Virtualization and Optimization

These key technology solutions help organizations reduce costs and operate more efficiently.

TABLE OF CONTENTS

Executive Summary

The rapid expansion of Internet technology in the 1990s was a boon for public sector organizations. It provided these agencies and institutions with a new set of tools to advance their missions. Operations were able to function more efficiently and even more cheaply.

Much of this expansion was facilitated by the x86 server form, which housed network applications and systems on individual servers. These servers were (and still are) used in conjunction with desktop computers to manage large environments.

As time has passed, this server-desktop structure has become unwieldy. Growing data centers has become expensive in terms of hardware, power and cooling, management, and maintenance; not to mention that the low utilization rates of servers typically hover below the 20 percent mark, according to International Data Corporation.

Today, government and educational entities are realizing that they need a fresh approach to their network infrastructure. Many are being forced to find new ways to go lean by reducing costs and streamlining operations. Two technological advances, virtualization and optimization, have evolved to address the numerous downsides of the sprawling, inefficient data center.

These increasingly popular go-to approaches can help a great deal in reducing costs and increasing the efficiency of the enterprise.

The Virtues of Virtualization

IT managers have embraced virtualization with enthusiasm primarily because it reduces costs and complexity. With newer focal areas such as client virtualization now reaching maturity, IT managers are finding ways to employ virtualization throughout their IT environments.

Virtualization additionally allows for the separation of resources, or dependencies. As a result, it enables the control and movement of other resources to different locations in order to enhance the versatility and performance of the overall system. Different types of virtualization can be used in a variety of scenarios to deploy resources where they're needed within the organization.

Why Virtualize? Cost Savings.

Saving money is the top reason for switching over to virtual machines. Chris Wolf, a senior analyst with the Burton Group in Midvale, Utah, points out that the lower capital expenditure costs from server consolidation, coupled with reduced power and cooling savings and reduced spending for maintenance, "build a strong return on investment case for server virtualization and consequently make it easy for IT folks to secure funding for virtualization projects."

Simplify Via Optimization

Optimization refers to the overall goal of doing more with less. (Virtualization is one means of achieving that goal.) Using a much smaller set of hardware components (via virtualization), optimization can be applied to PCs, servers, storage or networking traffic.

An optimized IT environment provides a simpler backup and disaster recovery (DR) methodology to keep your organization safe, a much lower power consumption rate to keep your organization in the black, a simpler suite of data center management tools to help an organization stay on top of all of its IT assets, and a better experience for end users.

Server Virtualization

Among the different types of virtualization, server virtualization is the most widely adopted of these technologies. It allows for the virtualization of multiple application servers onto a single physical server system.

What makes this approach such a boon for IT managers is that it reduces the number of actual servers in the data center while at the same time increasing their utilization. In doing so, it is a solution to many of the challenges that IT departments face today.

CHALLENGE 1. INCREASED TCO: Perhaps the most common requests heard by IT departments are to lower the total cost of ownership (TCO) and achieve a faster return on investment (ROI) for all new IT purchases. These demands, coupled with stringent high-availability and disaster-preparedness requirements, have made cost reduction a major challenge for CIOs and IT managers everywhere. Server virtualization can lower that TCO significantly.

CHALLENGE 2. SERVER SPRAWL: Data centers have come to rely on x86 servers to support organization growth and today's more widely distributed enterprises. This proliferation owes a great deal to the concept of distributed computing (the ability to spread server application loads across multiple tiers, different platforms and locations).

Another reason for this increased use has been the requirement by many of the application manufacturers to have applications deployed on dedicated hardware, and in some cases, dedicated database and operating systems.

CHALLENGE 3. LOW SERVER UTILIZATION: Industry-standard x86 systems continue to be the best-selling server platform. Processor, memory, network and disk speeds continue increasing while technologies such as multicore processor architecture continue to improve performance. However, most operating systems and applications can't make use of these performance increases. This is why the average server utilization rate is around 15 percent.

