

Incorporating Virtualization into Government System and Datacenter Consolidation Plans: When, Where, How?

United States Government Infrastructure Optimization

STRATEGY

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GOVERNMENT INSIGHTS OPINION

System and datacenter consolidation is a top priority for many government agencies, both as a cost-cutting measure and as a move toward better control of data and business processes and enterprise IT architecture standardization. These efforts have been underway for over eight years at some agencies, but recent success stories have pushed the issue of consolidation, and the associated popularity of virtualization, to the forefront of both financial and IT managers. Some issue we've noted:

- Consolidation for its own sake is not cost effective. Consolidation should be driven by a need to reduce licensing, power consumption, and operational costs while also taming IT complexity. Whenever possible, it should also include a move toward standardization on a preferred enterprisewide IT architecture.
- An effort toward consolidation should start with an enterprisewide survey and full system evaluation. This should include not only current system performance but details on the money that is spend on maintaining those systems. Consolidation often starts with servers then extends to storage, applications, and IT services that support a services-oriented architecture (SOA) environment. Understanding greatest potential cost savings helps set priorities.
- Virtualization is increasingly important as a consolidation tool, but consolidation considerations must be evaluated first. Only then can a proper virtualization approach be outlined and selected.
- Virtualization often exists on server configurations that are built to offer grid performance and a services-oriented architecture environment that supports separation of applications from specific hardware. This is a complex job and often takes specialists, such as the top-tier commercial systems integrators, to assure proper execution.

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IN THIS REPORT

This report is designed to help government IT managers understand the driving forces behind system and datacenter consolidation. It provides the following:

- An understanding of what needs to be assessed when making consolidation decisions
- Ways to consider return on investment, citizen service improvement, and enterprise architecture factors when assessing consolidation
- Details on how virtualization might help with consolidation efforts, in certain circumstances (Virtualization has become a key, though not the sole, driver behind system consolidation efforts. Well-implemented virtualization can greatly accelerate IT consolidation, but it can also complicate such efforts if not considered carefully.)

We cover both application and overall datacenter consolidation and also look at the U.S. federal government's Information Technology Infrastructure (ITI) initiatives that help drive consolidation.

Brief Description of the Solutions

- **System consolidation.** It is the effort to reduce the number of overall computers servers, applications, networks, storage systems, and more that are managed by government IT departments or their partners and contractors. The goal is to reduce numbers of systems, hopefully cutting costs on a number of levels, while offering the same services or even improved services.
- **System virtualization.** It is not a specific technology. Government IT managers should view virtualization as multiple technical solutions that have the potential to facilitate resource sharing and cost savings via consolidation. System virtualization enables more effective use of an organization's available computing power. Virtualization technologies can:
 - Make a single physical resource appear to function as multiple logical resources (such as disk or system partitions)
 - Make multiple physical resources function as a single logical resource (such as a redundant array of independent network interfaces, which merge several network access points into a unified, higher-bandwidth link)

Government IT managers should view virtualization as multiple technical solutions that have the potential to facilitate resource sharing and cost savings via consolidation.

From a solution standpoint, government agencies should be focused on system consolidation first and foremost, not virtualization. The starting point should be an evaluation of which systems are their best candidates for consolidation. (Details on how to do this are outlined hereafter.) Only after IT managers have surveyed their systems and made consolidation recommendations should they investigate whether virtualization is the best way to achieve the outlined consolidation goals.

From a solution standpoint, government agencies should be focused on system consolidation first and foremost, not virtualization.

Considering virtualization first, without evaluating systems and end goals, is a backward approach. While virtualization offers a powerful consolidation solution, it is not the best solution in all circumstances.

SITUATION OVERVIEW

An average agency spends about 24% of its IT budget on development, modernization, and enhancement projects. The remaining 76% (on average) goes to legacy systems. This includes both back-end systems (the databases, database servers, and other systems that feed information to front-end servers and desktop machines) and front-end systems (personal computers, some types of Web servers, and smaller application servers)

The most likely place for system consolidation to start in a federal agency is in its larger back-end systems. Government wide, about 14.4% (\$9.8 billion) of the federal information technology budget goes to "information management," which is heavily focused on back-end systems, while 16.8 (\$11.5 billion) is targeted at "IT infrastructure maintenance," which reaches across back-end, middleware, and front-end systems. It's this cost — the ongoing maintenance — that most IT departments are looking to trim when they seek to reduce the number of systems they need to maintain.

A broad assessment of current systems along with an effort to restructure and refocus information technology gives government agencies a unique opportunity to also restructure management and personnel. This can provide better alignment of employees, hardware, and business and IT functions. Done correctly, this should allow departments focus more on their core missions and less on developing and maintaining their IT, save those IT requirements that are unique to their departments.

Government agencies often have competing pressures. The pressure for cost savings prompts many agencies to move toward a centralized organizational structure, while the pressure for local response and customization drives them back toward a decentralized organizational structure.

If possible, make business process assessment part of your enterprisewide system assessment.

Government agencies often have competing pressures. The pressure for cost savings prompts many agencies to move toward a centralized organizational structure, while the pressure for local response and customization drives them back toward a decentralized organizational

structure. So the compromise that many have discovered is that it can be more efficient to centralize common or shared processes but allow unique locally oriented processes to be decentralized. From an IT perspective, this can mean centralizing the common IT infrastructure (networks, standardized desktops, common business applications, and phone service) that reach across multiple departments under an office of information technology services, while individual department CIOs can focus on their core business applications unique to their department — keeping them directly involved in citizen services.

