the architecture, operational policies, etc.

Note: See Table 5 in Appendix C for a more detailed list of asset information to document. This information is used to help define the end state during Phase 2. For example, applications hosted on servers A through G will be consolidated onto eight virtual machines that are hosted on a single HP DL580 4-way server with an expected average CPU utilization of 50%.

Step 3. Review current/planned projects to assess impact and identify candidate projects for collaboration
Because of its broad impact on infrastructure, virtualization can have a significant impact on many current and planned projects. It is therefore helpful to do a quick inventory of the current and planned projects. It is not necessary to collect a lot of detailed information on these projects, but rather collect enough information to assess if it is impacted by virtualization and should be addressed in more detail during the planning phase. To prioritize the effort, a minimum threshold project size (for example, >$100K) can be set to identify the most important projects. For IT organizations that track project information centrally, this is a relatively easy task. For IT organizations that do not do this, a quick survey of project managers can usually identify these.

Note: See Table 6 in Appendix C for a more detailed description of the information to collect.

This information is also helpful for identifying candidate projects where there may be particular synergies with virtualization (for example, major application release, IT infrastructure technology refresh, or physical data center consolidation). Combining other projects with virtualization can not only enhance the value of those projects, but also streamline virtual infrastructure deployment.

Step 4. Document current application portfolio and fit with virtualization
A high level review of business applications infrastructure is important input into planning migration to a virtual environment. This information can be used in conjunction with the asset and project information to plan the migration path. Applications that are typically good candidates for migration are those with low CPU utilization, planned life of more than one year, low I/O requirements, and tied to a major project.

Note: See Table 7 in Appendix C for a more detailed description of the information to collect.

The four steps taken in Phase 1 should provide enough context to both determine readiness and to move to the plan/design phase. We find that most companies can virtualize 70-80% of their environment and deployments that are most successful are those at companies that do the proper planning and prioritization.

Phase 2: Plan/Design (2 to 6 months)
Depending on the outcome of the Assessment phase, the planning phase usually includes the following tasks: Completing Phase 2 generally raises the VMM score to 2.

- Develop technical architecture – Size the ESX Service Console to ensure that adequate CPU and RAM resources are allocated to it, based on the number of virtual machines that will be supported, plus the workload profile of all software agents that may run in the ESX Server Console, such as system management agents, monitoring and backup agents, etc. Then configure and integrate the VMware Virtual Infrastructure solution. A migration plan may also be required for consolidating existing workloads that are currently hosted on dedicated server hardware.
- Develop operational designs for the implementation of virtual infrastructure. The objective is to understand the impact of virtualization on the IT organization and infrastructure in terms of deployment, design, operations, and support. This design can be accomplished through a series of workshops to come up with the necessary operational changes required. During the design process, it is also important to consider groups outside of IT that may be impacted (for example, the procurement of additional hardware by Purchasing). The processes that are typically documented include capacity management, Physical-to-Virtual migration, VMotion, Consolidated Backup, VMware HA, monitoring, helpdesk operations, and lifecycle management.
- Evangelize – Review benefits of VMware with stakeholders and consider offering promotions or incentives to early adopters (for example, reduced pricing, higher support levels.)
- Training – Training should be provided for the IT functions most impacted by virtualization (for example, server administrators or the deployment group). The training should focus on Change Management, Configuration Management, Incident Management, Problem Management, Release Management, and Service Help Desk. Training should also be planned for the broader support staff to be offered at a later date.
- Define virtualized infrastructure service offerings – Specify the service offerings in the new virtualized environment (for example, category of hardware, service levels, monitoring/reporting available).

Phase 3: Build (4 to 8 weeks)
This phase has many dependencies on other teams such as network and storage design and support groups. During this phase, virtual capacity is built (for example, ESX Server and supporting systems), not the guests. (Note that consumption of capacity is a separate activity, although it is loosely coupled via capacity planning.)

- Execute test plans that were defined in the Planning phase to demonstrate that all of the virtualization success criteria have been met and that core virtualization features such as VMotion and fault tolerance work as expected. A test report should be generated demonstrating that the success criteria have been met. This report should be distributed to application owners and end users throughout the enterprise to communicate success and start building confidence in virtual environment operations.

- Build out virtual environment – Get the necessary approvals, schedule the necessary resources, install hardware, complete configurations, and build the virtual machines.
- Implement required operational changes – Based on the operational designs, implement the required changes. Targeted communications (for example, to managers and IT employees) may be required to facilitate any transitions.

Phase 4: Manage (ongoing)

- Go live – Many companies have an operations guide or "run book" that documents routine standard processes and procedures like backup and restore, adding new file systems, patching/upgrading, and monitoring. All of these production capabilities should be extended to the virtual infrastructure.
- Continuous improvement – Based on lessons learned from managing the environment, identify ways to improve the process such as providing additional training, etc. Streamline processes such as Service Desk integration, Incident Management, and Problem Management. The Service Desk should be aware of which services are running, where they are running, and how to troubleshoot problems with virtual machines.