CHALLENGE 4. HIGH-AVAILABILITY COMPLEXITY: High availability is a series of measures undertaken to implement minimal to near-real-time fail-over for a particular application. Because of the variety of application architectures and operating systems available, high availability can be challenging to implement.

As the size of the data center grows, it becomes increasingly more complex to make the infrastructure highly available, and thus more costly to implement and maintain. Most organizations do not need

every system to be highly available. Systems that serve the network backbone, such as directory services, file and print sharing, e-mail, and enterprise applications fall into the high-availability category.

The same issues apply to setting up either a hot or cold disaster recovery site.

CHALLENGE 5. IMPROVED POWER AND COOLING EFFICIENCY: Data centers were originally built at a 1KW to 2KW per rack average. Today, newer systems such as blade centers, multiprocessor systems and storage arrays themselves consume 4KW of power. Analysts are now suggesting that new data centers should be built with a minimum of 9KW to 15KW per rack average.

This forces most data center designs to explore larger heating, ventilation and air-conditioning (HVAC) and water-based cooling systems. Additionally, most data centers do not receive volume discounts from utility companies due to the increase in power consumption, causing operational costs to rise continuously.

Client Virtualization

Desktops, notebooks, thin clients and other computing devices are in use throughout the workplace. Because of their popularity, organizations are struggling to find ways to manage and maintain these devices while simultaneously reducing costs and increasing end-user productivity. Overall, client virtualization can greatly simplify and lower both IT management and administration costs.

Client Systems

When building a client virtualization solution, the most important consideration is the end-user experience. Therefore, you need to determine the audience, not only in terms of what systems end users will employ (such as notebooks, desktops, tablet PCs, mobile devices, etc.), but also the locations from which they will connect, available bandwidth, the peripherals (such as printers) to which they will need to connect, and whether they have a single or multiple display.

For those users that require stringent security, solutions such as smart-card readers, biometric scanners and two-factor authentication tokens also require consideration.

Operating Systems

There are many ways to present an operating system to your computers. In a hosted model, the operating system can run on blade PC/workstations in the data center or on virtual machines on a hypervisor.

Client Virtualization Benefits

For most IT enterprises that have a variety of client devices, the following benefits of employing a client virtualization solution apply:

RAPID DEPLOYMENT: The timeframe to deliver new desktops and applications can range from days to minutes.

EFFICIENT PATCHING: Both operating system and application patching can be done quickly and reliably in a short period of time, as can rollback.

EASIER IMAGING: With client virtualization, the need to have multiple images for different hardware becomes a thing of the past. Maintaining fewer images and the ability to deploy them on demand makes imaging a painless task.

SECURITY: With the proper design, client virtualization can enable stringent security policies (once difficult to maintain) with a variety of client devices. This approach results in a consistent security policy from end to end.

REDUCED ENERGY COSTS: If the solution employs thin clients, the power/cooling footprint will reduce dramatically since most thin clients have no moving parts and require very little power.

Either way, a display protocol, such as remote desktop protocol (RDP), independent computing architecture (ICA) or remote graphics software (RGS) usually "presents" the operating system while the processing actually occurs on the hosted platform. In other words, your computers can be thin or thick since connecting to the remote systems requires minimal hardware.

However, hosting the operating system images on a server and then streaming the operating system to existing desktops presents another possible solution. This proves a great option for organizations looking to extend the lifecycle of existing desktops, as it doesn't involve any blade workstation or hypervisor investment in the data center.

Applications

With server-based computing, applications are hosted on a server and then delivered to users via sessions. These application-delivery solutions enable all of the processing to take place at the server itself. This is referred to as publishing applications.

Application streaming, a newer technology available from a number of manufacturers, focuses on isolation and streaming. Isolation

refers to technology that installs the application locally on a desktop but isolates it from other applications and processes so that it is completely contained.

This approach avoids the dynamic link library (DLL) conflict issues normally associated with running multiple versions of the same application on the same desktop. Streaming technology then delivers these applications on demand to the desktop and facilitates removal, upgrades and metering.