Thus, the first step toward consolidation is often consolidating the common or shared systems across most departments within a larger agency. The second step is often finding common services or applications that can be consolidated across multiple government agencies.

Introduction

Government agencies today face serious "system sprawl." This situation has occurred because of the way IT systems evolved over the past 25 years. Traditionally, each department within an agency developed its own databases, applications, networks, and desktop ecosystems. In many cases, these departments used the same applications and collected similar data. But geographic separation meant redundant systems were a logical choice.

As networking technology evolved and as high-bandwidth connections expanded, these separated systems became better connected. At that point, it made far less sense to have multiple servers, databases, applications, and IT management staff spread across multiple locations.

But while consolidation sounds good, it's not always easy to accomplish:

- Combining databases can be difficult because field names, data structures, and rules often have significant differences.
- Combining applications might be simple if most systems are using similar commercial off-the-shelf (COTS) software. But if the applications were custom developed for each office, chances are that significant differences exist and combining them could be a time-consuming challenge.
- Combining servers is a challenge because larger servers, capable of handling all existing applications and data queries, can be very expensive. And if existing applications reside on different platforms, migrating to a common server isn't always possible.

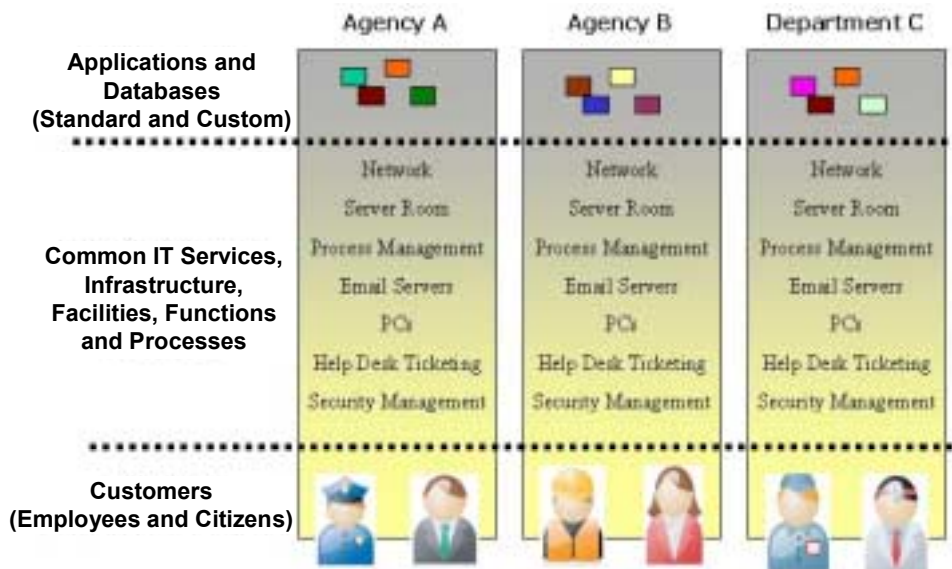
Yet, the long-term savings promised by system consolidation cannot be ignored.

Current Environment

Figure 1 shows the typical arrangement found in many government offices. Agency A and Agency B maintain their own applications, networks, servers, and more. Even large departments within an agency (Department C in the figure) often have their own dedicated applications, servers, and so forth. This is a very stovepiped way of serving citizens, and many agencies have abandoned this design to save costs and reduce redundancies.

FIGURE 1

Typical Arrangement of IT Systems in Government Offices



Source: Government Insights, 2008

In most cases it can be more efficient to allow common or shared processes to be centrally managed.

Some typical areas for agency consolidation include centralized network infrastructure and management; IT security, managed desktop services and IT support, email and calendar systems, asset tracking and management, and enterprisewide purchasing systems, including IT purchasing.

As an agency moves to assess its current systems and processes, here are some questions to ask:

- What is the full range of current usable resources across your enterprise?
 - How many servers are in use?
 - What networking resources are in place, and what software and storage resources are present?
- Which operating systems (OSs) and applications are present throughout the enterprise?
- Which systems are similar? Can they be combined? What is the most likely common platform for such a consolidation? (server, OS, and best network connectivity)
- What impact might consolidation have on the management, monitoring, and administration of your existing (and proposed) infrastructure?
- Can you still achieve your necessary redundancy and uptime levels with fewer servers? Do you need to improve redundancy as part of your consolidation effort?