Summary and Key Takeaways

The decision to implement a virtual infrastructure within your enterprise is a smart one that will provide numerous financial and operational benefits to your organization. Making the right decisions regarding how to mobilize the technical team and business owners will ensure success. We've found that most fundamental takeaways for a smooth and strategic implementation of this new infrastructure are as follows:

- Have your organizations understand that virtualization is an architectural decision and a new IT service—not another new project.
- Appoint a high caliber internal core team and empower them to learn, design, operate, and drive internal changes to make virtual infrastructure successful.
- Focus heavily on business owner buy-in, particularly during the initial stages. Educate business owners on improved benefits and service levels, engage them actively in acceptance testing, and provide quality remediation options.
- Secure a proper upfront assessment of existing application and IT assets, and a high quality, long term design of the virtual infrastructure. Involve and educate internal IT stakeholders throughout the design and rollout process.
- Use proper project phasing and workload selection to quickly achieve initial success, reinvest the organizational confidence derived from the first pilot to expand deployments.
- Evolve your core team into a virtual infrastructure center of excellence (CoE) virtual organization to provide governance and to maintain and manage your virtual infrastructure over time.

Appendix A: Related Links

1. VMware ESX Server: Advanced Technical Design Guide

http://www.amazon.com/exec/obidos/ASIN/0971151067/102-7998862-4706534

2. Virtualization with VMware ESX Server (Paperback)

http://www.amazon.com/gp/product/1597490199/102-0447846-8868157?n=283155

3. Timekeeping in VMware Virtual Machines

http://www.vmware.com/pdf/vmware_timekeeping.pdf

4. Architecture and Performance Implications

http://www.vmware.com/pdf/esx2_performance_implications.pdf

5. VMware User Groups

http://vmware.rsc02.net/servlet/campaignrespondent?_ID_=vmwi.1053

6. VMware Discussion Forums

http://www.vmware.com/community/index.jspa

7. VMTN Blog

http://www.vmware.com/vmtn/blog/

Appendix B: ISV Support for Applications on VMware

When thinking about ISV support for applications running in a virtual machine it is critical to note the following:

- A VMware virtual machine is just another x86 architecture system
- VMware virtual machines run unmodified instances of Windows, Linux, BSD, and Netware
- VMware has full support from all major x86 hardware OEMs
- Each supported guest OS is tested thoroughly by VMware, and VMware will support and problem resolve any and all interaction issues
- Outside of hardware-specific applications, if your application runs on a supported guest OS, it will run in a VM. There is no certification required to run an application in a VM.
- If a company does not have a Hardware Compatibility List (HCL) and certify to IBM, HP or Dell specifically, then they should not have to certify to VMware machine.
- Over 90% of VMware customers run some of their production applications in a virtual machine.

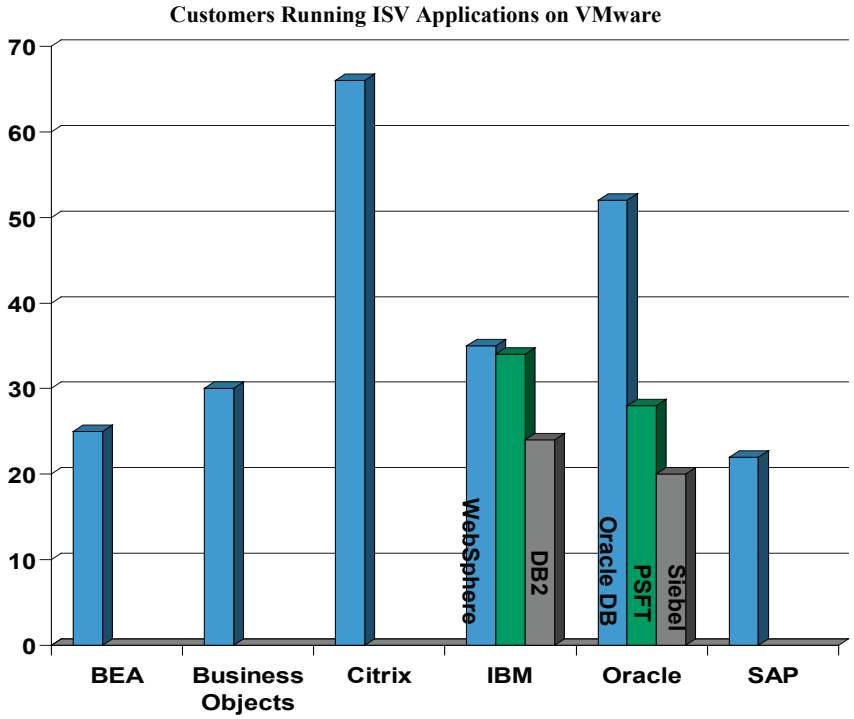

Figure 8. Production workloads running on VMware

Given the transparency and compatibility of a VMware environment and the rapid uptake of VMware within the customer base, over 75% of the top 70 ISVs provide support for their application running in a Virtual Machine from VMware. This support is varied and comes in four types:

1. Case by Case: Very few of the top ISV have this policy and will provide full enterprise support upon explicit request.
2. Non-production – Some ISVs will support their applications on a VMware environment but not for production use.
3. Support VMware on a commercially reasonable, best efforts basis, which may require reproduction of a problem on physical hardware: – The vast majority of ISVs minimally provide this level of support.
4. Full clean support: Many ISV are moving to this support after experiencing minimal or no customer issues of their applications running in a VMware environment.