Another option to deliver applications would be the traditional method of installing software locally, either manually or with a managed software delivery technology. Some applications, such as antivirus technology, may require local installation because of the way they interact with the desktop operating system.

Management

When determining what devices, operating systems and applications make up your client virtualization solution, a number of important components related to management demand consideration.

PRINTING: This component has always represented a challenge for both physical and virtual worlds. Depending on the type of client virtualization solution used, the design elements have to be considered carefully. While printing in a server-based computing environment may prove tricky, hosted operating systems make it a little easier because the printing model doesn't change much.

SECURITY: When designing a client virtualization solution, the consideration of security becomes essential for most organizations because you may be delivering access to critical applications and data via the Internet to devices over which the organization may not have any control. So security should be scrutinized end-to-end to ensure the solution meets the organization's operations objectives.

USER PROFILES: If delivering a solution via a streamed or hosted desktop, the centralization of user profiles may become important in order to lock down desktops and deliver a consistent user experience across any system.

IMAGING: For more than a decade, many organizations have used imaging technologies to deliver a consistent image to desktops, notebooks and workstations. When considering client virtualization, most solutions already include this technology.

For example, Citrix Provisioning Server not only streams an operating system (via PXE Boot) to physical and virtual desktops, it also enables the streaming of a single image to those computers. It thereby saves a tremendous amount of disk space.

UPDATING: All desktops, notebooks, thin clients, applications, operating systems and their management applications will need patches and updates at some point during the lifecycle. Developing a strategy for deployment and rollback proves essential in a client virtualization environment because of all the intricate dependencies.

Although device updates will still require OEM tools, operating system and application patching will grow much easier.

Network Optimization

As more organizations utilize virtualization, the network plays an increased role in ensuring communication flows between fewer physical servers. As a result, organizations use network links more than ever before, and network redundancy becomes increasingly important.

Planning the Network

When designing a resilient network, the first step is to determine the requirements to support operations functions and develop a network strategy accordingly. The second step, the planning phase, includes both an accurate assessment of the current environment and a gap analysis to determine whether the existing infrastructure, sites and production environment can scale to include a new, resilient infrastructure.

This assessment should take into consideration the following:

- Current applications and data on the network, such as Voice over IP (VoIP), e-mail, structured query language (SQL), common Internet file system (CIFS), Internet and video-on-demand
- Virtualization and consolidation of server infrastructure
- Current network topology, including but not limited to: network devices, physical and logical links, external connections, frame types, routed and routing protocols, application-specific protocols and IP addressing schemes
- Traffic and network utilization analysis

Designing the Network

The third step in building a resilient network is the design of the network. The design must incorporate all gathered information concerning operations and technical requirements. It must also include specifications for availability, reliability, security, scalability and performance.

Network engineers commonly recommend designing a resilient network in modules. Modules allow an organization to provide the highest degree of resiliency by segmenting traffic and preventing a single point of failure.

A common best practice, aggregate redundant links at Layers 2 and 3, increases resiliency. Technologies such as EtherChannel, which combine switched or routed links into one logical link, effectively double the bandwidth on the link and minimize the convergence. Because the switch or router sees aggregated links as a single link, traffic continues to flow through the other links if one should fail.

Minding the Details of WAN Optimization

When implementing a WAN optimization solution, organizations need to factor in the following critical factors:

- Current WAN connection speeds
- Current WAN latency
- The age of the WAN routers
- The Internet operating system (IOS) of the WAN routers
- Current WAN utilization and TCP flows
- Proprietary or uncommon applications that may traverse the WAN
- Network infrastructure
- Multimedia or streaming content that traverses the WAN

WAN Optimization

Through wide area network (WAN) optimization, IT departments can provide service nearly as effective as local area networks (LANs) to branch offices over low-speed WAN links. WAN optimization accomplishes this feat in two ways: by optimizing the WAN and optimizing applications for WAN communications.