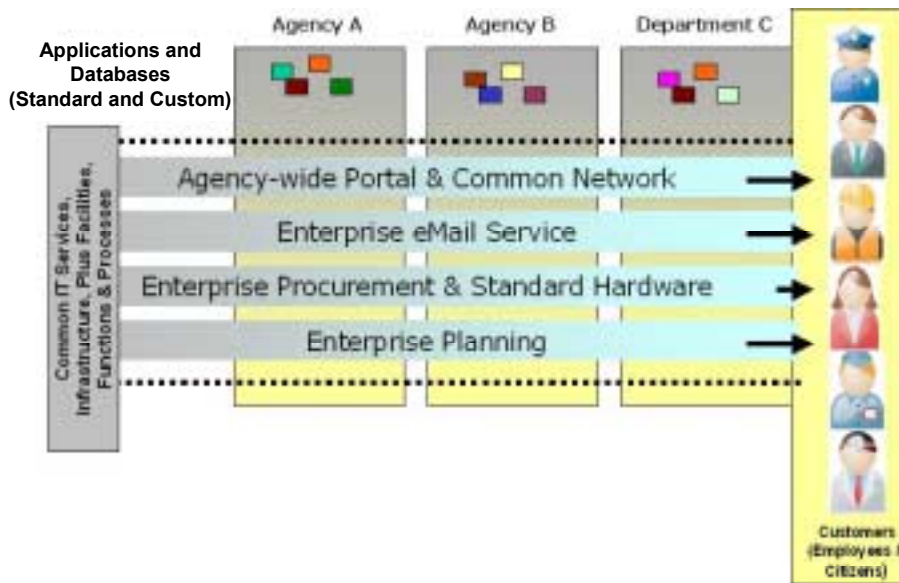
Later in this report we address several questions related to virtualization as a possible consolidation solution . But this is a good time to start thinking about which servers might be candidates for virtualization and whether server blades might be a possible consolidation platform for some applications.

The desire to streamline such services and reduce redundancies often nudges agencies toward centralized shared services. Figure 2 shows some of the initial consolidation efforts that are often tackled by agencies. In such cases, many applications and databases remain under departmental or local control . But significant efforts are made toward cross-departmental or cross-agencies sharing of common IT services.

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FIGURE 2

Initial IT Systems Consolidation Efforts Typically Tackled by Government Agencies



Source: Government Insights, 2008

Initial Moves Toward Virtualization

During initial consolidation efforts, virtualization may or may not come into play, depending on the size of the operation. Here's one place where many agencies start — if an agency has many different Web servers, with different configurations, it may be best to move them to a common virtual system, which can provide virtualized iterations of multiple Web servers. From this starting point, agencies may decide whether virtualized environments will suit their needs.

At this point it's important to note that high-traffic systems may not be ideal candidates for virtualization. Virtualization works well when most of the systems hosted on the virtualized server have equal demand, and if none are claiming over 40–50% of CPU cycles over an extended period of time. But if one of the virtualized servers is a high-transaction system with a great deal of demand, it is either not the ideal candidate for virtualization or managers may need to consider a much more powerful server, which can drive up overall costs.

THE APPROACH

Note that centralizing an IT resource does not mean centralizing all staffers related to that resource. For example, multiple human resource systems can be consolidated into just one or two HR datacenters. But individual human resource employees can still remain at their regular locations. They'll just interact with machines located in a different place.

Where Should Consolidation Efforts Be Focused?

A government agency's consolidation efforts should always focus on one of the following:

- Cost savings
- Improved citizen services

Secondary considerations may include moving toward a standardized enterprise architecture, improving system security, and meeting reporting requirements that are set by federal mandates. Obviously, addressing security issues must be done at any time to keep systems safe. But when focusing on the question of consolidation, security or any of the secondary considerations should not be the primary driver for consolidation. Secondary issues can always be addressed separately if needed, or they should be included in a consolidation equation if addressing them also helps with cost savings or improved citizen services.

Start with a System Assessment and a Needs Assessment

To understand all of the variables, managers need to do an analysis of their systems to find the specific areas where consolidation efforts can be most beneficial:

- Form a consolidation team that includes stakeholders from the IT, management, systems engineering, and end-user community
- Evaluate all servers and databases to determine current (and desired) performance characteristics, resource requirements, and dependencies:
 - Data access and usage patterns should be analyzed. Which machines have a high-transaction volume and high CPU usage? Which are lower?
 - Be aware that multiple dependencies for a database or application can greatly complicate a consolidation plan. If you're just starting on an enterprisewide consolidation project, it's best to start with the more simple applications first, then work your way up.
 - What are your current licensing agreements? What are the prices and how many end users are served? Understand all of these variables to make your cost-savings projections if specific systems can be merged or retired.
- Look for consolidation opportunities that extend beyond databases:
 - Can Web servers be consolidated into a virtualized environment without compromising transaction performance?

Be aware that multiple dependencies for a database or application can greatly complicate a consolidation plan.

- Look carefully at department-level applications, which tend to burgeon with time, such as SharePoint Team Services, Lotus Notes databases and work spaces, and networked project resources. Can these be consolidated onto a common platform for all?
- Can SQL Servers be consolidated into a cluster?
- Can storage be consolidated and shared via disk arrays and storage area networks?
- Understand that, in a consolidated environment, it can be more efficient for databases to be grouped or stacked together based on performance characteristics, and sometimes based on their internal or external dependencies, or even service-level agreements.
- Pay attention to when peak loads happen. For example, regular business applications may see peak use during work hours, backup storage systems may see their greatest activity after hours, payroll applications may receive a lot of use every two weeks, and financial systems may see a spike in activity near the end of each quarter.
- Can current patterns be duplicated and improved in a consolidated environment? (Rely on systems engineers to evaluate this question.) Don't overstress systems in the name of perceived efficiency. In general, virtualization may not be the best approach for servers that use more than two CPUs or over 3.6GB of RAM. You also can rule out systems that use over 85% of resources such as CPU cycles, disk storage, or memory. Note that some engineers suggest keeping up to 50% of a systems processing power in reserve in anticipation of peak loads, so even the 85% threshold may be too high in some instances. Engineering issues may vary for each agency.