VMware Approach with ISVs

Our approach is to work closely with ISVs to remove support obstacles for our customer. We offer a Validation program for ISV that allows them to have a free copy of our software for testing and validation. In addition we are working with many top ISV on signing mutual Customer Support Agreements. These agreements ensure that the ISV and VMware will work together to diagnose and resolve issues. Finally, we have initiated programs with our OEM partners to encourage ISVs to gain access to resources in order to develop best practices, reference configuration and benchmarks for their software stack running in a VM.

Suggestions:

Even with all of the efforts by VMware to help ISVs, it is ultimately the customer who has the most leverage over ISVs for support. One of the most successful approaches to gaining ISV support has been customer's adding support for VMs in ISV purchase or support contracts.

For the case that an ISV may require reproduction of problems on physical hardware, it is very useful for customer to develop a "Virtual to Physical" (V2P) strategy for the critical applications. The following document provides information about how to develop a V2P strategy. http://www.vmware.com/support/v2p/index.html Many customers have implemented and tested a V2P process, but in practice they are almost never used due to the ability to achieve problem resolution in a virtual environment.

Appendix C: Assessment and Data Collection

This appendix provides additional information for getting started and collecting data as part of Assessment steps (See "Getting Started: Going Beyond the Proof of Concept" earlier in this paper for more information.)

Role	Key responsibilities
Relationship Manager	Understand and keep up-to-date with current and expected future business needs. Provide guidance to application developers on the impact of virtualization to their work
IT Analyst	Understand how each Service Management function is impacted by virtualization. Recommend changes to operational processes to support new virtualized projects and applications (for example, new application deployment model, ongoing capacity management, etc.) Develop the organization's strategy and roadmap for deploying virtualization.
IT Infrastructure Architect	Translate business requirements into architectural designs. Direct development and maintenance of virtual infrastructure blueprints and documentation. Develop virtual infrastructure patching policies and procedures.
IT Infrastructure Engineer	Provide specific technical designs for virtualized solutions. Install virtualization software. Execute test plans. Develop virtual environment management guide.

Table3. Virtualzation center of excellence (CoE) roles and responsibilities

Service Management area	Virtualization assessment criteria (high-level)
Change Management	What information is required for changes to virtual machines and how is this recorded? What constitutes a virtual infrastructure change, and what categories of changes are there (for example, VM virtual hardware memory)? Are processes documented? Are different procedures followed for the assessment and approval of normal or complex changes as opposed to simple changes (for example, migration of a virtual machine across a farm group)?
Configuration Management	What are the purpose, scope, and objectives of configuration management in a virtual infrastructure? What are the SLAs for the virtual machine systems? Are permissions used to limit manipulation of the virtual infrastructure? How are virtual machines tracked in the Configuration Management Database (CMDB)? How are virtual machine versions mapped to patch levels?
Incident Management	How are incidents identified as virtual infrastructure related? How are virtual infrastructure related issues captured in a knowledge base? How are virtual infrastructure components monitored?
Problem Management	Are there separate procedures to isolate problems related to the virtual infrastructure? How does the way that virtual infrastructure problems are addressed compare to other platforms? How are known virtual infrastructure errors logged?
Release Management	Are standard build blueprints used within the virtual infrastructure? Are virtual infrastructure releases tested prior to implementation? Is a back-out plan developed for each virtual infrastructure release? Are the master copies of all software in use within standard builds stored in a single repository (Definitive Software Library)?
Service Help Desk	What tools are used to record virtual infrastructure related issues and how are they classified? How are escalations of virtual infrastructure related issues escalated?

Table 4. Operational readiness assessment criteria

Environment Data
Type of IT infrastructure asset (for example, server, storage)
Vendor
Hardware configuration (for example, HP DL380 2-way, EMC Symmetrix)
Operating System
Asset physical location
Applications that currently use the IT infrastructure asset
Current asset utilization (for example, peak and average utilization over a 30 day period)
Associated infrastructure (for example, physical network, shared versus local storage)
Security policies

Table 5. Infrastructure environment data to collect

Key responsibilities
Project name and description
Project manager
Business sponsor
Estimated project completion date and key milestones
Project status
Project size (or estimated size)
Anticipated IT infrastructure needs
How project is impacted by virtualization (initial determination to be done by project manager or project team

Table 6. Sample project data to collect

Application Information
Application name
Key user groups
Dependencies on other applications
Where application is in its lifecycle (for example, scheduled to be retired in 6 months, scheduled for major upgrade
Licensing agreements (for packaged software)
Supporting infrastructure (for example, server type or storage type)
Level of I/O (can rate as "low", "medium", or "high")
Suitability for migration to virtual infrastructure (based on above criteria)

Table 7. Sample application data to collect

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