WAN optimization devices optimize WAN links in several ways. First, they implement a WAN optimized version of transmission control protocol (TCP). This version of TCP maintains large initial windows and enhancements to deal with WAN congestion. Additionally, advanced compression and disk caching contribute to minimizing WAN traffic.

WAN optimization devices also provide enhancements to optimize applications for WAN communications. Most commonly they optimize common protocols, such as file transfer protocol (FTP) for WAN communications. This reduces application ping-pong over the WAN, while advanced disk caching helps prevent redundant data traffic.

Application Networks

Traditional networks perform network-related decisions based on the packet. Application networks provide enhanced intelligence by examining packets at the message level to make network-related decisions based on the organization's policies.

Application networks have the ability to inspect the full message, including all content and headers, and can thus apply gradual policies to different types of applications within the same protocol. Through this deep inspection, these networks provide improved application availability, security and accelerations.

Through network intelligence, application networks can do the following:

- Enable disparate applications to communicate by appropriately routing application messages in the format expected by that destination.
- Enforce consistent security policies for application access and information exchange.
- Provide a high level of information flow visibility, including the monitoring and filtering of messages for both operations and infrastructure purposes.
- Enhance application optimization by providing application-level load-balancing, offloading security and XML operations, achieving TCP optimization and offering application-level caching and compression services similar to WAN optimization.

Storage Networks

Centralized storage stands as one of the keys to any consolidation project. Storage networks attach remote storage devices to servers in such a way that storage appears locally to the host operating system. To achieve this result, they interconnect storage devices and servers through an array of different protocols, most commonly Fibre Channel, iSCSI or InfiniBand.

Although they function in different ways, each of these protocols has the same goal: to provide lossless, low-latency access to shared storage.

The underlying principles of storage network design remain relatively straightforward:

- Plan a storage network topology that can handle the number of ports necessary now and into the future.
- Design with a given end-to-end performance and throughput level in mind, taking into account any physical requirements.
- Provide the necessary connectivity with remote data centers to handle the operations requirements of continuity of operations plans (COOP) and disaster recovery.

Data Center Optimization

One way to address the problems associated with server sprawl is through physical consolidation, where an organization reduces the total number of servers in use by merging the workload onto fewer servers. This allows them to make more efficient use of their computing resources, free up data center space, reduce power and cooling costs, and reduce complexity for easier management.

Blade Solutions Considerations

When an organization is shopping for a blade solution, it should consider these two important factors:

- **PORT COUNT:** Be sure that the port count matches your organization's needs, especially if the blades will be used for virtualization.
- **BLADE MANAGEMENT:** This is a key feature. Be sure to pick a management solution that is well designed and sets up with no hassle.

Blade Servers

The use of blade servers in the data center is one approach to physical consolidation. Blade servers are different than traditional rack-mount servers. Blade systems are built with a modular infrastructure that can share many resources with fewer components. Unlike rack-mount servers, blades do not have their own power supplies or fans. Rather, they share these components with other blades in a chassis that they all reside in.

Blade servers' consolidated design is more affordable to purchase and maintain than rack-mount servers. Less rack space is used. Blades offer an almost 20 percent reduction in server airflow and around a 30 percent power savings over traditional servers.

Deployment is much easier, too. A blade server can be set up in minutes. And best of all, the IT team can add resources to a blade setup without having to rewire the entire rack. That's a tremendous time saver.

Load-balancing

Load-balancing has become an increasingly popular option for optimizing in the data center, maximizing resource utilization and throughput and minimizing response time, while providing high availability with fail-over.

Load-balancing divides the amount of work that a computer has to do between two or more processors or computers so that the work gets done in the same amount of time and all network users get served faster.

Load-balancing is especially helpful in situations where it's difficult to predict the number of requests that will be issued to the network's server. Popular websites typically employ two or more web servers in a load-balancing setup. If one server gets swamped, the requests are forwarded onto another server with more capacity.