Pay attention to when peak loads happen.

Only after stepping through these considerations is it possible to develop a migration plan for those systems that are prime candidates for consolidation.

Cost Savings Related to Consolidation Efforts

When executed properly, system consolidation can facilitate significant cost savings for government information technology installations and to the managers of those installations. Those savings fall into three broad categories, plus the subcategories listed below:

- Equipment and software related — reduce numbers of:
 - Servers (current costs and long-term replacement costs)
 - Software licenses
 - Software updates and patches needed across the system

- Facility related:
 - Reduced power consumption for:
 - Servers
 - Cooling (individual systems or datacenters)
 - Lighting
 - Space savings:
 - Lower rental costs
 - Less maintenance
 - Fewer overall datacenters
- Staffing related:
 - Likely reduction in facility maintenance
 - Only minor reductions if IT staff

IT managers who are considering consolidation as a way to cut systems costs often overestimate the savings they will achieve from staff cuts, which brings us right back to the virtualization question (see next section). Virtualization doesn't necessarily reduce the number of applications that have to be managed — just the number of machines where those applications reside. But managers also often underestimate the savings they can achieve from other sources, such as the long-term equipment and facility savings mentioned previously.

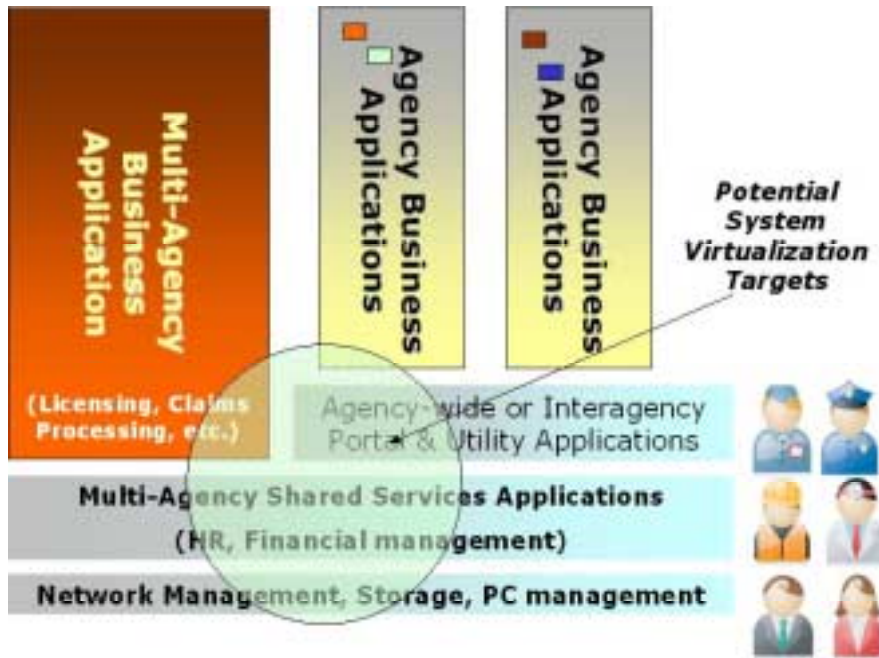
Figure 3 shows a more long-term view of where many government agencies are headed. IT infrastructure and internal functions used by multiple agencies, such as payroll, online transactions that require a credit card, human resources, and network security are collective while applications used by one or a limited number of departments or agencies are offered as a centralized resource. This type of arrangement balances the demand for consolidation and cost savings while still supporting a local response for locally important applications.

As Figure 3 shows, the most likely candidates for virtualization may be the larger shared services that cut across multiple departments or agencies. But some applications may also qualify for virtualization depending on their configuration and usage. There are many variables, so a qualified systems engineer should be enlisted to determine which consolidated systems are likely virtualization candidates.

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FIGURE 3

Shared Services Targeted at Virtualization Across Government Agencies



Source: Government Insights, 2008

The Virtualization Question

Only after stepping through the cost-savings considerations is it possible to decide which solutions are good candidates for virtualization and which should remain on their own dedicated platforms.

Virtualization has evolved as a key element of consolidation efforts for many industries. But before deciding if virtualization is the right path for an agency's consolidation plans, it's important to understand the different types of virtualization — as it applies to databases and applications.

To expand on the idea that virtualization itself should not be considered a specific technology (see the Brief Description of the Solutions section of this report), consider the following virtualization examples:

- Volume management tools can combine multiple disks across a network to make them appear as a single large logical disk. Likewise, a single disk can be segmented to appear as multiple disk drives.

Only after stepping through the cost-savings considerations is it possible to decide which solutions are good candidates for virtualization and which should remain on their own dedicated platforms.

- Network bandwidth can be enhanced using technologies such as redundant array of independent network (RAIN) interfaces to merge several network access points. This allows them to function (when needed) as a single, higher-bandwidth link.
- Application software no longer needs to be "installed" on the machine where it will run. Runtime environments can now isolate the application from hardware resources and the application programming interfaces (APIs) of an underlying operating system. The most effective application virtualization systems can dynamically assemble applications in real time and load balance across multiple processors or machines. Essentially, this allows an IT manager to run multiple servers on a single server. The multiple servers are actually virtualized implementations, but they appear (and function) as discreet machines.

This means that virtualized environments can be an extremely powerful solution when working toward system consolidation. This allow for a very effective use of computing power.

In particular, look for workloads with low resource utilization rates and small footprints. In particular, infrastructure- and appliance-type systems are good initial targets (print servers, file servers, low-level Web servers).

Also look at your in-house development and staging servers. If these can be virtualized, you can often cut the time it takes to reconfigure these systems for their next use.

Virtualization — Where's the Power?

Government Insights sees the emerging era of virtualization technologies as an opportunity for organizations to refresh their IT infrastructures with more strategic systems. To track virtualized solutions, IDC and Government Insights break server virtualization into four general components:

- **Virtualization platform.** In most cases, this is the core hypervisor, basic resource controls, and APIs. Competitive differentiation includes number of sockets, number of processors in a virtual machine (VM), number of guests supported by the license, and OS support. The hypervisor itself also represents the stability and the reliability of the overall virtual platform.
- **Virtual machine management (VMM).** This includes the host-level management as well as management across virtualized servers and datacenters. Today the differentiator between vendors is whether they offer virtualization management and at what scale. IDC believes the gaps here are likely to close quickly and differentiation will shift to managing physical and virtual machines from a common interface.

- **Virtual machine infrastructure (VMI).** These are the value-added features that drive most customer purchasing decisions today and represent the area with the biggest gaps between vendors. They include live migration, automatic restart, and workload balancing of virtual machines across hosts.
- **Virtualization solutions.** These represent the bundling of the aforementioned technologies with some enabling workflows and process automation capabilities to meet specific business needs. These solutions are just now emerging and likely represent an important future competitive front. This category includes solutions such as virtual desktop infrastructure (VDI) or disaster recovery.

Product types tend to fall into three buckets focusing on different technologies. The main two are:

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- Those that virtualize within the operating system, such as SWsoft and Sun. (With operating system virtualization, all of the applications that reside on that server must run the same OS.)
- Those that virtualize below the OS, such as VMware, XenSource, Virtual Iron, Red Hat, Microsoft, and Novell. These solutions mainly rely on hypervisor-based virtualization. (This type of virtualization allows systems to operate multiple types of operating systems on the same server, sometimes including Linux, Windows, and Unix.)

We say there are three types of virtualization because there is a technical split within the second bullet above. One group creates hypervisor and virtualization environments within the OS (Microsoft, Red Hat, and Novell). While the other relies on a standalone software layer (VMware, XenSource, and Virtual Iron).

Are There Also Virtual Complications?

As we noted previously, some applications don't easily translate into virtual environments. Because virtual systems that reside on the same machine share the same processor or set of processors, that means processor intensive applications, such as high-volume transaction servers, CAD systems, or geographic information systems (GIS) may place too much demand on the shared environment. As mentioned previously, a virtualization team should review all servers, databases, and applications. Part of this evaluation should be quantification of processor demand.

Another complication is that licensing structures for virtualized environments are in a difficult transition for software vendors. As applications are consolidated, agencies may anticipate significant savings because they need fewer licenses. But software vendors are

savvy enough to understand that they need to change their license fees if they will sell fewer overall licenses, so long-term savings for end users who consolidate systems are not totally clear.

The benefits of virtualization for some applications is considerable. But virtualization also presents systemwide risks if done without care and expertise, both areas that services providers and enterprise IT staff must approach with attention to governance and policies. In particular, continuity planning could mean a shift from traditional diagnosis of a single-server failure to avoidance of systemwide cascade failure in a virtualized environment.

But virtualization also presents systemwide risks if done without care and expertise, both areas that services providers and enterprise IT staff must approach with attention to governance and policies.

IT managers also need to ask the following questions:

- What is the current knowledge level of virtualization within my organization? What training is needed, and how much will it cost?
- How will virtualization impact current business processes, both positively and negatively?
- How will virtualization impact the current user experience? How transparent can it be made?

Virtual Machine Sprawl — Consolidation Gone Wrong?

One issue that has occurred since the virtualization became popular is the recognition that virtual machine solutions can create their own sprawl, with multiple systems and multiple virtual machines. If not controlled, this can evolve to a problem that's similar to the issue agencies are trying to solve. The solution is to create a centralized solution that can be tightly controlled and rolled out in an organized way as new machines are needed.

Concerns persist about software, security, and systems management, but better middleware tools are helping to make virtualized environments more manageable.

On top of this, agencies need more IT professionals who are experienced with virtual environments. This skill set can help them manage their expansion of virtualized solutions without the complications of machine sprawl.

What Virtualization Means to Government System Managers

Virtualization offers government systems the prospect for strategic IT infrastructure rollout with an emphasis on consolidation, interoperability, and cost savings throughout the life cycle of products. If properly implemented, using virtualized environments can offer improved economies and efficiencies of scale.