Power and Cooling Management

Power and cooling management can be defined as the process of designing a modular, energy-efficient system to reduce energy costs and limit server downtime. A fully integrated power and cooling strategy can help an organization address the following concerns:

- **GROWING POWER DEMANDS:** Consolidation strategies create higher density data centers and increased individual power consumption.
- **INCREASING POWER COSTS:** Every dollar spent on new hardware in the data center requires an additional 50 cents spent on power and cooling.
- **EXCESSIVE HEAT:** Higher density data centers create more hot spots.

In a typically dense data center, both rack-mount and blade servers often have trouble staying cool. These hot spots need direct cooling solutions to ensure that the servers continue to run properly. Putting an effective power and cooling strategy in place gives an organization's data center greater flexibility and maximizes its hardware lifecycle.

Organizations have four main power and cooling solutions to choose from:

- **ROOM ORIENTED:** One or more air-conditioning units distribute air through a duct system to lower the temperature of the entire room.

- **ROW ORIENTED:** Air-conditioning units are mounted either directly above or below equipment racks and can be adjusted to the unique needs of each row.
- **RACK ORIENTED:** These cooling systems are dedicated to specific racks and are mounted within each rack.
- **MIXED COOLING DESIGN:** The most effective solution combines all of the above options.

Hosted and Managed Services

Some organizations may opt to completely forgo having a data center and turn over the operation of their network to a commercial hosting center. These kinds of hosted services operate much like a utility, offering enterprise-class service in an on-demand and usage-based model.

Here are some of the common services available through hosted services:

- **INTERNET:** connectivity through 100Mbps or 1Gbps connections to the network
- **WAN:** configure, troubleshoot and optimize WAN network connections
- **FIREWALL:** virtual firewalls and multiple firewall interfaces
- **DATA STORAGE:** on-demand storage capacity and management services
- **DATA BACKUP:** 24x7 availability of mission-critical data and applications
- **DISASTER RECOVERY:** hot-site recovery, virtualized hot server and cold-site recovery
- **INFRASTRUCTURE:** high-performance, fault-tolerant network and systems infrastructure

Storage Consolidation

One of the more popular approaches to storage consolidation is storage virtualization, which abstracts the physical storage subsystem and allows the creation of a new virtual type LUN (logical unit number) that is disconnected from the physical storage it is attached to. This allows data to be moved from one subsystem to another without incurring any outage or the need to physically move the data.

By virtualizing the storage subsystem, an organization gains many benefits:

- **MANUFACTURER INDEPENDENCE:** Storage virtualization allows seamless migration between different subsystems regardless of the manufacturer. At any point an organization can switch manufacturers/subsystems to better meet current needs.
- **STORAGE TIERING:** Data can move from high-priced/high-performance storage to low-priced/lower-performing storage as the data's value decreases over time.
- **STORAGE EFFICIENCY:** Because data is easy to assign and move around, organizations can run subsystems at higher efficiencies without concern regarding procurement cycles.
- **STORAGE MANAGEMENT/PERSONNEL:** Administrative tasks that traditionally were done during weekend outages can now be performed during the production day. Storage administrators are more satisfied with their workloads and tend to turn over less frequently.

Test Your Apps

One of the biggest pitfalls for data center consolidation projects is the quirks found in individual applications. Not all applications are good candidates for virtualization, and not all virtual applications play together nicely on the same host. You'll need to test each one at maximum capacity to determine where and when to virtualize.

Storage Area Networks

As storage virtualization becomes more popular, networked storage remains popular. With networked storage, the data already resides on a shared disk array, which speeds the process and allows organizations to take greater advantage of virtual machine technology. There are two forms of networked storage: basic network attached storage (NAS) and higher-speed storage area network (SAN).

A SAN connects separate disk arrays scattered over a network into one monolithic virtual storage device that can be managed uniformly. What differentiates a SAN from a standard NAS system is high speed.

SAN solutions move applications across an enterprise instantaneously and transparently to end users. They are ideal for high-performance applications. And they provide flexibility, higher utilization rates and lower costs, especially when combined with a server blade system.