The IT infrastructures of government agencies often have been created in a piecemeal fashion. Consolidating these systems offers cost savings if numbers of machines, numbers of software licenses, management man hours, and power consumption can all be reduced. Virtualization gives government agencies an opportunity to invest in an IT infrastructure with a fresh holistic approach with potential enterprisewide cost savings if multiple applications can be migrated to the virtualized environment.

But in government, as in many other environments, the incentive for migrating may be a problem. Traditionally, the manager of a large application had full responsibility for hardware, software, and end-user access to the application. Moving an application to a shared virtualized environment can make the manger feel like control has been lost. And even if cost savings can be achieved, some agencies may fear that any cost savings they achieve will turn into permanent funding cuts to their organization. For this reason, consolidation and virtualization efforts often have to be driven by an agency's CIO, who mandates consolidation efforts from the top.

The greater the extent to which virtualization technologies are implemented across multiple departments and multiple agencies, the greater the possibilities for conserving resources and recognizing savings. But sometimes the initial investment for virtual environments can be costly. For this reason, some agencies have been reluctant to make the first push because of budget constraints. Once again this indicates that the effort may need to be coordinated through the agency's CIO office. Once the first sets of virtual environments are constructed, organizations can be invited to share the platform.

The greater the extent to which virtualization technologies are implemented across multiple departments and multiple agencies, the greater the possibilities for conserving resources and recognizing savings.

Through this, agencies should not lose their focus on interoperability. Vendors that offer proprietary network-based solutions should not be favored when decisions for virtual environments are underway. The essence of resource savings enabled by virtualization depends on the interoperability of the widest range of IT infrastructure components. Vendors with proprietary solutions defeat the essence of virtualization. They lock organizations into systems that could be more expensive down the road. Users should ensure virtualized solutions have end-to-end interoperability before making purchases.

Strategy Impact

Some of the biggest impacts of system consolidation is the promise of associated business process consolidation. Consolidating business applications and processes that multiple departments, including enterprise resource planning (ERP), permitting, grants management systems, holds great promise for cost savings, but detailed analysis of what can be merged and what can be eliminated must be conducted.

President's Management Agenda and Line-of-Business Initiatives: Giving Consolidation a Boost?

Making government more citizen centered has been a multiyear goal of the President's Management Agenda (PMA). Enhancing delivery of government services' eGovernment initiatives has been a key way to deliver on the administration's promise to "make it simpler for citizens to receive high-quality service from the federal government, while reducing the cost of delivering those services" (PMA Chapter 4, original 2004 version. The document has been updated once since then with addition emphasis on eGov solutions.).

By policy the federal government tries to be technology agnostic and vendor neutral. Virtualization, by definition fits both of these descriptions, though there are always proprietary solutions available to fill specific niches. But the main focus of virtualization is to share resources and allow systems to be optimized so that supply automatically meets demand. The essence of virtualization is saving money and it fits nicely with the PMA.

One federal mechanism developed to maximize IT economies and efficiencies of scale is the IT Infrastructure Line of Business (ITILOB), a cross-agency initiative, sponsored by the OMB and run through the General Service Administration's (GSA) office of governmentwide policy. The ITILOB is finding that through virtualization, complexity can be reduced, new technologies can grow, and organizations can be modernized.

Management Challenges

The main management challenge for most organizations will be conducting their full system evaluations and then doing the return on investment analysis to determine if consolidation will help them save money and improve services.

The secondary challenge is to use consolidation efforts as a catalyst to nudge an organization toward a more standardized architecture, in hopes of improving efficiencies and costs.

GSA has set four goals for IT infrastructures:

- Interoperability of functions across agencies and programs
- Collaboration within and across agencies, sectors, and government levels
- Reducing costs by better aligning IT infrastructure investments with agency missions through savings realized through reductions in total costs
- Investments governed to achieve agency mission and government-wide goals

Once these goals are met, OMB estimates the federal government can save between 16% and 27% annually on its aggregate IT infrastructure budget. Based on a five-year technology refresh cycle this amounts to a savings between \$18 billion and \$29 billion over 10 years.

Currently, the Information Technology Infrastructure initiative is in its developmental stage. When mature, the ITI seeks to cause government to act more like private industry and to develop market-driven common solutions.

Virtualization seems to be favored by those agencies that rely on it in working environments.

In a late 2007 communication to employees, the U.S. Department of Agriculture's Office of the CIO stated that the department's "NITC [National information Technology Center] will continue to maximize virtualization of its shared computing environments and when applicable, recommend this solution to customers on dedicated platforms." Since that time, the USDA has demonstrated its virtualized environment as one of its success stories for system consolidation.

Incentivizing Virtualization as a Catalyst for Consolidation

The ITI intends to reinvest savings made possible by common architectures into the IT infrastructure. Doing so will provide incentive to agencies that may otherwise hesitate to contribute to efficiencies of scale by allowing other agencies to manage elements of their IT enterprise. Interoperability across agencies, sectors, and government levels demands broad participation.

Differentiating the Adopters

The top virtualization vendors are:

- **VMware:** Owned by EMC, VMware is by far the top competitor in this space. It has offered hypervisor-style virtual machines since 2000. The VMware solution has gained popularity because of its virtual infrastructure capabilities including live migration, resource scheduling for load balancing across virtual machines. VMware also supports virtual machines that can be used for running a disaster recovery operations in a virtualized environment. The company also offers VMware Fusion for the Apple Macintosh OS X.
- **IBM:** Big Blue offers server, storage, and application virtualization (via WebSphere) solutions. The company focuses a bit more heavily on classic Unix solutions but also offers x86 solutions. The company focuses heavily on offering systems for rapid application deployment and business continuity. IBM also offers VMware solutions to its Lotus Foundations product.

- **HP:** HP offers solutions in classic Unix environments, with a focus on virtual server environment reference architectures, integrated adaptive network architecture, and disaster tolerance. It also offers virtual storage solutions and the HP Serviceguard Storage Management Suit.
- **Parallels:** With a host of desktop and server virtualization solutions, Parallels has found a solid niche in enterprise IT automation, database automation, and Web consolidation. Its desktop solutions have proven popular in small to medium-sized businesses. Also offers virtualization products for Apple Macintosh OS X.
- **Microsoft:** This summer, Microsoft launched Hyper-V, its much anticipated built-in hypervisor for Windows Server 2008. Unlike Microsoft's older Virtualization products, such as Virtual PC and Virtual Server, Hyper-V is a "native virtualization" solution, meaning software that runs directly on the hardware. But Hyper-V does not yet have the robustness available in other virtualization solutions, but with Microsoft's built-in user base, it's sure to evolve into a major force.
- **XenSource and Citrix:** It's logical to talk about these two solutions together. Xen originated a virtual machine monitor that allows guest operating systems to be executed concurrently on the same computer hardware. It was created by the University of Cambridge Computer Laboratory and is now offered as free open source software under the GNU General Public License. Modified versions are available for Linux, NetBSD, and Solaris. An associated company called XenSource grew up alongside the open source effort, and Citrix Systems acquired XenSource in 2007. But Citrix itself has been developing powerful multiuser environments since the early 1990s. Today, the Citrix XenApp (Application Virtualization — formerly Citrix Presentation Server), XenDesktop (Desktop Virtualization, VDI), XenServer (Server Virtualization), and NetScaler (Application Optimization, Application Delivery Networking, Load Balancing, and Web Application Acceleration) have found a home in several government agencies.
- **Virtual Iron:** This company provides software for system virtualization and management of virtual infrastructures. It claims to be one of the first companies to offer virtualization software to fully support Intel-VT and AMD-V hardware assisted virtualization. It supports 64-bit virtual operating systems and offers tools to control, automate, modify, and monitor virtual resources.

- **Red Hat:** Company managers claim that Red Hat Enterprise Linux 5 is the first product to deliver commercial quality open source virtualization with support for fully integrated server and storage virtualization, high-availability clustering capabilities, and multi-OS desktop environments. It offers support for multicore processors, Intel's network accelerator technology, and dynamically switchable I/O schedulers.
- **Novell:** With SUSE Linux Enterprise Server for Intel server hardware, Novell's key focuses today include lowering server administration, maintenance and energy costs; reducing software and hardware costs; controlling system complexity and creating a small datacenter footprint that is still capable of scaling. Novell also is collaborating with Microsoft to develop virtualization solutions for Windows servers. The company allows Linux and Windows to now reside side by side, sharing the same physical servers.
- **Swsoft:** SWsoft is a server automation and virtualization software company and the parent company of Parallels (mentioned previously). The company offers software for running datacenters, with a focus on Web-hosting services companies. But it also supports application service providers and managed service providers. Its products allow its customers to run multiple operating systems, including Windows, Mac OS X, Linux, and Solaris, on a single computer.

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The Platform Question

Various flavors of the Intel x86 processor are becoming the dominant platform for virtualization solutions. More than half of federal virtualized systems are built atop Windows server platforms, often using Citrix, VMware, or Parallels solutions. Roughly a third are built atop Linux or Unix platforms, while the rest reside on older mainframe or midrange systems.

Design and integration of virtualized solutions are often handled for government clients by large IT service providers. Top virtualization services provided by external vendors, in descending order of popularity, include:

- Systems integration
- IT consulting and systems design
- Hardware support services
- Software support services
- IT education and training

Some of the largest government IT systems integrators capable of support virtualized environments include CSC, EDS/HP, Accenture, Lockheed Martin, Capgemini, and SAIC.

Business Need

Business needs can be considered in various ways. The most logical business need, as mentioned previously, is consolidation for cost savings or to improve system performance (and thus citizen services).

The Need to Conform with Enterprisewide Architectures

- Enterprise architecture provides the broad logic for an organization's business process and a standardized IT that is used to address that process, while also moving the enterprise toward sets of standardize requirements for things such as data structures, database design and types, and sometimes even specific machines.
- Compliance with tightly controlled enterprise architectures often can help an organization save money and improve efficacy.

In an example of a focus on enterprise architecture driving system consolidation, the Commerce Department had this to say last year about its large-scale Commerce Business Systems (CBS) effort:

The overall intent of this initiative is to document the as-is architecture and develop a target architecture with a consolidated transition plan (roadmap) for the administrative areas within the Department — consistent with the Department Enterprise Architecture (EA) and the Office of Management and Budget (OMB) Federal Enterprise Architecture (FEA).