Data Storage

The raw storage (LUNs, disk drives, storage subsystems) referred to so far is different than the actual data residing on top of the storage infrastructure. The data itself still needs to be backed up to additional

devices in case of drive or subsystem failure. In the past this backup was typically done to tape.

As the volume of data has grown, IT administrators have recognized that significant portions of data, though required to be saved and accessible, aren't being accessed with much frequency. Backup software manufacturers responded with archiving software.

Utilizing archiving software, data that is intermittently accessed can be moved to lower cost alternatives such as tape or slower disk. One of the only noticeable drawbacks to this approach is a brief delay while the data is being brought back from the slower device.

Data Deduplication

The latest storage advancement is the ability to eliminate duplicate data from even the subfile level. With earlier storage options, if a small amount of data changed in a larger file, the entire file was rewritten and viewed as new. Imagine 20 people all have the same file saved and a small amount of data is changed and sent out to those same 20 people; you now have 20 new files.

Data deduplication not only recognizes these files as the same, it saves only one copy of the file and references the others through a sophisticated set of algorithms. And if one person changes a portion of one file, data deduplication saves only the small portion of changes and not the entire file. With this example, a nearly 20:1 savings in space can be gained.

Manufacturer Options

SERVER VIRTUALIZATION: VMware stands at the forefront of virtualization software today, with its VMware Infrastructure suite of products that enable consolidation, high availability and a more efficient use of resources. However, newer products such as Citrix XenServer and Microsoft Hyper-V have begun to compete in this space.

Although most servers are compatible with server virtualization software, HP, Sun and IBM servers are valued for their virtualization heritage. Also, their established product lines have key enterprise features and functionality. The last component, storage, has a number of solid contenders to choose from including IBM, NetApp, EMC, HP and LeftHand Networks.

CLIENT VIRTUALIZATION: In a hosted model, Windows runs on blade PC/workstations in the data center or on virtual machines on a hypervisor. VMware View and Citrix XenDesktop both offer powerful solutions for hypervisor-based virtual desktop connectivity.

Hosting the Windows images on a server and then streaming the operating system to clients is another approach. Citrix revolutionized the way applications are delivered with WinFrame and MetaFrame, and its solutions remain the standard in many organizations (with its XenApp product). Microsoft Terminal Services is another option for hosting on the server.

Streaming application-delivery solutions enable all of the processing to take place on the server itself. Microsoft App-V, a part of the Microsoft Desktop Optimization Pack (MDOP), Citrix XenApp Client-Side and VMware ThinApp are options for application-delivery solutions.

Another option to deliver applications is the traditional method of installing software locally, either manually or with a managed software delivery technology such as Altiris' (Symantec) Software Delivery Solution or Microsoft's System Center Configuration Manager.

NETWORK OPTIMIZATION: Optimizing the network has to start with an accurate assessment. Cisco offers Network Based Application Recognition (NBAR), a tool that facilitates the viewing of interface statistics, CPU and memory utilization, netflow and application flows. When looking for a storage consolidation solution, EMC, EqualLogic, Hitachi, HP, IBM and LeftHand Networks all offer viable options.

DATA CENTER OPTIMIZATION: For blade server and processor solutions, HP's ProLiant BL Series systems and IBM's eSeries BladeCenter are both strong options. Load-balancing hardware solutions are offered by Coyote Point and Barracuda. For power and cooling solutions in the data center, Eaton, APC and Liebert are the market leaders.

STORAGE CONSOLIDATION: EMC, HP, IBM and NetApp are the top manufacturers in the storage consolidation industry. EMC offers its CLARiiON CX4 series storage platform. HP has the LeftHand NSM line of SAN storage appliances. IBM produces the DS4800 disk storage system. NetApp offers the FAS3100 series storage system.

3 Load-balancing Features to Focus On

When researching load-balancing solutions, organizations should give careful consideration to the following features:

- Fail-over features
- Availability
- Overall performance