Compliance with the President's Management Agenda:

- System consolidation and virtualization is helping the government save money using information infrastructures to better deliver services to citizens. OMB has identified some of these benefits, including:
 - The ability to rapidly save, copy, and provision a virtual machine enabling zero downtime maintenance and support new agency "go live" initiatives
 - A dynamic sharing of idle resources across server platforms resulting in improved performance and use while eliminating stovepipes
 - Higher technology standardization and currency, resulting in lower operations and maintenance costs

- Seamless failover when a virtual server component fails, resulting in higher system availability
- Reduced complexity, resulting in improved logical and physical disaster recovery

In an example of the PMO driving consolidation efforts, the Environmental Protection Agency (EPA) Office of the Chief Financial Officer (OCFO) developed a Web-based OCFO reporting and business intelligence tool to integrate financial, administrative, and program performance information. At this point it's more of a management dashboard capable of providing an integrated view of EPA's financial and budgetary status. It also incorporates analytics to alert users when more than 50% of an annual appropriation has been obligated early in a fiscal year.

On a larger scale, OMB indicated last year that successful integration of financial management "line of business" systems took place over the past several years as 7 large agencies and 79 smaller agencies moved to a government or commercial shared service center for hosting their core financial management systems.

FUTURE OUTLOOK

Remaining Challenges

Consolidation

Besides the driving force of better economy through server consolidation, datacenter functionality can be extended by the ability of server virtualization to allow application portability. Thus any effort toward server consolidation should keep this requirement in mind.

Virtualization

In virtualized environments, servers achieve the functionality of files, meaning they can be copied, moved, and replicated. By unlinking them from the actual server infrastructure, applications are also unchained from a physical location, enabling a more dynamic IT organization.

People implementing virtual machines need significant training on how to do so without compromising their systems. Things such as IP address configuration, locations of control counsels, and storage network configuration are all very important, and mistakes can be made.

Virtualization is driving government organizations to reconsider best practices when deploying new applications. Within commercial industries, we have noticed that a growing number of end users report

that unless there is an economic or technical reason to do otherwise, their stance is to deploy all new applications as a virtual machine. While government has been a bit slower to adopt this stance, we believe that it is the wave of the future. This could foreshadow the expanded role that virtualization may have in addressing multiple IT management and process challenges. A virtualized environment allows them to consolidate and focus their resources.

ESSENTIAL GUIDANCE

Actions to Consider

Advice for Dealing with Virtualization Software Vendors

Supporting quality service will be increasingly important as critical IT services move to virtualized and remotely hosted environments. Look for virtualized software vendors that have developed a reputation for service excellence that are capturing market share based on this market perception. This often includes establishing a set of trusted services providers, particularly as IT environments increase in complexity. It's important that all vendors establish clear lines of communications among the software vendor, hardware platforms, and IT services partners. Government IT managers shouldn't have to navigate through this maze without help.

Be aware that systems vendors are attempting to expand their IT services branches by offering software consulting, systems integration, and support related to virtualization. This is often a good thing, but examination will be required to make sure this isn't just a "me too" offering. High-quality services are paramount.

To boost partner ecosystems and associated relationships, virtualization software vendors are being pressed to create APIs, while also being nudged toward development of a standard virtual machine interfaces. While this effort is still evolving, government agencies should be aware of it because it presents them with greater flexibility in their selection of virtual machine technology.

Advice for Dealing with IT Systems Vendors and Integrators

As virtualization technologies expand and improve, they will prompt a divergence from server-centric standards when it comes to system functionality. Instead, we expect to see a move toward monitoring full IT infrastructure performance in support of business processes. Thus government agencies should be prepared to set this as a requirement for future datacenter and system development contracts. Likewise, systems vendors will be increasingly pushed toward standards-based solutions to meet government requirements and take

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advantage of the various established frameworks, such as offering Information Technology Infrastructure Library support and IT service management (ITSM), for the larger datacenters. Systems integrators need to be able to offer a full view of the IT infrastructure to ensure applications performance and policies. Agencies will likely build this into their service-level agreements of the future.

The most reliable IT consultants and systems integrators should be focused on developing a suite of best virtualization practices in conjunction with government CIOs. This should especially focus on long-term management of consolidated and/or virtualized solutions.

Virtualization often exists on server configurations that are built to offer grid performance and a services-oriented architecture environment that supports separation of applications from specific hardware. This is a complex job, as such, it will likely be the top-tier commercial systems integrators that are most experienced at designing and delivering these flexible solutions.

Eventually we will see a shift from focusing most virtualization on server consolidation to using it to improve business continuity and application development flexibility in an SOA environment. But at the same time, this will make greater demands on network bandwidth and storage environments. Thus it will be important to look for SIs, or their contract partners, who have expertise in these niche areas. They should not be left out of the overall system design.

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LEARN MORE

Related Research

- *U.S. State and Local IT Spending 2008–2012 Forecast* (Government Insights #GI214502, October 2008)
- *U.S. Federal Government IT Spending 2008–2012 Forecast* (Government Insights #GI214086, September 2008)
- *Federal IT Security Spending Benchmarks — How Does Your Agency Compare to Others?* (Government Insights #GI213071, August 2008)
- *A Perfect PC Storm: A Tool for Federal Agencies to Calculate Service Gains and ROI as Events Converge to Force Client-Side Infrastructure Optimization* (Government Insights #GI212429, June 2008)

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